Research Bulletin

December 2016
Volume 1 • No. 2

CENTRAL BANK OF LESOTHO

$$y_{it} = \propto y_{i,t-1} + x_{it}\beta + (\eta_i + v_{it})$$

$$U(c_t, c_{t+1}) = \mu(c_t) + \beta E_t[\mu(c_{t+1})])$$

$$\dot{k} = f(k) - c - (n + g + \delta)k$$

Research Bulletin

Produced by Research Department • Central Bank of Lesotho • December 2016 • Volume 1 • No. 2

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THE LIBERALIZATION of exchange control regulations by the Common Monetary Area (CMA) countries and Lesotho in particular, is a commendable milestone though there is still a long way towards full liberalization. As indicated in the National Strategic Development Plan (NSDP) for 2012/13-2016/17, it is part of the Government of Lesotho's (GoL's) strategy to encourage cross-border trade and for the country to operate as a liberal open economy. In a nutshell, the study reveals that the CMA countries are at par in terms of exchange control liberalization on a number of transactions. However, South Africa (SA) is the most liberalized within the region and this is mainly attributable to the fact that it is more developed and, also has more developed capital and financial market compared to the rest of the CMA member countries. In a number of transactions, Lesotho is more or less liberalized than Namibia and Swaziland, however, in such instances - the gap is narrow.

JEL Classification: E49, E58, E59
Key words: Current Account, Capital and Financial Account, Exchange Control Liberalization, Exchange Control Regulations

THIS PAPER BUILDS on previous work by the Central Bank of Lesotho to estimate Lesotho's yield curve. Its purpose is to contribute to capital market development goals by helping encourage corporate bond issuances, improving pricing of financial products, and providing guidance as to yields that will be achieved at government bond auctions. Since South African zero-coupon yields are available on a daily basis, the model developed in this paper harnesses this information to estimate Lesotho's zero-coupon yield curve at any date. The model performs well as measured by both in-sample and out-of-sample testing, producing negligible bias.

JEL Classification: G12, E43, E47
Key words: Zero-Coupon Yields, Government Bonds, Yield Curve

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THE PROLIFIC USE of mobile telephones in developing countries has given birth to financial innovations such as mobile money. As a result, the use of mobile money has expanded the grid of financial services to include previously unbanked populations in Africa. This development is a harbinger for increased financial intermediation and positive spill-overs in terms of credit growth to entrepreneurs and faster economic growth. Based on monthly data for the period 2013m7 – 2015m12, this study employs time series techniques to unpack the proliferation of mobile money and its attendant impact on financial inclusion in Lesotho. The findings reveal existence of long-run steady state relationship between financial inclusion and mobile money in Lesotho and that mobile money Granger causes financial inclusion both in the short-run and long-run in Lesotho. Therefore, financial inclusion policies should be directed towards leveling the playing ground for mobile money to flourish to create a more financially inclusive society in Lesotho.

JEL Classification: C01, C22, C87, G23, O10, O30
Key words: Financial Inclusion, Mobile Money, Credit Growth

THIS PAPER INVESTIAGES the spill-over effects of South Africa's economic growth on the Common Monetary Area (CMA). It uses simple correlation analysis and panel data econometric techniques (Fixed Effects, Difference and System Generalised Methods of Moments and Panel Vector Autoregression). The findings reveal that even though South Africa is closely linked with the Lesotho, Namibia and Swaziland (LNS) countries through trade, financial and institutional linkages, economic growth in South Africa does not appear to have a significant spill-over effects on the CMA. However, a simple correlation analysis shows that there is indeed a statistically significant positive relationship between economic growth in South Africa and economic growth in the CMA region, implying that a slowdown in SA economic growth is likely to have negative implications on the CMA.

JEL Classification: C13, C33, C36, E60, O41, O47.
Key words: CMA, South Africa, Economic Growth, Spill-overs.

Exchange Control Regulations In the CMA: Is Lesotho Lagging Behind?

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Key words:

Current Account, Capital and Financial Account, Exchange Control Liberalization, Exchange Control Regulations

JEL Classification: E49, E58, E59

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1 INTRODUCTION

EXCHANGE CONTROLS are policies that countries design and implement with the general objective of limiting and/or redirecting their foreign exchange transactions. Foreign exchange in Lesotho is defined as any currency, or means of payment, that is not legal tender in Lesotho. Thus, the South African rand and any other rand-denominated means of payment is not considered as foreign exchange since it circulates freely in Lesotho amid the Common Monetary Area (CMA)[3] agreement. There are many purposes behind exchange controls[4] and these have evolved quite interestingly over time. According to Neely (1999) exchange controls were used to maintain a tax base in order to finance wartime expenditures during World War I. During the Great Depression of the 1930s exchange controls were intended to enhance the ability of countries to boost their economies without the threat of capital flight. During the fixed exchange rate regimes of the Bretton Woods era countries limited foreign exchange transactions to minimize balance of payments (BOP) challenges.

Similar to many other countries, Lesotho has exchange control regulations in place and these are derived from the country's membership to the CMA. Exchange control regulations in the CMA were initially introduced through the South African Currency and Exchange Control Act 9 of 1933, and this was later changed to Exchange Control, Orders and Rules of 1961 (Ellyne and Letete, 2012). According to Ellyne and Letete (2012), the objectives behind the introduction of exchange controls in the CMA were to minimize the outflow of capital during the apartheid regime in South Africa (SA) with the purpose of maintaining adequate levels of foreign reserves and national savings, and therefore preventing erosion of the tax base on interest and dividends. They were also intended to enable foreign owned companies to bring capital from external sources to support SA's economy while controlling their domestic borrowing.

However, these regulations and rules continued to be amended as the CMA countries progressed with their respective liberalization processes. According to the CMA agreement, member countries are committed to maintaining exchange controls that are in line with those prevailing in South Africa (SA). In this regard, Article 5 of the CMA agreement states that the enactment, modifications and liberalization of exchange control regulations for all the CMA countries closely follow South African regulations. The Article further requires the exchange control regulations of Lesotho, Namibia and Swaziland (LNS countries) to be similar or tighter than those in effect in SA, but not more relaxed. Individual countries are responsible for implementation of those regulations, and usually this responsibility is vested with the respective Ministries of Finance, which usually delegates such responsibility to the Central Bank.

In terms of institutional arrangements, the exchange control regulations in the CMA allow for free movement of capital between member states. These regulations are enacted in line with the CMA agreement of 1986 and allow for free flow of funds within the CMA countries, while concurrently imposing common restrictions to the third parties around the CMA countries. As articulated in Article 3 of the CMA Agreement, there shall be no restrictions imposed on the transfer of funds (current or capital transactions), to or from any member country.

[3] Comprises: Lesotho, Namibia, South Africa and Swaziland.
[4] Both on the Current account, and capital and financial account.

Liberalization of exchange controls in the CMA implies that no single member state can pursue unilateral exchange control liberation, it remains a consultative process led by SA. The member countries have been progressively liberalizing their exchange control systems since 1994 (Ellyne and Letete, 2012). The gradual approach of liberalizing involves a process of increasing the limits on permitted foreign exchange transactions. As the limits become sufficiently high and are no longer binding, then they will be abolished. Economic reasons for maintaining exchange controls include: increasing the domestic savings and investment by residents; protecting the financial sector from sudden swings in capital flows and exchange rate risks; and minimizing money laundering[5].

The objective of this paper is to assess the current status of exchange control regulations in the CMA in order to gauge Lesotho in comparison with its CMA counterparts. The rest of the paper is structured as follows: after this introduction, section 2 briefly reviews the empirical literature behind exchange control regulations, while section 3 summarises the evolution of exchange control regulations across the CMA countries. The cross-country comparison is captured in section 4. Section 5 concludes the paper and offers some policy recommendations for consideration.

[5] Blueprint of the development of the Foreign Exchange Market in Lesotho, July 2002

2 EMPIRICAL LITERATURE

The literature on exchange controls is quiet scarce and the findings regarding the effectiveness of controls in curtailing capital flight and on their impact on macroeconomic outcomes are diverse. On the one hand, the experiences of China and India during the Asian crisis of 1997-98 seem to suggest that the controls on capital transactions may have contributed in reducing the vulnerability of these countries to the effects of the crisis. According to Ariyoshi et al. (2000) the controls helped to shift the composition of capital inflows toward longer-term flows. Furthermore, in both countries, enforcement of the controls was facilitated by strong administrative capacity. Nonetheless, other factors including strong external positions with ample foreign exchange reserves, larger sizes of the domestic markets, relatively weak trade and financial linkages with the rest of the world may have also played a role in reducing China and India's financial vulnerability.

On the other hand, Neely (1999) contends that the exchange controls resulted in costs and distortions leading to their gradual removal by developed countries from the 1960s and the less developed countries (LDCs) began to liberalize in the 1980s. According to the Organization for Economic Corporation and Development (OECD) in 1993, the decision to dismantle all capital controls in Australia in December 1983 and in New Zealand in December 1984 was preceded in each case by episodes of massive capital flight that the controls were unable to arrest. The results of the study by Tamarisa (1998) pointed out that while controls on current payments and transfers are a minor deterrent to trade, capital controls significantly reduce exports into developing and transition economies. Controls could also discourage foreign investments as some investors could view their existence as an indication that more stringent controls could be utilized in periods of economic crisis. Neely (1999) further showed that the use of controls results in administrative costs and also that their evasion fuels corruption. There appears to be a general view that exchange controls may temporarily relieve pressures on the BOP, but their positive impact cannot be sustained when the fundamental causes of the imbalances are not dealt with. Ariyoshi et al. (2000) and Neely (1999) observed that in the absence of adequate macroeconomic and financial policies, capital account liberalization may increase vulnerability to external and domestic shocks.

3 COUNTRY STUDIES

3.1 Case of entire CMA

As the CMA as a whole, several exchange control relaxations are in place. Among these, a single discretionary allowance of R1 million per adult and R200,000 per child per calendar year for purposes of travel, study allowance, gifts, donations and maintenance was introduced. This was in addition to R2 million individual foreign capital allowances. There was also removal of restrictions on payments for services rendered by non-residents, including directors' fees paid to non-residents. Furthermore, there was an increase in the prudential limit for direct and indirect foreign exposure by authorised dealers up to 25 per cent of their assets, excluding total shareholders' equity. Although there has been some relaxation of several exchange controls within the CMA, there are still some controls that are remaining.

- *Current account*

Pre-payment for imports of capital goods is still being limited to 50 per cent of ex-factory cost across all CMA member states. Second, there is a requirement to surrender unused foreign exchange from travel allowance within 30 days and surrender all foreign exchange holdings/earnings by individuals within a period of 30 days across all CMA countries. Third, in Lesotho, Namibia and Swaziland (LNS) countries, exporters are required to surrender their exports proceeds to banks within 180 days.

- *Financial account*

All outwards foreign direct investment (FDI) in excess of a given limits still needs approval of exchange control in SA while in other CMA countries, any outward investment (not necessarily FDI) needs approval from Exchange Control Departments. Authorised Dealers (ADs)[6] are allowed to undertake foreign investment based on a Macro Prudential Limit (MPL) of 25 per cent of assets. Institutional investors such as pension funds are subject to MPL of 30 per cent or 35 per cent of their assets in the CMA. Corporate subsidiaries are not allowed to lend to their parent companies outside the CMA. Even though there are similarities in the CMA as a whole, the stages of liberalization differ across respective countries. Therefore, this section briefly looks at each individual country's progress (to-date) as far as exchange control liberalization process is concerned. For detailed exchange control regulations for each respective country, please refer to the appendix.

[6] These are usually commercial banks and their function is to assist the central bank in administering exchange controls

3.2 Case of Lesotho

The exchange control policy in Lesotho is the responsibility of the Ministry of Finance (MoF), but this has been delegated to the Central Bank of Lesotho (CBL). The exchange controls are administered through the Exchange Control Order No.175 of 1987 and are subject to Exchange Control Regulations of 1989 (CBL, various issues). ADs in Lesotho are the commercial banks and they are mandated to enforce exchange controls. The banking sector in the country is largely under-developed[7]. The CBL accumulates foreign exchange largely from government transactions, Southern African Customs Union (SACU) receipts and rand compensation.

- *Current account*

Despite on-going liberalization, certain restrictions still remain, such as restrictions on advance payments for importation of capital goods to 50 per cent of ex-factory costs. Import permits are required by the Ministry of Trade and Industry for certain classified commodities (this is more of a trade restrictions), and these permits specifically state the amounts of the goods that may be legally imported into the country. An exporter requires repatriation of export proceeds and has to complete Form 178[8] and have it stamped/endorsed by the commercial bank. In doing so, the commercial banks have to guarantee the repatriation of export proceeds within 6 months. However, Lesotho and hence the CMA has relaxed the requirement of surrendering export proceeds to commercial banks and this allows authorised companies to hold foreign exchange in the local foreign currency accounts for as long as they wish. Both the services and income transfer components within the current account are fully liberalized.

- *Capital and financial account*

Lesotho has partially liberalized these accounts with non-CMA and fully liberalized with the CMA. All controls on inward financial flows are liberalized and non-residents are allowed by law to own and invest in fixed property in the country. However, there are still remaining limits to certain outwards flows (for both short-term and long-term capital) and these limits only apply to transfers to non-CMA countries. Lesotho residents are subject to a limit of M4 million per annum to invest outside the CMA for: fixed investment, equity bonds and money market portfolio investment instruments, and prior approval by the Central Bank is required. Furthermore, companies are not allowed to keep offshore accounts in excess of M4 million per annum. The transfer of dividends to non-CMA countries is not subjected to any limit as long as there are legal supporting documents such as the audited financial statements declaring dividends for the company[9].

[7] Comprising of only four commercial banks (First National Bank, Nedbank, Standard Lesotho Bank and Postbank)
[8] This form is a declaration of goods exported for sale abroad.
[9] This may lead to tax evasion and high capital outflows.

3.3 Case of Namibia

The exchange control in Namibia is regulated by the Currency and Exchanges Act, 1933 (Act No.9 of 1933) and the Regulations. Similar to Lesotho, the exchange control policy in Namibia is the responsibility of the Ministry of Finance, but this has been delegated to the Bank of Namibia (BON) subject to the Exchange Control Regulations and Article 46 of the Bank of Namibia Act, 1997 (Act No.15 of 1997). The BON has delegated several exchange control functions to the commercial banks and these are appointed as ADs, in foreign exchange and they are mandated to assist the BON with administration of exchange controls. Just like Lesotho, exchange controls regulations in Namibia are governed by the CMA agreement. Similar to all the LNS countries, the liberalization of exchange controls in Namibia follows closely the SA liberalization process and the only differences are attributable to the limits set under certain exchange control relaxations.

- *Current account*

ADs are allowed to provide foreign exchange for advance payments up to 100 per cent of ex-factory cost of capital goods to be imported into Namibia to a total value not exceeding N$20 Million. Payments for the importation of capital goods in excess of N$20 Million may only be provided up to 50 per cent of the ex-factory cost of the goods to be imported. All exports, except those which have been exempted administratively, must be supported by the prescribed declaration on Forms F178 and NEP[10] (depending on whether exported goods are for sale or not for sale abroad) irrespective of the country of destination of the goods.

- *Capital and financial account*

Namibia private individuals (natural persons) are allowed to invest up to a total of N$4 Million outside the CMA, but prior to the transfer of any funds, a duly completed tax clearance certificate issued by the Ministry of Finance must be presented to the AD. Namibian residents who are taking up permanent residence in any country outside the CMA are allowed to remit foreign capital allowance of N$4 Million and N$8 Million of individual persons and family units, respectively. Corporate entities in Namibia are allowed (upon approval by the BON) to transfer any amount in the form of FDI elsewhere in the world, provided a longer term benefit to Namibia can be demonstrated. Similar to SA, Namibia has moved away from the traditional exchange control framework, aimed at preventing the outflow of foreign exchange, towards a new thinking entailing direct regulation of macro-prudential financial management and anti-money laundering concerns, hence changing the organizational structure by moving exchange control department into the Financial Intelligence Unit (FIU).

[10] This form is a declaration of goods exported NOT for sale abroad, e.g. for exhibitions purposes, repairs, temporary exportation etc.

3.4 Case of South Africa

The exchange control regulations in SA were initially introduced in 1933 through the Currency and Exchange Control Act 9 of 1933, which were later refined to Exchange Control, Orders and Rules of 1961. Similar to the rest of the CMA member countries, SA has also adopted a gradual approach towards liberalizing exchange controls since 1994 and, therefore the regulations and rules have been amended from time to time as the country progressed with its exchange control liberalization efforts. The latest regulations and rules operating exchange controls are Government Notice R.9 in Government Gazette No.33926 of 14 January 2011. Similar to other CMA countries, the responsibility of exchange control policy is vested with the National Treasury, however, the responsibility for implementation of these controls has been delegated to the South African Reserve Bank (SARB). Similarly, ADs have been appointed to implement these regulations. As indicated earlier, SA shifted from restrictive exchange controls to prudential regulations, reflecting a change in objective to include; financial soundness of institutions and stability of the financial system as a whole. Consequently, Exchange Control Department within the SARB was renamed the Financial Surveillance Department (FSD).

- *Current account*

Similar to other CMA member countries (except Namibia), advance payments for importation of capital goods is limited to 50 per cent of ex-factory costs on capital goods exceeding R10 million and 100 per cent on capital goods not exceeding R10 million. The SARB removed obligation to convert foreign earnings to domestic currency within 180 days by businesses engaged in foreign trade or earning foreign currency and this allowed such businesses to hold their repatriated earnings in their foreign currency accounts (FCAs). Furthermore, the use of Form F178 was abolished and this has reduced the administrative procedures and therefore improved efficiency and it is more cost effective.

- *Capital and financial account*

Restrictions on payments of services rendered by non-residents, including directors' fees paid to non-residents were removed. Furthermore, international companies with headquarters in SA (provided they meet prescribed shareholding and asset requirement criteria) are allowed to register for approval with the FSD to invest offshore without any restrictions.

3.5 Case of Swaziland

In Swaziland, the enabling legislation is the Exchange Control Order, 1974 and the Exchange Control Regulations issued under Legal Notice No.2 of 1975. The exchange control functions and duties are delegated to the Central Bank of Swaziland in terms of Section 48 of the Central Bank of Swaziland Order, 1975. The exchange control regulations in Swaziland are split into three broad clauses; prohibitive, mandatory and punitive. The prohibitive clauses tabulate what may not be done without administrative authorisation, the mandatory clauses detail what must be done in particular circumstances, and the punitive clauses specify the penalties for contraventions.

- *Current account*

Similar to all other CMA countries (Except Namibia) the limit on the advance payments for capital imports is 50 per cent of ex-factory cost for goods in excess of R10 million and 100 per cent for goods not exceeding R10 million. There are restrictions on goods related to second hand goods and pharmaceuticals, and both require an import permit and this is issued by the Ministry of Finance and it states the amount of the goods that may be legally imported. As far as exports are concerned, just like in the LNS countries, an exporter requires repatriation of export proceeds and has to complete Form 178 and have it stamped/endorsed by the commercial bank. In doing so, the commercial banks have to guarantee the repatriation of export proceeds within 6 months. Obligations to convert foreign earnings to domestic currency by businesses engaged in foreign trade or earning foreign currency were removed. This allowed such businesses to hold their repatriated earnings in their FCA as long as they wish.

- *Capital and financial account*

The biggest source of FDI is China and therefore Chinese textile investors have been given special dispensation from exchange controls. These are allowed to keep all their export proceeds offshore and only repatriate the funds needed to pay their local workers and other local operating expenses.

4 CURRENT STATUS: CROSS-COUNTRY COMPARISON

There are still a number of exchange controls in the CMA. There are a few areas in the different accounts where the CMA countries impose exactly the same restrictions while there are also some differences, particularly with respect to the limits imposed on different transactions.

4.1 Similarities throughout the CMA

- Export proceeds should be repatriated within 180 days of their accrual.
- Central Bank approval is required for barter or counter trade of any value.
- The limit on travel allowances is up to a discretionary allowance of R1.0 million per adult and R200 000.0 per child per annum.
- Central Bank approval is required for advance payments for tours and hotel accommodation, which are limited within the discretionary allowance of
- R1.0 million per adult and R200 000.0 per child per annum.
- Export of foreign bank notes by resident travellers is allowable within the discretionary allowance and when they return they may import bank notes within the amount originally exported.
- Non-resident travellers may export foreign bank notes against proof of prior importation.
- Prior central bank approval is required for emigrant settling-in allowances above R4.0 million per individual and R8.0 million per family unit.
- Central bank approval is required for residents temporarily abroad allowances, access to which is also limited within the discretionary allowance.
- Residents may not issue guarantees to non-residents without prior approval from the central bank.
- Residents may not enter into foreign loan agreements as borrowers without prior approval of the central bank.
- Foreign currency that has accrued to resident investors should be declared within 30 days of its accrual.
- Accrued foreign assets should also be declared within 30 days of their accrual.
- Residents may enter into loan agreements as lenders to non-residents without prior approval of the central bank for loans to the tune of R1.0 million and less, otherwise approval is required.
- Transfers of monetary gifts to non-residents and residents temporarily abroad of amounts that fall within the discretionary allowance of R1.0 million per calendar year may be effected without prior approval of the central bank.

4.2 Transactions on which Lesotho is more liberalized than other CMA countries

- Lesotho, SA and Swaziland are liberalized and Namibia is the only CMA country that imposes an obligation that export proceeds in onshore customer foreign currency (CFC) accounts should be converted to local currency within 180 days of accrual.
- While Lesotho and SA require prior CB approval for exports of personal effects of travellers worth R200 000.00 and above Namibia and Swaziland impose a lower limit of R50 000.00.
- Advance payment for imports of capital goods is restricted to 50.0 per cent for goods of ex-factory cost of R10.0 million or more while 100.0 per cent is allowed for goods costing less for Lesotho, SA and Swaziland and 100.0 per cent of ex-factory cost for goods amounting to R20.0 million for Namibia.
- Lesotho, Namibia and SA impose a limit of R25 000.00 for bank notes that may be exported (imported) by resident (non-resident) travellers and they are more liberalized than Swaziland whose limit is R15 000.00.
- Retirement funds can hold foreign portfolio investments of up to 25.0 per cent of the total retail assets in Lesotho and SA and only 20.0 per cent in Swaziland. The limit is 35.0 per cent of total assets in Namibia.
- Alimony is limited within the discretionary allowance in Lesotho and SA and a limit of R9 000.00 per month is imposed by Namibia and Swaziland

4.3 Transactions on which Lesotho is less liberalized than other CMA countries

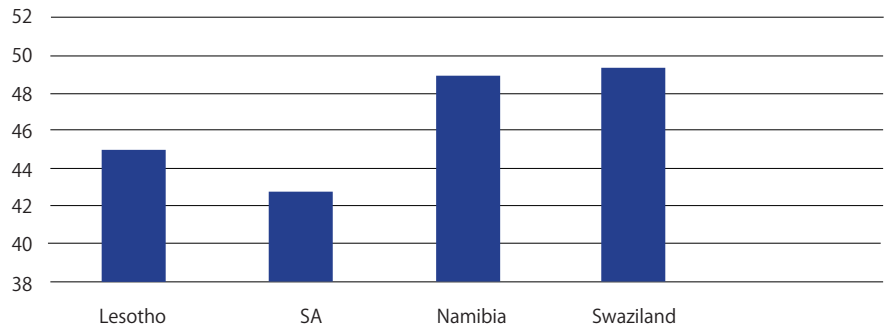
- Regarding emigrants' household and personal effects and motor vehicles SA is fully liberalized followed by Lesotho which imposes a limit of R2 000 000.00 while Namibia and Swaziland are less liberalized with a limit of R1 000 000.00.
- Lesotho and Namibia allow the use of credit cards up to a maximum of R20 000.00 while SA and Swaziland are more liberalized at R50 000.00.
- Lesotho and SA restrict study allowance for student accompanied by spouse to R1.5 million and are less liberalized than Namibia and Swaziland whose limit is R2.0 million.
- On the financial account, concerning outward FDI, SA limits foreign bank accounts that private individuals may maintain and investments on fixed property, equity, portfolio investment, bonds and money market instruments to R10.0 million while the limit is R4.0 million for the same transactions in the rest of the CMA countries.
- With regard to holding of foreign portfolio investments by Long-term insurers, SA is more liberalized because it allows 35.0 per cent of total retail assets with linked companies. Lesotho is more liberalized than Swaziland..

4.4 Summary

The detailed tables in the appendix depict that in most instances, the CMA countries impose exactly the same restrictions with exactly the same limits on a number of transactions. However, there are still some areas of variations among the CMA countries. There are a few areas where Lesotho imposes more liberal limits and in all the cases it shares this with one or two other CMA countries. There are also a few cases where Lesotho is less liberalized compared with other CMA countries (See the appendix for detailed current status on exchange control regulations in the CMA).

Similar findings can also be observed when we analyse the Exchange Control Restrictiveness Indices (ECRI) calculated for the entire region by Ellyne and Letete (2013). The ECRI translated 153 quantitative and qualitative exchange control restrictions into a single index of easily accessible and understandable indicators[11]. Figure 1 shows that in 2013, SA was the most liberalised country followed by Lesotho, and then Namibia. Furthermore, the figure depicts that Swaziland is the less liberalised country in the CMA.

Figure 1 Exchange Control Restrictiveness Indices for the CMA - 2013)



Source: Ellyne and Letete (2013)

[11] The indices were calculated for the entire SADC countries and an index is structured in such a way that a higher (lower) number represents greater (lesser) restrictiveness. For detailed description of ECRI, see Ellyne and Letete (2012).

5 CONCLUSIONS AND RECOMMENDATIONS

The liberalization of exchange controls by the CMA countries and Lesotho in particular, is a commendable milestone though there is still a long way towards full liberalization. The CMA countries are at par in liberalizing a number of transactions. SA is the most liberalized within the region and this is largely attributable to the fact that it is more developed and has more developed capital and financial markets compared to the rest of the CMA member countries. In a small number of cases where Lesotho is more or less liberalized than Namibia and Swaziland, the gaps are narrow. These findings are in line with the recently estimated Exchange Control Restrictiveness Indices (ECRI) by Ellyne and Letete (2013).

Figure 1 depicts that ECRI for 2013 was estimated at 42.7, 44.8, 49.0 and 49.6 for SA, Lesotho, Namibia and Swaziland, respectively. Thus reiterating the fact that SA is the most liberalized country in the CMA, followed by Lesotho, then Namibia and least liberalized, Swaziland. Therefore, Lesotho should continue with the exchange control liberalization that mainly responds to liberalization developments in SA as dictated by its CMA membership. It is important for Lesotho and other CMA countries to ultimately attain full liberalization because while there seems to be a consensus that exchange controls may minimize pressure on the BOP and help maintain adequate levels of reserves, their effectiveness may diminish over time as people find means and ways of evading them.

As indicated in the National Strategic Development Plan (NSDP) for 2012/13-2016/17, it is part of the Government of Lesotho's (GoL's) strategy to encourage cross-border trade and for the country to operate as a liberal open economy. Therefore, as the country continues with liberalization of exchange controls it should also strengthen macroeconomic policies relevant for maintaining foreign exchange reserves at levels that are commensurate with maintenance of the fixed exchange rate regime. Amongst others, these include policies aimed at enhancing fiscal prudence, especially in the wake of dwindling SACU revenues and expanding the economy's foreign exchange earnings. In addition, in line with OECD (1993) the necessary measures would have to be undertaken to ensure that liberalized transactions are strictly undertaken through the banking system with the objective of combating tax evasion and money laundering. The financial institutions and the tax administrators would have to be capacitated and prudential supervision and regulation of the financial sector would have to be tightened in order to minimize excessive risk taking that could arise as the lack of controls is likely to be taken advantage of.

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APPENDICES

Table 1: Exports

Type of Transaction	Exchange Controls				
	South Africa	Lesotho	Namibia	Swaziland	Comments
1. Current Account					
1.1 Merchandise Exports					
Period for repatriation of exports proceeds	180 days	180 days	180 days	180 days	All CMA countries are at par.
Obligation to convert export proceeds in onshore CFC accounts	No obligation	No obligation	should convert to local currency 180 days from accrual	No obligation	Lesotho, SA and Swaziland are liberalised, Namibia is the only one with a restriction.
1.2 Other Exports					
Limit for which prior CB approval is required for numismatic items	R300.00	0	0	R300.00	Lesotho and Namibia are less liberalised than SA and Swaziland.
Limit for which prior CB approval is required for personal effects of travellers	R200 000.00	R200 000.00	R50 000.00	R50 000.00	Lesotho & SA are more liberalised than Namibia and Swaziland.
Limit for which prior CB approval is required for emigrants' household and personal effects and motor vehicles	CB approval not required at all	R2 000 000.00	R1 000 000.00	R1 000 000.00	SA is fully liberalised. Lesotho is more liberalised that Namibia and Swaziland.

Table 2: Imports

Type of Transaction	Exchange Controls				
	South Africa	Lesotho	Namibia	Swaziland	Comments
1.2 Merchandise Imports					
Limit for which prior CB approval is required for imports of capital goods	ex-factory cost > R10 million	ex-factory cost > R10 million	ex-factory cost > R20 million	ex-factory cost > R10 million	Lesotho is at par with SA and Swaziland and the three are less liberalised than Namibia.
Limit for which prior CB approval is required for barter or counter trade	No limit	No limit	No limit	No limit	Barter or counter trade is not liberalised throughout the CMA.
Limit on advance payment for capital goods	50.0% of ex-factory cost for goods > R10 million and 100.0% for goods < R10 million	50.0% of ex-factory cost for goods > R10 million and 100.0% for goods < R10 million	100.0% of ex-factory cost for goods > R20 million	50.0% of ex-factory cost for goods > R10 million and 100.0% for goods < R10 million	Lesotho is at par with SA and Swaziland and the three are less liberalised than Namibia.
Limit on the use of credit cards	R50 000.00	R20 000.00	R20 000.00	R50 000.00	Lesotho is at par with Namibia and are less liberalised than SA and Swaziland.

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Table 3: Gold

Type of Transaction	Exchange Controls				
	South Africa	Lesotho	Namibia	Swaziland	Comments
1.3 Gold					
Is prior approval of the CB required to export gold jewelry by manufacturers, import gold coins and export other wrought gold?	Yes	Yes	Yes	Yes	All CMA countries are at par.
Is prior approval of the CB required for residents to hold unwrought gold, acquire gold for trade purposes and import other wrought gold?	No	Yes	Yes	Yes	All CMA countries are at par except SA which is fully liberalised.

Table 4: Travel

Type of Transaction	Exchange Controls				
	South Africa	Lesotho	Namibia	Swaziland	Comments
1.4 Travel					
Limit on travel allowances	Up to a discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	Up to a discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	Up to a discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	Up to a discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	All CMA countries are at par.
Limit for which prior CB approval is required for advance payments for tours and hotel accommodation	Within the discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	Within the discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	Within the discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	Within the discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	All CMA countries are at par.
Resident travelers may export foreign bank notes within the dicretionary allowance	Yes	Yes	Yes	Yes	All CMA countries are at par.
Non-resident travelers may export foreign bank notes against proof of prior importation	Yes	Yes	Yes	Yes	All CMA countries are at par.
Returning resident travelers may import bank notes within the amount originally exported	Yes	Yes	Yes	Yes	All CMA countries are at par.
Limit for bank notes that may be exported (imported) by resident (non-resident) travelers	R25 000.00	R25 000.00	R25 000.00	R15 000.00	Lesotho is at par with Namibia and SA and are more liberalised than Swaziland.
Limit on study allowance that may be effected without prior approval of the CB	R1.0 million per unaccompanied student and R1.5 million per student accompanied by spouse	R1.0 million per unaccompanied student and R1.5 million per student accompanied by spouse	R1.0 million per unaccompanied student and R2.0 million per student accompanied by spouse	R1.0 million per unaccompanied student and R2.0 million per student accompanied by spouse	Lesotho is at par with SA and are less liberalised than Namibia and Swaziland for student accompanied by spouse.

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Table 5: Services and Capital Account

Type of Transaction	Exchange Controls				
	South Africa	Lesotho	Namibia	Swaziland	Comments
1.5 Services					
Are there any controls?	No	No	No	No	Services are fully liberalised in all CMA countries.
1.6 Income					
Are there any controls?	No	No	No	No	Services are fully liberalised in all CMA countries.
2. Capital Account					
Limit for which prior CB approval is required for emigrat settling-in allowances	Amounts greater than R4.0 million per individual and R8.0 million per family unit	Amounts greater than R4.0 million per individual and R8.0 million per family unit	Amounts greater than R4.0 million per individual and R8.0 million per family unit	Amounts greater than R4.0 million per individual and R8.0 million per family unit	All CMA countries are at par.
Limit for which prior CB approval is required for residents temporarily abroad allowances	Within the discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	Within the discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	Within the discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	Within the discretionary allowance of R1.0 million per adult and R200 000.00 per child per annum.	All CMA countries are at par.
May residents issue guarantees to non-residents without prior approval from CB?	No	No	No	No	All CMA countries not liberalised

Table 6: Financial Account - Inward

Type of Transaction	Exchange Controls				
	South Africa	Lesotho	Namibia	Swaziland	Comments
3. Financial Account					
3.1 Inward					
May residents enter into foreign loan agreement without prior approval of the CB?	Yes	Yes	Yes	Yes	All CMA countries not liberalised
After how long from accrual should foreign currency be declared?	within 30 days	within 30 days	within 30 days	within 30 days	All CMA countries not liberalised
Is the sale and purchase of foreign currency between residents restricted?	Yes	Yes	Yes	Yes	All CMA countries not liberalised

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Table 7: Financial Account - Outwards

Type of Transaction	Exchange Controls				
	South Africa	Lesotho	Namibia	Swaziland	Comments
3.2 Outward					
Allowable period for declaration of accrued foreign assets except foreign inheritances	within 30 days	within 30 days	within 30 days	within 30 days	All CMA countries are at par.
Limit on foreign bank accounts that private individuals may maintain	R10.0 million per annum	R4.0 million per annum	R4.0 million per annum	R4.0 million per annum	SA is more liberalised than the rest of the CMA.
Limit on investment by private individuals on fixed property, equity, portfolio investment, bonds and money market instruments and prior approval of CB is required	R10.0 million per annum	R4.0 million per annum	R4.0 million per annum	R4.0 million per annum	SA is more liberalised than the rest of the CMA.
Limit on loan agreements that residents, excluding commercial banks may enter into with non-residents without prior approval of the CB	R1.0 million per year.	R1.0 million per year.	R1.0 million per year.	R1.0 million per year.	All CMA countries are at par.
Limit on transfers of monetary gifts to non-residents and residents temporarily abroad for maintenance purposes that may be effected without prior approval of the CB	Within the discretionary allowance of R1.0 million per calender year.	Within the discretionary allowance of R1.0 million per calender year.	Within the discretionary allowance of R1.0 million per calender year.	Within the discretionary allowance of R1.0 million per calender year.	All CMA countries are at par.
Alimony	CB approval is not required at all but alimony should be limited within the discretionary allowance of R1.0 million per calender year.	CB approval is not required at all but alimony should be limited within the discretionary allowance of R1.0 million per calender year.	CB approval is not required but it is limited to R9 000.00 per month.	CB approval is not required but it is limited to R9 000.00 per month.	CB approval is not required in all CMA countries. Namibia and Swaziland are more liberalised than SA and Lesotho.
Limit on study allowance that may be effected without prior approval of the CB	R1.0 million per unaccompanied student and R1.5 million per student accompanied by spouse	R1.0 million per unaccompanied student and R1.5 million per student accompanied by spouse	R1.0 million per unaccompanied student and R2.0 million per student accompanied by spouse	R1.0 million per unaccompanied student and R2.0 million per student accompanied by spouse	Lesotho is at par with SA and are less liberalised than Namibia and Swaziland for student accompanied by spouse.

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Table 8: Other Financial

Type of Transaction	Exchange Controls				
	South Africa	Lesotho	Namibia	Swaziland	Comments
3.3 Other Financial					
Many residents issue bonds, debt securities, shares or other securities of a participative nature in a foreign market or issue locally derivative instruments, options and futures without prior approval from the CB?	Yes provided the underlying assets are domestic in nature.	No	No	No	Lesotho is at par with Namibia and Swaziland and are less liberalised than SA.
May Banks borrow or lend locally in foreign currency without prior approval from the CB?	Yes	No	No	No	Lesotho is at par with Namibia and Swaziland and are less liberalised than SA.
Limit on foreign portfolio investments that can be held by retirement funds	within 25.0 per cent of the total retail assets	within 25.0 per cent of the total retail assets	within 35.0 per cent of their total assets	within 20.0 per cent of their total retail assets	Lesotho is at par with SA and more liberalised than Swaziland.
Limit on foreign portfolio investments that can be held by long-term insurers	Within 25.0 per cent non-linked and 35.0 per cent linked of the total retail assets.	within 25.0 per cent of the total retail assets	within 35.0 per cent of their total assets	within 20.0 per cent of their total retail assets	Lesotho is at par with SA on non-linked while SA is more liberalised on linked. The 2 are however more liberalised than Swaziland.
Limit on foreign portfolio investments that can be held by collective investment scheme management companies and investment managers	Within 35.0 per cent and an additional 5.0 per cent for Africa of the total retail assets.	Within 35.0 per cent of their total retail assets.	within 35.0 per cent of their total assets	Within 30.0 per cent of their total retail assets	Lesotho is at par with SA on foreign countries other than Africa while SA is more liberalised on African countries. The 2 are however more liberalised than Swaziland.
Limit on study allowance that may be effected without prior approval of the CB	R1.0 million per unaccompanied student and R1.5 million per student accompanied by spouse	R1.0 million per unaccompanied student and R1.5 million per student accompanied by spouse	R1.0 million per unaccompanied student and R2.0 million per student accompanied by spouse	R1.0 million per unaccompanied student and R2.0 million per student accompanied by spouse	Lesotho is at par with SA and are less liberalised than Namibia and Swaziland for student accompanied by spouse.

Estimation of Lesotho's Yield Curve

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Key words:
Zero-coupon yields, Government bonds, Yield curve

JEL Classification: G12, E43, E47

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1 INTRODUCTION

TRADING OF GOVERNMENT or default-free securities produces important financial information useful to public, private, financial and non-financial entities alike. In particular, "risk-free" rates of return, normally calculable from bond or swap prices, contain important information about macro-economic conditions, market expectations of future real interest rates and inflation, as well as the time value of money. They can be used for many purposes, including the pricing of insurance products, as a benchmark for bank lending, the pricing of other financial or investment products such as derivatives, the valuation of pension liabilities, as an input into the benchmarking of a project's Internal Rate of Return (IRR), and general assessment of an economy's prospects.

In Lesotho, financial markets are underdeveloped and thus highly illiquid. While treasury bills are frequently issued and some medium- and long-term treasury bonds are occasionally issued and re-opened, there is little to no observable secondary market trading in either. This means that Lesotho's government bond interest rates are normally not known with precision, especially for longer maturities. As a result, commercial and government entities in Lesotho therefore miss out on the benefits of the information normally provided by government bond yields when making pricing and capital allocation decisions.

The purpose of this paper is therefore to use available information in order to build a model to estimate, at any date, Lesotho government's zero-coupon yield (ZCY) curve (the plot of government interest rates for different maturities of zero-coupon bonds). Of particular interest are maturities of greater than one year, given that ZCYs of maturities up to one year are generally known due the aforementioned regular and frequent issuance of treasury bills. Of course such an estimate will not provide the same level of information as would exist if Lesotho's financial market were more fully developed. Further, there may arguably be a non-negligible chance of the Lesotho government defaulting on its obligations, meaning that such a ZCY curve would not be risk-free. However, the paper is prepared on the basis that such an estimate is nevertheless valuable, as long as the uncertainty of the estimate is well understood.

The model developed is expected to contribute to capital market development goals through the information it provides. It is expected to help encourage corporate bond issuances, improve private sector ability to price financial products such as insurance and loans, and provide guidance regarding yields that will be achieved on issuance or re-opening of government bonds. As such, it should contribute to the improvement of overall capital allocation in Lesotho.

Other benefits from this project and the model developed include the following:

- Help establish the Central Bank of Lesotho's (CBL) reputation as a provider of timely and useful financial market information in Lesotho
- Potentially (marginally) reduce the government's cost of capital, to the extent that better information leads to less uncertainty surrounding Lesotho government securities and thus greater demand for them
- Attract (marginal) additional capital from abroad since investors will better understand local market conditions
- Draw additional traffic to CBL's website

The remainder of this paper is structured as follows. Section 2 summarises previous work by CBL on estimating Lesotho's yield curve. Section 3 briefly touches upon relevant literature not covered by the aforementioned CBL work. Section 4 describes the methodology adopted and its specific rationale given Lesotho's circumstances. The data used, including the process used to establish historic data points for Lesotho's ZCYs is also captured in section 4. Section 4 further explains the preferred model to estimate Lesotho's ZCY curve based on that of South Africa (SA) at any date, and sets out the estimation results for its parameters. Section 5 provides testing results for bond yield estimates produced, including the preferred model and a number of other models that were also considered. Section 6 concludes and Section 7 provides recommendations to take the project forward into implementation..

2 PREVIOUS WORK BY THE CENTRAL BANK OF LESOTHO

Earlier work on estimating Lesotho's ZCY curve culminated in two main papers. The first was 'Modelling Yield Curve in Lesotho' by Molise et al. (2010). In this paper, the authors advocated for the adoption of the bootstrapping method in order to measure Lesotho's yield curve. The bootstrapping method was chosen for its balance between simplicity, ease of computation, accuracy and purpose. For the purpose of extrapolation to maturities beyond five years (the longest-dated bond on issuance in 2010), a "shape factor" assumption was made.

The second was a paper entitled 'Lesotho Yield Curve – Simple Parametric Model (Nelson-Siegel)' by Noosi B. and Nthontho T. (2014). The authors of this paper adopted a Nelson-Siegel model, one type of parametric model that is commonly-used for modelling the yield curve. The model was selected based on its good prediction ability, its wide use among many Central Banks and financial markets practitioners, its simplicity compared to other parametric models, and its flexibility. In the paper, the authors fit a Nelson-Siegel model to treasury bill data (up to a term of 1 year) and use it to extrapolate zero-coupon yields up to a term of 2 years

3 LIRERATURE REVIEW

Due to the relatively comprehensive review of yield curve modelling techniques in previous CBL work (e.g. Molise *et al.* 2010), this section does not replicate this work. Rather, it seeks to focus on additional literature and peer benchmarking not covered by previous work.

Many techniques are available to address the issue of yield curve smoothing, based on knowledge of some points on the ZCY curve. One of the most commonly used is the Nelson-Siegel model, which can be used to fit a curve to the available interest rate data points at a particular date. This model is described (alongside others) by CBL in Molise *et al.* (2010) and used in Noosi and Nthontho (2014). Some papers use these techniques in the context of secondary markets for government securities with low trading volumes (Chakroun and Abid 2013, Chou *et al.* 2009, Vaidyanathan *et al.* 2002). However, given the lack of existence of a secondary market in Lesotho, these techniques are not as readily applicable. For example, it is only possible to use a Nelson-Siegel curve to estimate longer-term maturities on days when there is trading data for longer-term securities. In Lesotho, this is only the case when bonds are issued or re-opened.

However, the peg of the Loti to the Rand creates an opportunity to consider the use of SA financial market information. As explained in Box 1, another country in a similar situation to Lesotho in this regard is Denmark. That is, the Danish Krone is pegged to the Euro, and Denmark's bond and swap markets are less liquid relative to those of some countries in Europe, e.g. Germany (albeit much more liquid than Lesotho's markets). Danish and European authorities therefore use the euro swap yield curve with an adjustment, for the purpose of valuing Danish insurance liabilities (Danish FSA 2004, CFO Forum and CRO Forum 2010).

Box 1 Danish yield curve for insurance liability valuation

In deriving a yield curve, Denmark faces a similar problem to Lesotho due to the small, relatively illiquid nature of its government bond market. Combined with the fact that its currency (the krone) is pegged to the Euro, this means that Denmark's situation bears important similarities to that of Lesotho. In 2004, the Danish financial regulator, Finanstilsynet (Danish FSA), sought to develop a method for deriving Denmark's yield curve for the purpose of insurance company regulation (Danish FSA, 2004). Specifically, in order to require insurance companies to report their liabilities' market value, a discount rate for each liability cash flow had to be specified. The previous regulation regime, which allowed a single discount rate to be applied to all liabilities regardless of term, was considered inadequate.

In specifying a yield curve, the use of government bonds was viewed negatively due to the scarcity of long-term Danish government bonds (i.e. maturity of greater than 10-12 years)—only one such bond existed. Further, liquidity in the government bond market was a problem, particularly for long term yields, meaning that yields are prone to influence by individual large transactions. Lastly, there was little indication that long-term government bond issuance would be sustained in future.
Danish FSA also considered drawing upon the domestic interest rate swap market, which are effectively the interest rates at which banks lend to other banks. While this option is preferable to the use of government bonds, the swap market is still illiquid relative to euro swaps, and similarly to government bonds it is prone to influence by individual large transactions due to Denmark's small market.

Therefore, the option that Danish FSA chose was to use the euro swap yield curve, with an adjustment for the credit risk of Denmark relative to Euro countries. The reason for this choice was that Danish FSA decided to place significant weight on market liquidity, in order to achieve smoothness and stability of the yield curve to be used. The benefits of the much larger and more liquid euro swap market were thus considered sufficient to outweigh the disadvantage of not closely reflecting any changes in the relationship between the Danish and the Euro yield curve, as could have been better achieved through use of the Danish swap rates. This disadvantage is nevertheless minimized through the adjustment for credit risk, which is based on the observed difference between Danish and German government yields (Danish FSA, 2011).

Applying the Danish experience to Lesotho, it is interesting to note the three problems identified with the use of the government bond market to derive a yield curve: scarcity of long-term bonds, illiquidity, and uncertain future government issuance. Since these problems also apply to Lesotho's government bond market but to a much more severe degree, this would argue against relying only on Lesotho government bonds for the purposes of this paper. Thus, since Lesotho does not have an observable domestic swap market, this leaves the option of using the SA interest rate swap curve with adjustment. Accordingly, the remainder of this paper proceeds to develop a method of predicting Lesotho yields based on SA yields.

4 METHODOLOGY

As explained above, approaches taken to date have consisted of applying smoothing methods (bootstrapping in once instance, and the Nelson-Siegel model in the other). Both of these approaches rely on the availability of longer-term yield observations on the same date for which the yield curve must be estimated, which is an unfortunately restrictive condition in Lesotho.

This restriction can be relaxed by making use of the abundant information produced by SA's financial markets. The high degree of reliability of the peg of Lesotho's Loti to SA's Rand means that there is a strong connection between the two countries' interest rates, since any investor can readily choose between investing in SA's vs. Lesotho's money market without exchange rate fluctuations being a concern. In fact, under simplified circumstances, Lesotho's yield curve would actually be identical to SA's. In practice, Lesotho government bonds tend to exhibit higher yields than SA government bonds. Nevertheless, any approach that ignores this relationship is likely to produce suboptimal estimates of Lesotho's yield curve.

Therefore, this paper seeks to model the Lesotho zero-coupon yield curve based on that of SA, using appropriate adjustments. Specifically, the approach taken is to use the bond yield data available from issuances and re-openings of Lesotho treasury bonds and bills in order to estimate Lesotho's Zero-Coupon Yield (ZCY) curves at particular dates when data is sufficient for this. A generalised bootstrapping method is used for this. The resulting ZCYs are then regressed on their SA equivalents in order to develop a model for estimating the Lesotho ZCY curve—a variety of regression models are considered, as set out later in this paper. This model can produce estimates for the Lesotho ZCY curve on any day, since data for SA's ZCY curve are available on a daily basis.

4.1 Data and Bootstrapping Methodology

(a) Data

For this study, information was obtained from CBL's Financial Markets Department (FMD) on the yields obtained at issuances and re-openings of treasury bonds and bills, as well as on the characteristics of the bonds and bills in question. As mentioned earlier, data for Lesotho's treasury bills are more plentiful than for its treasury bonds. Nevertheless, there have been 36 issuances/re-openings of treasury bonds on 19 dates since the commencement of this market in 2010, which is sufficient for achieving useful results in this study.

The dynamics of these auctions are that the government typically tries to issue or re-open bonds at par, or at a premium. So far it has succeeded; out of the 36 issuances/re-openings, 29 have been at par and 7 have been at a premium. Although this behaviour may influence the yield obtained, ultimately bond yields anywhere are driven by both supply and demand, with the supply of government bonds being determined by the government's issuance preferences. Therefore, these transactions still provide relevant information about Lesotho's yield curve.

Data used for the SA yield curve is based on zero-coupon swap mid rates, which are available from Bloomberg on a daily basis (ICVS Curve ID: ZAR.3M, Field: ZC.MID). Although there may be small differences between swap yields and bond yields, either is sufficient for the purpose of estimating the Lesotho yield curve, as any differences are likely to be accounted for by the regression model.

(b) Bootstrapping Methodology

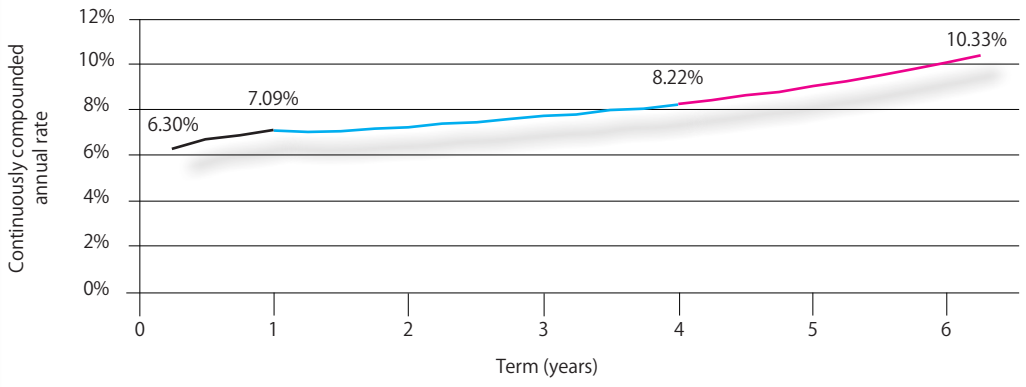
The Lesotho bond yields in the data from CBL's FMD are bi-annually compounded bond yields, and thus cannot be directly compared to the SA ZCY curve. Therefore it is necessary to derive Lesotho's ZCY curve on each auction date from the bond yields observed. Although the ZCYs are observable for terms up to and including one year due to the Treasury Bill auctions, beyond the short term tenors a bootstrapping exercise is required for each bond auction date to estimate the ZCY curve for that date. Historically in Lesotho, two bonds have normally been sold on each auction date (with two exceptions where only one bond was sold), leading to two data points at those dates where this has been the case. Combining this with the nearest Treasury Bill auction data (typically from a week earlier), this leads to six yield curve data points for each bond auction date. This data is included in Appendix I. For each auction date, the bootstrapping methodology is therefore applied to these six data points to obtain the ZCY curve for that date.

Although this process produces a full ZCY curve for each date, it is unlikely that all ZCYs produced are reliable given the relatively few data points beyond the payment term of 1 year. Therefore, since the final bond payments are by far the largest and thus have much more weight in the calculations than the bonds' coupon payments, the most reliable ZCYs are those that coincide with the bond's maturities. Therefore, only those ZCYs from the bootstrapped yield curve are collected for analysis.

In summary, this method produces one ZCY for each treasury bond at each auction, for a total of 36 observations. This data is complemented with yield data from the (zero-coupon) treasury bills that are issued around the same time as the treasury bonds, leading to 76 observations for treasury bills and a total dataset of 112 observations. It would be possible to incorporate more treasury bill data from other auction dates into the analysis. However, since the main focus of this study is to estimate longer-term ZCYs, this was not done, for fear of overshadowing the longer-term data points in the analysis.

To calculate the ZCY curves, two bootstrapping methodologies are used. The first is based on the Nelder-Mead numerical method for non-linear optimisation of an objective function in multidimensional space. It is capable of calculating a zero-coupon yield curve that produces the correct bond prices given the coupon and maturity payments of the two bonds and the four treasury bills at a given date. The Nelson-Mead method produces smooth yield curves as per Figure 1. Given a limitation of the software used to implement the Nelder-Mead method, bond payment terms are rounded to the nearest quarter for both methods.

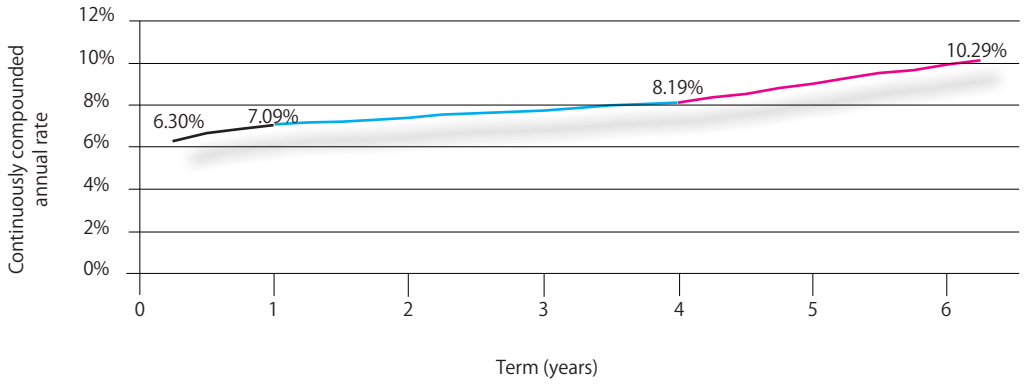
Figure 1 **Estimate of Lesotho Zero-Coupon Yield Curve** (Nelder-Mead Method, 18 March 2015)



Source: Central Bank of Lesotho

The second method used is that of a linear spline, as illustrated in Figure 2 for 18 March 2015, when the 7 and 10 year bonds (maturing in 4 and 6.25 years respectively as of that date) were re-opened. Starting from the 1-year Treasury Bill yield, a constant amount of ZCY increase per year of payment term is assumed, which is chosen such that the resulting ZCYs value the 7-year bond's remaining payments accurately. For terms that are later than 4 years (i.e. after the maturing of the 7-year bond), a different constant amount of ZCY increase per year of payment term is assumed, which is chosen such that the resulting ZCYs value the 10-year bond's remaining payments accurately. In the example illustrated, the two methods produce ZCYs that are very close, although this is not always the case.

Figure 2 **Estimate of Lesotho Zero-Coupon Yield Curve** (Linear Spline Method, 18 March 2015)



Source: Central Bank of Lesotho

SA zero-coupon yields corresponding to the yields calculated by the methods above are obtained by referring to the government swap yield curve for the same date, and applying linear interpolation where the exact term cannot be matched. For example, in Figure 1, the Nelder-Mead method produces the result that the 6.25 year ZCY in Lesotho was 10.33% on 18 March 2015. The equivalent SA yield would be obtained by taking 75% of the 6-year SA ZCY and 25% of the 7-year SA ZCY on that date.

4.1 Model Formulation and Results

(b) Model Formulation

The model proposed for Lesotho's ZCY curve is one whereby the variation in a Lesotho ZCY of any term is determined by a constant, the corresponding SA ZCY and the natural log of the term in years. This model is not a time-series model; it is assumed that any time-related effects such as serial correlation are adequately captured through the inclusion of the SA ZCY data.

$$L_i = a + b.SA_i + c.ln\,(term_i) + \epsilon_i \qquad (1)$$

Where:

- i = observation index, corresponding to a particular security at a particular date
- L_i = Lesotho's estimated continuously compounded annual zero-coupon yield
- SA_i = SA's continuously compounded zero-coupon swap yield
- $term_i$ = years until the payment is made
- ε_i = error term
- a, b and c = parameters to be estimated

The rationale behind this formulation is as follows. We expect Lesotho's ZCY to be closely related to SA's yield. However, we also expect factors such as default risk and illiquidity premia, which affect bond yields (see Longstaff *et al*. (2005) and Hull *et al*. (2005) which focus on corporate credit risk), to differ between SA and Lesotho. In terms of default risk, since it is likely that there is an increased level of country risk in Lesotho relative to SA, this may result in a default risk premium relative to SA bonds. This risk premium might be captured by the constant term, since sovereign default risk affects all government bonds equally in each time period. We also expect there to be an illiquidity premium on Lesotho bonds relative to SA bonds. Illiquidity, as measured by years required to liquidate (sell or redeem) an investment asset, increases in line with payment term in the case of Lesotho government bonds, meaning that the longer the tenor of a bond the greater the premium required each year by investors. This provides a rationale for including ln $(term_i)$ as an explanatory variable, to capture illiquidity and any other term-varying risk premia. The use of the natural log of the payment term, instead of the payment term without any transformation, helps account for non-linearity of term-dependence, and in practice was found to eliminate the problem of non-normality of the error term.

Impulse and other types of dummy variables have been avoided in the construction of the model, since the authors are not aware of any reasons why particular observations or groups of observations deserve nullification. In particular, one cannot suppose that any observation or group of observations in the dataset is representative of an event that will never re-occur in the future.

5 EMPIRICAL RESULTS

Upon examination of the results presented in Table 1, it is evident that both bootstrapping methodologies produce acceptable results that are in line with prior expectations. That is, the explanatory variables used appear to be relevant and the co-efficient of SA_i (represented in the estimation results as SA_YIELD) is reasonably close to one, consistent with the intuition that a large part of the Lesotho ZCY curve is driven by the SA ZCY curve.

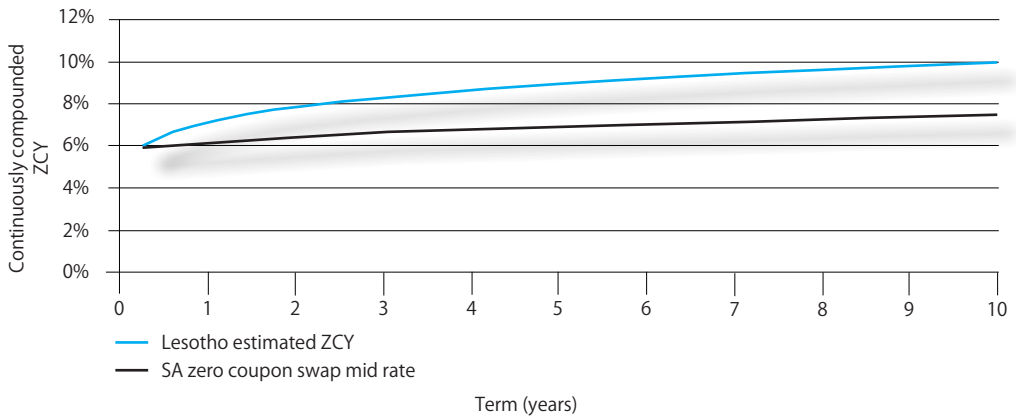
The high R^2 values and the highly significant t-statistics, particularly on SA_i, do imply that some cointegration may be present. This is plausible given the relationship we expect between Lesotho and SA ZCYs. Explicitly modelling any the cointegration relationship, or more generally taking a more sophisticated modelling approach, may be a topic for further research. However, it is far from obvious that such a model would produce more reliable ZCY estimates than the simple ones shown above. Moreover, the possibility of super-consistency in the above regressions does not invalidate the parameter estimates. It only indicates that the standard errors, and thus the t-statistics and p-values for individual coefficients, cannot be relied upon. It is therefore preferable to rely on statistics such as the Schwarz Information Criterion (SIC) in order to select between model specifications.

Table 1: Empirical Results

Dependent Variable: LESOTHO_YIELD		
	Model I	**Model II**
C	0.0159*** (3.011)	0.0151*** (2.842)
SA_YIELD	0.8870*** (9.632)	0.9029*** (9.803).
LOG (TERM)	0.0073*** (15.009)	0.0073*** (15.206).
Adjusted R^2	0.92	0.92
F-Statistic [P-value]	652.001 [0.00]	673.623 [0.00].
Wald F-Statistic [P-value]	451.02 [0.00]	473.21 [0.00]
Jarque-Bera Normality [P-value]	0.591	0.508
Breuch-Pagan-Godfrey Heteroscedasticity [P-value]	0.00	0.00
Number of Observations	112	112

Note: */**/*** denotes significance at 10,5 and 1 per cent levels, respectively. T-ratios are in parenthesis.
Model I and Model II, using Nelder-Mead and liner method for bootstrapping, respectively.

Figure 3 **Comparison of estimated Lesotho ZCY curve with SA ZCY curve** (As at 4 March 2015)



Source: Central Bank of Lesotho, Bloomberg. Lesotho ZCY estimated using regression model calibrated from Nelder-Mead bootstrapped ZCY curve data

It is also noteworthy that both the above models exhibit heteroskedasticity, primarily because short-term ZCYs are subject to different sources of variation than long-term ZCYs. This again leads to unreliable standard errors, but does not invalidate the estimates of the parameters, meaning that the model can still be used for the desired purpose. Heteroskedasticity can be avoided by omitting the short-term ZCYs (payment terms less than or equal to 1 year) and focusing solely on longer-term ZCYs. However, as explained in Section 7, this leads to other problems.

(a) Relative Importance of Model Diagnostics and Interpretation

It is imperative to bear in mind that this model, in accordance with the purpose of this project, is primarily designed to produce ZCY estimates. Therefore, while statistical diagnostics were used as tools in the development the model, the model is not optimised to have the best SIC or other diagnostic statistics, as good diagnostics can belie poor estimation power. Likewise, while qualitative understanding guided the methods used and variables included, the model is not designed to be the best model for developing understanding of the sources of difference between the SA and Lesotho ZCY. For example, the estimated parameters for the constant and for the coefficient of $ln(term_i)$ are unlikely to correspond exactly to the country risk and illiquidity factors discussed earlier. This is because, apart from these concepts being difficult to quantitatively isolate, the parameters mentioned may be functioning as a substitute for some component of the SA interest rate, particularly since the estimated coefficient of SA_i is less than one. A more informative study into these aspects could be achieved by having as the dependent variable the difference between the Lesotho and SA ZCY, but this is outside the scope of this paper.

Accordingly, the following section focuses on the power of the combined (bootstrapping and regression) modelling approach to predict bond yields. The following section also uses this testing approach to investigate some alternative formulations of the regression model.

(b) Tests of Model Accuracy

It is impossible to test the ZCYs generated by the bootstrapping process since Lesotho's ZCYs are not observable. It is possible to test the ZCYs that are estimated by the regression model against the ZCYs derived from the bootstrapping process, but this is less useful because the latter are themselves only estimates, not actual market data. Therefore, to test the model, this paper takes the approach of using the ZCYs estimated by the regression model to calculate the overall yields of bonds at their points of issuance/re-opening, and comparing these estimated bond yields with those actually observed in the market. It should be noted that such a comparison functions as a test of the entire approach taken in this paper, including both the bootstrapping methodology and the regression model for ZCYs.

Test metrics used include the Mean Absolute Error (MAE), the Root Mean Squared Error (RMSE), and the average bias of bond yield estimates. Testing focuses purely on estimates of treasury bond yields, not treasury bill yields, since the purpose of this paper is to provide insight into longer-term yields (up-to-date information on short-term yields normally exists due to approximately fortnightly issuances of treasury bills for monetary policy purposes). Testing is conducted on both an in-sample and out-of-sample basis. Out of sample testing is conducted in three phases, estimating the first third of bond yield data (using the remaining two thirds of data to estimate the model's parameters), then the second third, then the final third. Differences between estimates and actuals from the three phases are then used to calculate the relevant test metrics. In order to simulate the fact that in reality the model would be used to estimate the yield obtainable on a bond that is not yet issued, SA ZCYs from two weeks earlier than the bond's issue date are used, rather than using the SA ZCYs from the same day as the bond's issuance or re-opening date.

In addition to investigating the relative merits of the Nelder-Mead vs. linear spline method for estimating Lesotho's ZCY curve, a number of different equations for using the SA ZCYs to estimate the Lesotho ZCYs were investigated. The equations tested are set out in Table 3, and the results are presented in Table 4. It should be noted that the out of sample test results hold more weight than the in-sample results, since they represent a more stringent and realistic test. However, it is also important to include qualitative considerations in deciding on a model, since even out-of-sample testing is limited to the range of data experienced to date.

Of the models tested, the equation originally introduced in Section 0 using the Nelder-Mead method is preferred. The model makes intuitive sense, with a SA_i coefficient of close to one and a logical set of regressors that accord with prior expectations. It also performs well based on the above testing metrics, featuring negligible bias and a MAE and RMSE of less than 0.5%, meaning that more often than not we can expect this model's prediction to fall within 0.5% percentage points of the actual bond yield.

A close contender is Equation 1, which offers essentially the same forecasting performance but a SA_i coefficient that is slightly further away from 1. Otherwise, the best alternative candidates for modelling Lesotho's ZCY curve are Equations 4 and 5, when the Nelder-Mead method is used (with the linear spline method, these equations lead to biased estimates based on the above test results). These equations are roughly on par with the preferred equation (and Equation 1) based on the above statistics. However:

- Equation 4's use the natural log of SA_i is less intuitive, given that we think of Lesotho interest rates as being directly related to SA interest rates. As a result, this model is less likely to remain appropriate in scenarios of significantly higher SA interest rates than those within the dataset used to calibrate the models.

- Equation 5 assumes a constant elasticity between the Lesotho and SA ZCYs. Specifically, according to Equation 5 (using the Nelder-Mead method), a 1% change in the SA interest rate will lead to a 0.747% change in the Lesotho interest rate. Again, the intuition here is less clear, as we are talking about a percentage change in a percentage figure. It is much clearer to directly relate the level of Lesotho's ZCYs to those of SA.

Table 2: Alternative Equations Investigated*

Dependent Variable: LESOTHO_YIELD	
Preferred^	$L_i = a + b.SA_i + c.\ln(term_i) + \epsilon_i$
1.	$L_i = a + b.SA_i + c.term_i + \ln(term_i) + \epsilon_i$
2.	$L_i = a + b.SA_i + c.term_i + \epsilon_i$
3.	$L_i = a + b.SA_i + c.SA_i^2 + d.term_i + e.term_i^2 + f.term_i^3 + \epsilon_i$
4.	$L_i = a + b.\ln(SA_i) + c.term_i + d.\ln(term_i) + \epsilon_i$
5.	$\ln(L_i) = a + b.\ln(SA_i) + c.\ln(term_i) + \epsilon_i$

* Notation is as defined in Section 4.
^ The "preferred" equation is the same as that proposed in Section 4.

Table 3: Test results for bond yield estimation

			In-sample			Out-of-sample		
Bootstrapping method	Terms included	Equation^	Bias %	MAE %	RMSE %	Bias %	MAE %	RMSE %
Nelder-Mead	All	Preferred+	0.01	0.37	0.47	0.01	0.39	0.48
Nelder-Mead	All	1	-0.02	0.37	0.46	-0.01	0.40	0.48
Nelder-Mead	All	2	-0.14	0.45	0.54	-0.13	0.46	0.55
Nelder-Mead	All	3	0.05	0.33	0.42	0.04	0.40	0.47
Nelder-Mead	All	4	-0.01	0.35	0.44	-0.01	0.39	0.46
Nelder-Mead	All	5	-0.02	0.38	0.49	-0.02	0.39	0.48
Nelder-Mead	>1 year*	2	0.12	0.37	0.43	0.14	0.40	0.47
Linear spline	All	Preferred	0.02	0.37	0.48	0.03	0.40	0.49
Linear spline	All	1	-0.19	0.39	0.49	-0.18	0.42	0.51
Linear spline	All	2	-0.33	0.48	0.60	-0.32	0.49	0.61
Linear spline	All	3	-0.05	0.34	0.42	-0.06	0.40	0.48
Linear spline	All	4	-0.16	0.38	0.47	-0.16	0.41	0.50
Linear spline	All	5	-0.22	0.44	0.52	-0.22	0.45	0.53
Linear spline	>1 year*	2	0.02	0.35	0.42	0.03	0.39	0.46

* For these versions of the model, the data set included only ZCYs corresponding to terms longer than one year, leaving a total of 36 observations instead of the original 112.
^ Equations are set out in Table 2. Estimation output for these models is included in Appendix II.
+ The recommendation of this paper is to use the "preferred" equation combined with the Nelder-Mead bootstrapping method.
MAE = mean absolute error, RMSE = root mean squared error

Other equations listed above are less preferred, based on the following reasons:

- Out of Nelder-Mead and linear spline bootstrapping methods, the Nelder-Mead method leads to better performance under most specifications, leading to less bias and lower RMSE and MAE statistics.

- Equation 2 appears to perform well when only fitted to ZCYs corresponding to terms longer than one year. However, the coefficient of SA_i in these cases falls to an unreasonably low value – close to 0.45 for both bootstrapping methods. This model is therefore likely to become inappropriate in scenarios of significantly higher SA interest rates than those within the dataset used to calibrate the models. The use of only longer-term ZCYs appeared to lead to no available benefit from including non-linear regressors in the equation, which is why only Equation 2 was tested in this way.

- When using the entire dataset, Equation 2 is dominated by the preferred equation, indicating the need to account for non-linearity of interest rates in payment term. This is corroborated by regression diagnostics for Equation 2, which indicate non-normality of errors and a less favourable SIC statistic relative to the preferred equation.

- Equation 3 appears to perform roughly on par with the preferred equation based on the above statistics, perhaps a little better when using the linear spline method of constructing the ZCY curve. However, the use of polynomial terms to capture nonlinearity is highly likely to lead to unreasonable results when SA interest rates or the payment term are beyond the values present in the data used to calibrate the model. Further, Equation 3 leads to non-normality of errors when using the Nelder-Mead method to construct Lesotho's ZCY curve.

(c) Model Limitations

In evaluating this model, its limitations need to be borne in mind in order to achieve maximal benefit from its use. An important limitation of this model is that it is not sensitive to changes in the relationship between Lesotho and SA yields. For example, if there were a change in the perceived level of risk inherent in Lesotho's government securities relative to those of SA, such as might result from a sustained increase in political risk in Lesotho, this change would not be reflected by the model as currently estimated. In such a case the model could be reviewed and re-estimated using up to date information in order to maximise its predictive power. However, this limitation is also a positive feature of the model, since the estimated yield curves are less susceptible to undue influence by individual transactions that are large enough to move Lesotho's bond market.

The model assumes that the fundamental mechanisms facilitating bond markets in SA and Lesotho remain the same as those prevailing during the period from which data is taken. This assumption could be invalidated by, for example, improvement in Lesotho government bond liquidity, such as may arise from capital market development efforts. In the case of such developments, the model's estimates are likely to become less accurate. However, enhanced liquidity would also provide much valuable information about bond yields, which would potentially enable a different modelling approach to be taken.

The model's estimates of yields for terms above 10 years should be considered unreliable, since no data for such yields in Lesotho is available. Subjectively, the authors believe that the model's extrapolations for terms up to 12 years may still be somewhat useful, albeit less reliable. However, estimates by the model for terms above approximately 15 years are unlikely to contain any useful information, as the behaviour of that part of the zero coupon yield curve relative to SA yields is unknown, and could be significantly different to that prevailing at 10 years.

Finally, as mentioned earlier, a limitation of the model is that, being designed as an estimation model, it is less appropriate for isolating and understanding the underlying drivers of Lesotho's ZCY curve, a task which is outside the scope of this project.

These limitations, while important to bear in mind, do not compromise the model's overall contribution. Specifically, as per the test results in Section 0, the model succeeds in providing a reasonably indicative estimation of Lesotho's ZCY curve, in line with its purpose.

6 CONCLUSION

The purpose of this project has been to facilitate capital market development goals by providing estimates of Lesotho's government yield curve to the public. This is expected to improve overall capital allocation in Lesotho by enabling better pricing of financial products, helping encourage corporate bond issuance, and providing guidance as to yields that will be achieved at government bond auctions.

CBL's work to date on yield curve estimation has been based on yield curve smoothing models such as Nelson-Siegel. However, the bond markets to which these techniques are typically applied are far more liquid than Lesotho's bond market, where little to no observable secondary trading takes place. Therefore, a slightly more novel and innovative approach is taken in this paper.

Similar to a methodology that has been used to arrive at a Danish yield curve for regulatory purposes, this paper primarily draws upon interest rate information from SA financial markets, creating a model that is able to estimate Lesotho's ZCY curve using that of SA as an input. The model was calibrated using the scant interest rate data points available from Lesotho government bond issuances and re-openings since 2010, and using bootstrapped ZCYs as the dependent variable to be estimated.

Tests of the estimates produced by the model confirm its suitability, with the preferred model showing very little overall bias in estimates of government bond yields, and featuring MAEs and RMSEs of less than 0.5% based on both in-sample and out-of-sample testing. This suggests that the model, when used to estimate the yield obtainable on a prospective government bond issuance, can be expected to produce estimates that are on average less than 0.5% away from the actual bond yield.

While this model is a definite improvement on more naïve approaches (such as substituting the SA ZCY for the Lesotho ZCY), the estimates produced are far from perfect. This is inevitable due to data limitations arising from the illiquidity of Lesotho's bond market. Thus the model should be used with appropriate caution and care, bearing in mind its limitations..

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APPENDICES

Appendix I: Estimated zero-coupon yields

Yields in this Appendix are expressed as continuously compounded annual interest rates.

Date (dd/mm/yyyy)	Approximate term (years)	SA yield	Lesotho yield, based on Nelder-Mead	Lesotho yield, based on linear spline
20/10/2010	0.25	5.99%	5.95%	5.94%
20/10/2010	0.5	5.86%	6.09%	6.09%
20/10/2010	0.75	5.80%	6.87%	6.87%
20/10/2010	1	5.79%	7.05%	7.05%
20/10/2010	3	6.36%	8.16%	8.17%
20/10/2010	5	6.96%	8.96%	8.97%
08/12/2010	0.25	5.55%	5.70%	5.70%
08/12/2010	0.5	5.50%	6.02%	6.00%
08/12/2010	0.75	5.49%	6.79%	6.78%
08/12/2010	1	5.52%	6.94%	6.94%
08/12/2010	2.75	6.25%	8.58%	8.57%
08/12/2010	4.75	7.09%	9.20%	9.22%
16/02/2011	0.25	5.58%	5.48%	5.47%
16/02/2011	0.5	5.62%	5.76%	5.76%
16/02/2011	0.75	5.69%	6.52%	6.53%
16/02/2011	1	5.83%	6.68%	6.68%
16/02/2011	2.75	7.03%	7.92%	7.92%
16/02/2011	4.75	7.86%	8.51%	8.52%
20/04/2011	0.25	5.58%	5.39%	5.39%
20/04/2011	0.5	5.61%	5.61%	5.61%
20/04/2011	0.75	5.73%	6.04%	6.04%
20/04/2011	1	5.88%	6.49%	6.49%
20/04/2011	2.5	6.97%	8.19%	8.20%
20/04/2011	4.5	7.76%	8.94%	8.96%
22/06/2011	0.25	5.58%	5.33%	5.33%
22/06/2011	0.5	5.65%	5.56%	5.56%
22/06/2011	0.75	5.78%	5.99%	5.99%
22/06/2011	1	5.93%	6.44%	6.44%
22/06/2011	4.25	7.48%	9.21%	9.23%
22/06/2011	10	8.25%	10.00%	10.13%
17/08/2011	0.25	5.60%	5.33%	5.32%
17/08/2011	0.5	5.58%	5.42%	5.42%
17/08/2011	0.75	5.58%	5.88%	5.89%
17/08/2011	1	5.59%	6.20%	6.20%
17/08/2011	4.25	6.62%	8.82%	8.84%
17/08/2011	9.75	7.76%	10.37%	10.47%

Appendix I: Estimated zero-coupon yields (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

Date (dd/mm/yyyy)	Approximate term (years)	SA yield	Lesotho yield, based on Nelder-Mead	Lesotho yield, based on linear spline
19/10/2011	0.25	5.58%	5.32%	5.32%
19/10/2011	0.5	5.51%	5.41%	5.41%
19/10/2011	0.75	5.45%	5.82%	5.82%
19/10/2011	1	5.43%	6.10%	6.10%
19/10/2011	4	6.52%	9.04%	9.04%
19/10/2011	9.75	7.99%	9.85%	10.02%
21/12/2011	0.25	5.59%	5.31%	5.31%
21/12/2011	0.5	5.58%	5.34%	5.34%
21/12/2011	0.75	5.58%	5.68%	5.68%
21/12/2011	1	5.60%	5.95%	5.95%
21/12/2011	3.75	6.61%	9.17%	9.17%
21/12/2011	9.5	7.97%	9.91%	10.13%
15/02/2012	0.25	5.60%	5.47%	5.46%
15/02/2012	0.5	5.61%	5.47%	5.46%
15/02/2012	0.75	5.63%	5.68%	5.68%
15/02/2012	1	5.67%	5.94%	5.94%
15/02/2012	7	7.30%	8.59%	8.63%
15/02/2012	9.25	7.67%	11.06%	11.06%
18/04/2012	0.25	5.60%	5.58%	5.56%
18/04/2012	0.5	5.61%	5.62%	5.62%
18/04/2012	0.75	5.65%	5.87%	5.87%
18/04/2012	1	5.70%	6.02%	6.02%
18/04/2012	6.75	7.28%	8.74%	8.75%
18/04/2012	9.25	7.67%	10.52%	10.51%
15/08/2012	0.25	5.08%	5.46%	5.46%
15/08/2012	0.5	5.02%	5.54%	5.54%
15/08/2012	0.75	4.99%	5.77%	5.77%
15/08/2012	1	4.98%	5.66%	5.66%
15/08/2012	6.5	6.42%	8.69%	8.64%
15/08/2012	8.75	6.88%	9.12%	9.10%
17/10/2012	0.25	5.08%	5.47%	5.45%
17/10/2012	0.5	4.96%	5.40%	5.41%
17/10/2012	0.75	4.89%	5.72%	5.72%
17/10/2012	1	4.86%	5.76%	5.77%
17/10/2012	6.25	6.29%	8.79%	8.77%
17/10/2012	8.75	6.93%	8.65%	8.67%
19/12/2012	0.25	5.13%	5.38%	5.37%
19/12/2012	0.5	5.06%	5.36%	5.37%
19/12/2012	0.75	5.02%	5.63%	5.63%

APPENDICES

Appendix I: Estimated zero-coupon yields (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

Date (dd/mm/yyyy)	Approximate term (years)	SA yield	Lesotho yield, based on Nelder-Mead	Lesotho yield, based on linear spline
19/12/2012	1	4.99%	5.69%	5.69%
19/12/2012	6.25	6.16%	8.46%	8.44%
19/12/2012	8.5	6.67%	8.92%	8.92%
20/02/2013	0.25	5.08%	5.37%	5.36%
20/02/2013	0.5	5.08%	5.34%	5.34%
20/02/2013	0.75	5.06%	5.54%	5.53%
20/02/2013	1	5.06%	5.54%	5.54%
20/02/2013	6	6.30%	8.30%	8.27%
20/02/2013	8.25	6.82%	9.24%	9.23%
19/03/2014	0.25	5.73%	6.05%	6.05%
19/03/2014	0.5	5.95%	6.30%	6.30%
19/03/2014	0.75	6.15%	6.60%	6.60%
19/03/2014	1	6.38%	6.68%	6.67%
19/03/2014	5	8.07%	8.28%	8.28%
25/06/2014	0.25	5.81%	6.15%	6.15%
25/06/2014	0.5	6.02%	6.35%	6.35%
25/06/2014	0.75	6.17%	6.68%	6.68%
25/06/2014	1	6.31%	6.70%	6.70%
25/06/2014	4.75	7.51%	8.22%	8.21%
17/08/2014	0.25	6.08%	6.16%	6.15%
17/08/2014	0.5	6.15%	6.34%	6.32%
17/08/2014	0.75	6.25%	6.63%	6.68%
17/08/2014	1	6.34%	6.99%	6.95%
17/08/2014	4.5	7.37%	8.40%	8.43%
17/08/2014	6.75	7.83%	10.55%	10.54%
31/12/2014	0.25	6.13%	6.30%	6.30%
31/12/2014	0.5	6.26%	6.88%	6.88%
31/12/2014	0.75	6.37%	7.02%	7.02%
31/12/2014	1	6.48%	7.14%	7.14%
31/12/2014	4	7.31%	8.74%	8.74%
31/12/2014	6.5	7.69%	10.08%	10.08%
18/03/2015	0.25	6.11%	6.33%	6.30%
18/03/2015	0.5	6.19%	6.66%	6.67%
18/03/2015	0.75	6.27%	7.00%	6.86%
18/03/2015	1	6.38%	6.97%	7.09%
18/03/2015	4	7.25%	8.22%	8.19%
18/03/2015	6.25	7.59%	10.33%	10.29%

Source: **CBL, Bloomberg**

APPENDICES

Appendix II: Model estimation output for alternative models							
Yields in this Appendix are expressed as continuously compounded annual interest rates.							
ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 10/14/15 Time: 09:37				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.015959	0.005300	3.011016	0.0032
			SA_YIELD	0.887014	0.092088	9.632233	0.0000
			LOG(TERM)	0.007336	0.000489	15.00939	0.0000
Nelder-Mead	All	Preferred					
			R-squared	0.922860	Mean dependent var		0.069946
			Adjusted R-squared	0.921445	S.D. dependent var		0.015749
			S.E. of regression	0.004414	Akaike info criterion		-7.981620
			Sum squared resid	0.002124	Schwarz criterion		-7.908803
			Log likelihood	449.9707	Hannan-Quinn criter.		-7.952076
			F-statistic	652.0080	Durbin-Watson stat		1.646658
			Prob(F-statistic)	0.000000	Wald F-statistic		451.0242
			Prob (Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.591 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.000				

APPENDICES

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/30/15 Time: 15:15				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.018226	0.005039	3.616994	0.0005
			SA_YIELD	0.809073	0.091084	8.882755	0.0000
			TERM	0.001138	0.000430	2.644595	0.0094
			LOG(TERM)	0.005229	0.000914	5.720503	0.0000
Nelder-Mead	All	1					
			R-squared	0.928525	Mean dependent var		0.069946
			Adjusted R-squared	0.926540	S.D. dependent var		0.015749
			S.E. of regression	0.004269	Akaike info criterion		-8.040038
			Sum squared resid	0.001968	Schwarz criterion		-7.942948
			Log likelihood	454.2421	Hannan-Quinn criter.		-8.000646
			F-statistic	467.6730	Durbin-Watson stat		1.680148
			Prob(F-statistic)	0.000000	Wald F-statistic		323.9629
			Prob (Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.456 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.000				

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/30/15 Time: 15:13				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.008059	0.004851	1.661358	0.0995
			SA_YIELD	0.923599	0.089494	10.32025	0.0000
			TERM	0.002885	0.000252	11.46664	0.0000
Nelder-Mead	All	2					
			R-squared	0.906938	Mean dependent var		0.069946
			Adjusted R-squared	0.905230	S.D. dependent var		0.015749
			S.E. of regression	0.004848	Akaike info criterion		-7.793974
			Sum squared resid	0.002562	Schwarz criterion		-7.721157
			Log likelihood	439.4625	Hannan-Quinn criter.		-7.764430
			F-statistic	531.1300	Durbin-Watson stat		1.541317
			Prob(F-statistic)	0.000000	Wald F-statistic		339.4071
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.059 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.000				

APPENDICES

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/30/15 Time: 15:14				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	-0.048169	0.026418	-1.823326	0.0711
			SA_YIELD	2.811290	0.913532	3.077385	0.0027
			SA_YIELD^2	-17.24530	8.046874	-2.143106	0.0344
			TERM	0.010931	0.002035	5.372876	0.0000
			TERM^2	-0.001588	0.000538	-2.952347	0.0039
			TERM^3	8.65E-05	3.79E-05	2.282722	0.0244
Nelder-Mead	All	3					
			R-squared	0.935896	Mean dependent var		0.069946
			Adjusted R-squared	0.932872	S.D. dependent var		0.015749
			S.E. of regression	0.004080	Akaike info criterion		-8.113164
			Sum squared resid	0.001765	Schwarz criterion		-7.967530
			Log likelihood	460.3372	Hannan-Quinn criter.		-8.054075
			F-statistic	309.5126	Durbin-Watson stat		1.614106
			Prob(F-statistic)	0.000000	Wald F-statistic		264.8967
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.045 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.000				

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/30/15 Time: 15:16				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.205139	0.013595	15.08905	0.0000
			LOG(SA_YIELD)	0.049104	0.004644	10.57385	0.0000
			TERM	0.001237	0.000417	2.968268	0.0037
			LOG(TERM)	0.005120	0.000875	5.853085	0.0000
Nelder-Mead	All	4					
			R-squared	0.930924	Mean dependent var		0.069946
			Adjusted R-squared	0.929005	S.D. dependent var		0.015749
			S.E. of regression	0.004196	Akaike info criterion		-8.074180
			Sum squared resid	0.001902	Schwarz criterion		-7.977090
			Log likelihood	456.1541	Hannan-Quinn criter.		-8.034787
			F-statistic	485.1663	Durbin-Watson stat		1.653306
			Prob(F-statistic)	0.000000	Wald F-statistic		328.4225
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.358 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.000				

APPENDICES

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LOG(LESOTHO_YIELD)				
			Method: Least Squares				
			Date: 07/30/15 Time: 15:18				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	-0.584628	0.180581	-3.237483	0.0016
			LOG(SA_YIELD)	0.747236	0.063194	11.82458	0.0000
			LOG(TERM)	0.099237	0.006325	15.69082	0.0000
Nelder-Mead	All	5					
			R-squared	0.929820	Mean dependent var		-2.683329
			Adjusted R-squared	0.928532	S.D. dependent var		0.212930
			S.E. of regression	0.056924	Akaike info criterion		-2.867795
			Sum squared resid	0.353192	Schwarz criterion		-2.794978
			Log likelihood	163.5965	Hannan-Quinn criter.		-2.838250
			F-statistic	722.0715	Durbin-Watson stat		1.399653
			Prob(F-statistic)	0.000000	Wald F-statistic		619.2950
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.635 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.025				

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/30/15 Time: 15:18				
			Sample: 1 36				
			Included observations: 36				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.048719	0.012430	3.919504	0.0004
			SA_YIELD	0.439234	0.190448	2.306320	0.0275
			TERM	0.001909	0.000463	4.125539	0.0002
Nelder-Mead	>1 year*	2					
			R-squared	0.513801	Mean dependent var		-2.683329
			Adjusted R-squared	0.484335	S.D. dependent var		0.212930
			S.E. of regression	0.005781	Akaike info criterion		-2.867795
			Sum squared resid	0.001103	Schwarz criterion		-2.794978
			Log likelihood	135.9982	Hannan-Quinn criter.		-2.838250
			F-statistic	17.43675	Durbin-Watson stat		1.399653
			Prob(F-statistic)	0.000007			619.2950
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.412 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.143				

APPENDICES

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 10/14/15 Time: 10:15				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.015057	0.005298	2.841820	0.0054
			SA_YIELD	0.902939	0.092113	9.802520	0.0000
			LOG(TERM)	0.007334	0.000482	15.20621	0.0000
Linear spline	All	Preferred					
			R-squared	0.925150	Mean dependent var		0.069986
			Adjusted R-squared	0.923777	S.D. dependent var		0.015856
			S.E. of regression	0.004378	Akaike info criterion		-7.998210
			Sum squared resid	0.002089	Schwarz criterion		-7.925393
			Log likelihood	450.8997	Hannan-Quinn criter.		-7.968665
			F-statistic	673.6226	Durbin-Watson stat		1.624196
			Prob(F-statistic)	0.000000	Wald F-statistic		473.2138
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.508 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.000				

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/28/15 Time: 15:11				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.019053	0.004908	3.882154	0.0002
			SA_YIELD	0.769126	0.086777	8.863219	0.0000
			TERM	0.001224	0.000419	2.922906	0.0042
			LOG(TERM)	0.005068	0.000892	5.684141	0.0000
Linear spline	All	1					
			R-squared	0.931491	Mean dependent var		0.069986
			Adjusted R-squared	0.929588	S.D. dependent var		0.015856
			S.E. of regression	0.004207	Akaike info criterion		-8.068878
			Sum squared resid	0.001912	Schwarz criterion		-7.971789
			Log likelihood	455.8572	Hannan-Quinn criter.		-8.029486
			F-statistic	489.4807	Durbin-Watson stat		1.652890
			Prob(F-statistic)	0.000000	Wald F-statistic		352.3139
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.195 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.000				

APPENDICES

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/28/15 Time: 12:39				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.009368	0.004768	1.964817	0.0520
			SA_YIELD	0.874138	0.085714	10.19828	0.0000
			TERM	0.002915	0.000247	11.80795	0.0000
Linear spline	All	2					
			R-squared	0.911499	Mean dependent var		0.069986
			Adjusted R-squared	0.909875	S.D. dependent var		0.015856
			S.E. of regression	0.004760	Akaike info criterion		-7.830678
			Sum squared resid	0.002470	Schwarz criterion		-7.757861
			Log likelihood	441.5179	Hannan-Quinn criter.		-7.801133
			F-statistic	561.3093	Durbin-Watson stat		1.512213
			Prob(F-statistic)	0.000000	Wald F-statistic		389.9149
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.009 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.005				

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/28/15 Time: 16:13				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	-0.041933	0.024859	-1.686842	0.0946
			SA_YIELD	2.531632	0.833897	3.035905	0.0030
			SA_YIELD^2	-14.72022	7.130913	-2.064283	0.0414
			TERM	0.011173	0.002016	5.541402	0.0000
			TERM^2	-0.001685	0.000531	-3.171696	0.0020
			TERM^3	9.47E-05	3.73E-05	2.536721	0.0126
Linear spline	All	3					
			R-squared	0.938290	Mean dependent var		0.069986
			Adjusted R-squared	0.935379	S.D. dependent var		0.015856
			S.E. of regression	0.004031	Akaike info criterion		-8.137680
			Sum squared resid	0.001722	Schwarz criterion		-7.992046
			Log likelihood	461.7101	Hannan-Quinn criter.		-8.078592
			F-statistic	322.3428	Durbin-Watson stat		1.605372
			Prob(F-statistic)	0.000000	Wald F-statistic		276.7245
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.266 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.000				

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Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/28/15 Time: 15:42				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.200691	0.013209	15.19302	0.0000
			LOG(SA_YIELD)	0.048093	0.004548	10.57544	0.0000
			TERM	0.001330	0.000405	3.283091	0.0014
			LOG(TERM)	0.004952	0.000854	5.797435	0.0000
Linear spline	All	4					
			R-squared	0.933699	Mean dependent var		0.069986
			Adjusted R-squared	0.931857	S.D. dependent var		0.015856
			S.E. of regression	0.004139	Akaike info criterion		-8.101633
			Sum squared resid	0.001850	Schwarz criterion		-8.004544
			Log likelihood	457.6914	Hannan-Quinn criter.		-8.062241
			F-statistic	506.9777	Durbin-Watson stat		1.625074
			Prob(F-statistic)	0.000000	Wald F-statistic		353.1348
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.273 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.000				

Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LOG(LESOTHO_YIELD)				
			Method: Least Squares				
			Date: 07/28/15 Time: 15:40				
			Sample: 1 112				
			Included observations: 112				
			White heteroskedasticity-consistent standard errors & covariance				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	-0.647983	0.173395	-3.737033	0.0003
			LOG(SA_YIELD)	0.732457	0.061297	11.94927	0.0000
			LOG(TERM)	0.099416	0.006252	15.90194	0.0000
Linear spline	All	5					
			R-squared	0.931835	Mean dependent var		-2.683008
			Adjusted R-squared	0.930585	S.D. dependent var		0.213992
			S.E. of regression	0.056380	Akaike info criterion		-2.886984
			Sum squared resid	0.346479	Schwarz criterion		-2.814167
			Log likelihood	164.6711	Hannan-Quinn criter.		-2.857439
			F-statistic	745.0342	Durbin-Watson stat		1.389331
			Prob(F-statistic)	0.000000	Wald F-statistic		651.0000
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.653 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.063				

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Appendix II: Model estimation output for alternative models (continued)

Yields in this Appendix are expressed as continuously compounded annual interest rates.

ZCY curve-fitting method	Terms included	Terms included	Estimation output (Eviews 8 statistical package used)				
			Dependent Variable: LESOTHO_YIELD				
			Method: Least Squares				
			Date: 07/28/15 Time: 12:41				
			Sample: 1 36				
			Included observations: 36				
			Variable	Coefficient	Std. Error	t-Statistic	Prob.
			C	0.046823	0.011889	3.938252	0.0004
			SA_YIELD	0.446054	0.176117	2.532709	0.0163
			TERM	0.001989	0.000459	4.336454	0.0001
Linear spline	>1 year*	2					
			R-squared	0.545582	Mean dependent var		0.090919
			Adjusted R-squared	0.518042	S.D. dependent var		0.008249
			S.E. of regression	0.005727	Akaike info criterion		-7.407607
			Sum squared resid	0.001082	Schwarz criterion		-7.275647
			Log likelihood	136.3369	Hannan-Quinn criter.		-7.361550
			F-statistic	19.81022	Durbin-Watson stat		2.066459
			Prob(F-statistic)	0.000002			
			Prob(Wald F-statistic)	0.000000			
			Jarque-Bera normality test p-value: 0.460 Breusch-Pagan-Godfrey heteroskedasticity test p-value: 0.280				

* For these versions of the model, the data set included only ZCYs corresponding to terms longer than one year, leaving a total of 36 observations instead of the original 112.
^ Equations are set out in Table 3.

Source: **CBL**.

The Financial Inclusion Conundrum in Lesotho: Is Mobile Money the Missing Piece in the Puzzle?

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Key words:
Financial Inclusion, Mobile Money, Credit Growth

JEL Classification: C01, C22, C87, G23, O10, O30

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1 INTRODUCTION

MANY DEVELOPING COUNTRIES, especially in Africa, are characterized by financial exclusion in the form of low access to financial services. This is mainly a result of banking infrastructure gaps that hinder an all -inclusive financial system (Andrianaivo & Kpodar, 2012). According to Beck & Maimbo (2013) approximately 2.5 billion people in the world lack access to financial services and have to rely on cash or informal financial services which are typically unsafe, inconvenient and expensive. However, more than half of households in developing countries do not have an account with a financial institution. In the case of Lesotho, approximately 38% of the adult population has a bank account, which indicates that the majority of the adult population still lacks access to basic financial services (Ketly & Kasi, 2015). The mainstream banking sector fails to deliver financial services to millions of consumers especially those residing in rural areas. Banks are biased in favour of affluent consumers due to high costs of physical infrastructure and operational costs as well as low profits associated with serving the low income consumers (Dube, 2014). This lack of access to financial services not only limits the ability of the poor to save, repay debts and manage risk responsibly but also indirectly exposes them to poverty (see Donovan, 2012).

The development of mobile money has provided a glimpse of hope for the financially excluded members of the population. Mobile money is perceived as a solution that can circumvent poor banking infrastructure and geographical isolation and can offer low-cost distribution of financial services through the mobile phone network. In addition, the surge and near-universal use of mobile phones and the huge number of airtime distributors that can act as access points make mobile money a cost-effective solution to financial access (Ketly & Kasi, 2015). Following the successful adoption of mobile money in Kenya, numerous countries have scaled up their efforts to implement it in an effort to increase access to financial services. Hence, it is crucial to study the impact of mobile money on financial inclusion. This study pursues this objective in the context of Lesotho using monthly data for the period 2013m7 – 2015m12.

The rest of the paper is organized as follows: Section 2 reviews the literature on mobile money and financial inclusion while section 3 discusses mobile money developments in Lesotho. Section 4 describes the data and presents the analytical framework and section 5 discusses the empirical results. Section 6 concludes the paper and offers a menu of recommendations.

2 REVIEW OF THE LITERATURE

2.1 The Definition of Financial Inclusion and Identification of its Constraints

Financial inclusion is defined as a process that ensures ease of access, availability and usage of the formal financial system for all members of an economy. It entails access to financial services such as payment services, remittance facilities, savings, loans as well as insurance services offered by the formal financial system at costs that can be afforded by the poor and disadvantaged social groups. An inclusive financial system has several benefits. First, it facilitates efficient allocation of productive resources and can potentially lower the cost of capital. Second, access to appropriate financial services can considerably improve the management of finances on daily basis. Third, it can also help in reducing the growth of informal sources of credit such as money lenders that are often found to be exploitative. An all-inclusive financial system enhances efficiency and welfare by providing avenues for secure and safe saving practices and it also facilitates availability of a whole range of efficient financial services (Sarma & Pais, 2011). According to Dube et al (2014) financial inclusion does not only ensure access to basic financial services by all, but also promotes economic growth, reduces poverty and inculcates a savings culture in rural areas.

The issue of inclusive financial system has attracted greater attention both in academic and policy circles and has become a policy priority in many countries around the globe. Therefore, financial regulators, governments and the banking industry over the world have beefed up efforts to develop and implement various initiatives that deepen financial inclusion. For instance, the United States (US) has developed legislative measures that require banks to offer credit throughout their areas of operation without discriminating between the rich and the poor. France has also developed measures that emphasize a person's right to have a bank account. Furthermore, the banking industry has introduced products such as "no-frills" accounts and "General Credit Cards" for low deposits and launched low cost bank accounts to promote financial inclusion. In addition, micro-finance institutions and "Self-Help Groups" have also been promoted in some countries such as India to take care of the excluded groups (Sarma & Pais, 2011). These efforts are meant to ensure access and affordable financial services to the poor to allow them to plan for routine expenses, cope with external shocks and better cover unanticipated expenses. In addition, they contribute to increased access to more stable and productive activities (Gwalani & Parkhi, 2014). This, not only enhances economic growth and reduces poverty, but also promotes social inclusion[1].

The degree of financial inclusion differs among countries depending on their stages of economic and financial development. Developed countries such as the US and United Kingdom (UK) have managed to provide financial services to the vast majority of their populations. However, in developing countries particularly in Africa, the issue of financial inclusion still remains a challenge as most countries are severely constrained by limited infrastructure and the other difficulties of accessing financial institutions, which leave large proportions of

[1] Social inclusion is defined as the degree to which people are and feel integrated in the different relationships, organizations, sub-systems and structures that constitute everyday life. As a process, it refers both to integration into social, economic and civic life and the pursuit of active citizenship as well as a means to counter poverty understood in the sense of capability deprivation (see Cardo, 2014).

the population, especially those who reside in remote areas, with low access to affordable financial services or completely excluded from financial services (see Kempson,2006 and Oji,2015).

The literature identifies both demand and supply side constraints to financial inclusion. For example, people may choose not to use formal financial services because they do not need such services due to religious and cultural reasons, and/or lack of trust in formal financial institutions. Lack of trust may be a result of, among others, fear of bank failure or fraud. In addition, people who wish to use formal financial services may face several barriers. First, inaccessibility due to difficulty in reaching service points or absence of such services in the vicinity. Second, unaffordability as formal financial services are often too costly for low income persons. Third, inappropriate product design, which results in products that do not meet the needs of excluded customers. Fourth, inability to meet eligibility criteria, for example not having sufficient assets to meet conditions for the extension of a loan or being unable to provide documentation evidencing identity. In addition, other demand side constraints include cumbersome documentation and procedures that customers have to undergo when opening a bank account, limited literacy and numeracy skills, information asymmetry due to lack of awareness, branch operating hours, which may be inflexible for some sections of the population (see De Koker & Jentzsch, 2013; Gwalani & Parkhi,2014 and Kempson,2006).

On the supply side, some people who had initially utilized formal financial services may opt to withdraw from such services due to high costs inherent in maintaining them, lack of trust or faith in the banking system, bad credit records, difficulties associated with the management of their spending and inappropriate product design as well as complex procedures for availing financial services. Apart from that, regulatory requirements which require financial service providers to adopt stringent disclosure requirements, which must be met by the customers before the service is provided, deter customers from participating in the formal financial system (De Koker & Jentzsch, 2013). In addition, financial service providers may decide not to offer some services to customers if they feel that the environment does not protect their interests (Central Bank of Lesotho, 2013). Thus, in spite of intensified efforts to increase access and use of financial services, many developing countries still have the vast majority of their populations unbanked[2].

2.2 The Role of Telecommunication Technologies in improving Financial Inclusion

The conventional banking system has not been able to provide financial services to a large number of low-income and poor people, especially in remote areas, due to high costs of physical infrastructure, operational costs and unprofitability arising from serving low income consumers (see Boston Consulting Group, 2011; Goss, Mas, Radcliffe & Stark, 2011). However, the diffusion of information and communication technologies (ICT) and mobile telephony have the potential to significantly reduce barriers to financial inclusion and therefore allow millions of people who were otherwise excluded from the formal financial system to perform financial

[2] According to Gross et al (2012) and Breitbach & Walstad (2014/2015) the unbanked are individuals or households without checking or savings accounts and operate largely outside the banking system when making financial transactions. On the other hand, the underbanked are individuals or households that have a bank account(checking, savings or money market account), but supplement the account with alternatives to traditional banking services such as non-bank money orders, non-bank check-cashing services, payday loans, rent-to-own agreements, payday loan, payroll card or pawnshops.

transactions relatively cheaply, securely, and reliably through their mobile phones (Dube at al,2014). Mobile money, defined as the provision of a range of financial service such as mobile banking, mobile payments and mobile transfers to consumers through mobile devices, is one of many possibilities arising from advancement in technology. It encompasses common functions such as balance checks, funds transfer, depositing and withdrawing cash (cash-in and cash out), savings, access to credit, bill payments, airtime purchase and long distance remittance of funds (Donner and Tellez, 2008; Kasseeah & Tandrayen-Ragoobur, 2012; Jenkins, 2008).

Mobile phones have a great potential for delivering financial services to a broader base of customers due to their enormous uptake by large number of the unbanked and the poor in developing countries. Moreover, mobile phone systems can be placed anywhere as long as there is wireless phone connection and this overcomes the problem of distance and lack of bank branches in remote areas. In this regards, it enables the possibility of ubiquitous access to financial services. Furthermore, mobile money financial services are commonly set up with infrastructure provided by a network of "cash merchants" (or "agents"), who may be located all over the country, as well as a host of other supporting businesses such as banks, agent aggregators and liquidity management firms (Donovan, 2012; Ramada-Sarasola, 2012). Therefore, it does not only enable new entrants to the banking system but also offers such services at lower costs because it does not incur the costs of physical roll-out and faces lower costs of handling low-value transactions(Flores-Roux & Mariscal, 2010).

The fact that mobile money uses existing mobile infrastructure to deliver all services online brings cost efficiency to the provision of cash-in and cash-out services to the poor (Flores-Roux & Mariscal, 2010). These it lowers transaction costs, which translate into savings for the poor. Consequently, this assists the poor to reallocate their resources efficiently to smoothen their consumption patterns (Donovan, 2012 and Dube, 2014). In addition, it reduces transportation costs[3] and improves information flows between transacting parties while allowing efficiency gains (see Bhatia et al, 2008 & Sife *et al*, 2010). It can also be viewed as the most reliable, accessible and convenient medium for the delivery of financial services by poor households due to its speed and liquidity as well as its ability to act as a store of value since mobile money value does not decline with time[4].

Mobile money also increases the large scale financial connectedness among distant households and individuals. This allows users/customers to benefit from remittances from either family members or friends living in remote areas within the same country or abroad. Assuming other things remain the same, this alone improves the economic well-being as this acts as source of income for the poor (Hinson, 2011; Morawczynski & Pickens, 2009; Alleman & Rappoport, 2010), According to Morawczynski (2010) using mobile money also increases money circulation, boosts local consumption for the rural people as well as spurs economic activity by enabling "just-in-time" transfers that make capital available whenever and whenever it is needed. Apart from that, by acting as a channel through which households and individuals receive remittances, mobile money often enables households and individuals to absorb shocks arising from job losses and poor harvests, loss of relatives, health problems and so on (Donovan, 2012).

[3] This is relevant in cases where users or traders in rural areas would need to travel from to urban areas to send and receive money.
[4] Unlike cash, mobile money does not attract charges, which ultimately reduces its value. However, its value remains the same until it is used.

Mobile money serves as a form of savings account for people without a formal bank account. Thus, it enables them to engage in a safer and more efficient savings mechanism and improves efficiency and regularity of savings (Nandhi, 2012). In connection with this, by acting as remittance channel mobile money increases the income of the rural users, which leads to increase in savings. Apart from that, these mobile money accounts have the potential of adding social value to low-income people, who usually face constraints with respect to opening a formal bank account (Jack & Suri, 2011). In addition, mobile money account has the potential of integrating the mobile money users into the formal financial services grid by providing access to other accounts that cover a wide range of other financial services' needs (Alexandre & Eisenhart, 2013 and Flores-Roux & Mariscal, 2010). Furthermore, the fact that mobile money is less visible than other alternatives including cash enables mobile money users to keep their money safe from dangers of theft and accessibility by other family members (Jack & Suri, 2011). In this regard, it promotes privacy and individual autonomy within the family while also makes it possible to facilitate or enable financial transactions that either did not occur before or that were conducted at a higher risk and price (Donovan, 2012).

Moreover, when it has reached large scale and there is large customer base, provision mobile money services can also prove to be commercially viable. It generates considerable revenue for both service providers and cash agents, the success of which may lead to increased labor demand and employment generation for the poor. In recent years, access and use of more sophisticated financial services such as savings, credit, and insurance has proved to be far more beneficial to the poor. In light of this development, financial institutions, banks, governments, and other institutions have taken advantage of the payment services that are deployed by mobile money operators to actively innovate and develop these financial services and offer them to customers. For instance, in Lesotho some Alliance Insurance Company has partnered with Econet Telecom Lesotho (ETL) to offer funeral insurance covers for consumers whereas in Kenya, Equity Bank has partnered with Safaricom to offer micro savings account, credit and insurance. In addition, some governments have already adopted mobile money electronic payment services platform for cash transfers to reduce leakage, transaction costs and overheads. For instance, in Tanzania mobile money has also been adopted by the government to collect all levies, fees and taxes paid by the public. This helps to enhance the government's ability to monitor financial flows, collect tax revenue, and reduce illicit corruption and fraud (Donovan, 2012).

While mobile money reduces the dependency on cash and contributes to the development of an electronic ecosystem of financial services, it also generates data[5] in the form of financial transaction records. These transaction records can be efficiently used to analyze creditworthiness, enhance credit monitoring as well as facilitate access to micro-loans or other financial services (see Andrianaivo & Kpodar, 2012 and Mutsune, 2015). Furthermore, the data generated by mobile money can also act as tool that can be used to report suspicious financial transactions that mobile money operators or banks can identify in an effort to combat money laundering and terrorism financing (Alexandre & Eisenhart, 2013 and De Koker & Jentzsch, 2013). This is pertinent given the rampant increase in money laundering and terrorism financing activities in recent years.

[5] According to Alexandre and Eisenhart (2013), data is a strong asset for both financial inclusion and financial integrity.

From the business perspective, the payment behavior data of the unbanked and poor customers can shed some light on how poor customers transact, their payment behavior as well as their financial service needs. Therefore, the providers of highly data-dependent areas such as credit, insurance can use the payment data of customers to build business case to serve this new and diverse segment of the market that has largely been ignored by the many financial service providers. In addition, banks can use this information to develop opportunities to cross-sell additional products such as credit, long-term savings accounts, which enhance the business case for low-value bank accounts. On the other hand, the mobile money operators can generate revenue by selectively selling the data to other parties that can utilise it to market products and services that assists in terms of broadening the services that keep customers loyal to their existing mobile money schemes (Alexandre & Eisenhart, 2013)

Mobile money has several unique attributes that make mobile based transactions attractive. However, it also presents inherent risks, including money laundering, privacy and security, consumer protection, fraud, and liquidity risks just like any retail payment system. In many mobile money implementations, proportionally risk adjusted anti-money laundering (AML) procedures have been applied to extend the service to the underserved populations. These adjusted AML requirements are usually counterbalanced by transaction volume and value restrictions placed on the account. However, rogue actors circumvent these controls by dividing a large transfer of funds into small ones, which fit within the definition of the restrictions applied using multiple mobile phones and accounts and then transfer the funds. This is possible because unlike traditional banking, which require the face-to-face interaction, mobile technology-enabled payments create a more opaque and anonymous experience that may permit the opportunity for criminal activity. This is increasingly plausible as mobile retail payments can occur rapidly and in cross-border environments. In addition, there are numerous schemes for money laundering and terrorist financing that may migrate to the mobile channel. For instance, the runners of the so-called "digital value smurfing" scheme bypass banks and regulatory reporting requirements by exchanging ill-gotten funds for digital value through mobile devices and thereby enable the proceeds of crime or terrorist financing to be transmitted over airwaves to anywhere the runners intend to take funds(see Merritt ,2010 and Lake, 2013).

Mobile money may also compromise sufficient elements of the customers' information and privacy. This may not only allow another party to replicate the customer's identity in the system and use it to fraudulently conduct transactions but also exposes the customer to other risks such as lost payments through faulty transmissions, or criminal activity on the part of the mobile operator, agent, or other payment service providers. In connection with this, the recent surge in smart phone applications may introduce vulnerabilities to malware attacks, which may increase payments risks as bad actors gain access to personal information stored in the handset or accessed through a phone application (Lake,(2013).In addition, lack of cash or electronic float at the agent outlet may temporarily or permanently disable a client wishing to deposit or withdraw money to or from the system. On one hand, poor network coverage and insufficient service points may make it difficult for customers to undertake transactions, leading to withdrawal from the service. This can consequently compromise revenue generation by the agents. On the other hand, system technical errors and transaction delay by the network usually leave customers and agents in a difficult position to know whether or not the transaction has been delivered and therefore unsure whether or not to re-submit the transaction. Moreover, transactions within mobile payment network travel through many communication systems to reach to the mobile money backend. Any breakage in this chain as well as lack of literacy by the customer can lead to inability to transact by such

a customer. The length of the chains of message handling within the mobile money operation may also delay balance updates for any given transaction. This exposes the customer to possibility of incorrect decline in future transactions due to insufficient funds (see Lake, 2013).

According to Lake (2013) mobile money products are often delivered by consortia of mobile network operators (MNOs), banks, agent network managers as well as agents. Therefore, any significant relationship difficulty among these parties within this consortium could result in service unavailability to the client. Consequently, this could not only cause unnecessary inconvenience on the part of the customer but also lead to inability to transact. In addition, lack of clarity as to who holds customer's money may make it difficult for the customer to enforce rights whenever necessary. Therefore, the mobile payments landscape demands a collaborative effort among different stakeholders to balance intervention for risk mitigation with market innovation. These include mobile networks operators, banks, airtime sales agents, retailers as well as regulators.

2.3 Adoption of Mobile Money and Developments in Financial Inclusion: African Country Experiences

Mobile money services have become popular in developing countries predominantly due to large unbanked populations and low levels of financial inclusion. Among the countries that implemented this service, Kenya is a global leader in mobile payments implementation and adoption with its M-Pesa (mobile money in Swahili) service. Initially launched in 2007 by Safaricom, a subsidiary of Vodafone, for person-to-person transfers, M-pesa has become probably the most renowned and successful mobile money service to date. In May 2008, 14 months after its launch, M-Pesa had 2.7 million users and almost 3,000 agents (GSMA, 2012). Within five years of its launch, it had 15 million customers[6] and more than 18,000 agents and was processing $10 billion per year (Lal & Sachdev, 2015). It has become so successful to the extent that almost all households use it (IOS Press, 2012).

At its launch as money transfers service, M-pesa adopted the slogan "send money home". This positioned it to serve as an "urban-rural" remittance corridor to take advantage of significant domestic remittance market in Kenya. It allowed many urban migrants to remit to their relatives in rural areas (Gugler, 2002 & Donovan, 2012). In addition, it has since grown to provide many other financial services including bill payments, loan transactions, international remittances and public transport payments. The overwhelming dominance of Safaricom in the Kenyan market and high mobile telephony penetration rate as well as increased demand for additional services paved the way for M-Pesa's great success. In addition, an enabling regulatory environment and the relatively high availability of decision-making data continued to support its development (IOS Press, 2012). Of course, M-pesa still faces challenges. These include lack of universal mobile phone access (Jack & Suri, 2011a) and difficulties with liquidity management by agents and raising start-up capital (Eijkman, Kendall & Mas, 2009). Therefore, in order to develop further, Kenya needs to further enhance its institutional and market environments and develop consumer protection provisions. (Bilodeau et al, 2011).

[6] This represents 37.5% of the country's population.

Following the successful launch of M-pesa in Kenya, many mobile network operators (MNOs) became eager to launch such products in their jurisdictions. Therefore, one year after the Kenyan launch, Vodacom[7] launched M-pesa in April 2008 in Tanzania. Nonetheless, the user uptake of this service in Tanzania has been much slower compared to Kenya. In June 2009, 14 months after the launch, M-pesa had 280,000 users and 1,000 agents in Tanzania (Rasmussen, 2009). The slow M-pesa uptake in Tanzania was due to the fact that Vodacom may not have carefully judged the unique country context prior to implementing it in Tanzania. Therefore, it could not contextualize advertising to suit the level of financial literacy in the country for customers to understand the product. In addition, there were weaknesses in terms of contextualizing the nature of remittance market, which is urban-rural, rural-urban, urban-urban and rural-rural.

Still following the Safaricom's M-pesa in Kenya, Mobile Telephone Network (MTN) Uganda, launched MTN money in March 2009. In June of the same year, Airtel launched Airtel money. In an effort to increase their market share, other MNOs also launched their mobile money services. For instance, Uganda's Telecom launched M-sente in March 2010, Warid Telecom launched Warid Pesa in December 2011 and Orange Telecom launched Orange money in the first half of 2012. Since its launch, the subscriber base has increased steadily with over 9 million people using mobile money in 2012. Similarly, the number of mobile money transactions also reached 242 million during the same year while the total value exchange recorded US$4.5 billion during the same time period. Of this large subscriber base country wide, MTN money has the largest market share with over 15,000 agents and it remains one of the most successful mobile financial services deployments in East Africa. The successful expansion of this service is partly attributed to both high mobile phone network roll-out and mobile phone adoption rates (Munyegera and Matsumoto,2014; Orotin et al,2013).

With 15 million adults and mobile penetration rate of 74% of the population, Ghana had five mobile money services in 2010, the sixth of which was not operating in spite of acquiring a licence. These include AfricXpress (txtNpay) launched in 2008, MTN mobile money launched in July 2009 with nine partner banks, Airtel money launched in April 2010 with six partner banks and Tigo Cash established in October 2010 with three partner banks. Among these mobile money services, MTN money is the most successful mobile money deployment in Ghana. In 2011, it had 1.8 million registered customers, 4,000 trained agents in Accra and 2,000 in other parts of the country. Four years after the launch, the service had registered 4.8 million customers, 19, 500 merchants and 18.5 million transactions. Its success is underpinned by heavy investment in above-the line marketing and a primary marketing message focused on domestic remittance. This is due to the fact that Ghana has a large number of households that depend on domestic remittances because of increase in urbanization in city centres and constant migration (see CGAP, 2011 and Tobbin, 2010).

As the largest and most populous economy in Africa with a largest proportion of the population remaining unbanked, Nigeria is a promising market for mobile financial services. In March 2014, Nigeria had licensed 18 MNOs. These include Guaranty Trust Bank (GTBank), United Bank of Africa (UBA/Afripay), Stanbic IBTC, Ecobank, Fortis MFB, Pagatech, Paycom, eTranzact, Eartholeum, M-Kudi and Virtual Terminal Network (Phillips Consulting, 2013). Since commencement of operations in 2012, mobile money had 9,989,297 subscribers, 67,494

[7] A subsidiary of South African Vodacom Pty (Ltd).

enrolled agents and conducted over 11 million transactions worth over N105 billion. However, mobile payments market in Nigeria is still in its infancy. This is in part due to rapid deployment and rollout of the system, which has been inhibited by a number of challenges. These include inadequate capital outlay on the part of the MNOs, basic infrastructural challenges – power, telecommunications network etc, lack of awareness/customer education which has slowed down the adoption rate and lack of wide-spread agent network (see Ingba, 2014; Yakub et al, 2013 and Grameen Foundation, 2014)

In Zimbabwe, Ecocash was launched by Econet Services on the 30th September 2011. Initially, Ecocash invested heavily on upfront capital to build mass of agents and active subscribers. In this case, Ecocash provided incentives such as high commissions (80% of transaction revenues) and performance based rewards to their agents. In addition, they ensured adequate float liquidity for transactions and cash-on –hand to encourage investment in their business. They invested a lot of money on consumer marketing utilizing above-the-line to raise awareness and below-the-line to educate consumers on the service and drives registration. This service initially focused on the underserved segments of the population in semi-urban and rural areas and offered person-to-person transfers but over time the service expanded to other multiple products. The service achieved great success to the extent that it reached an agent network of 4,000 agents, 2.3 million customer registrations (which is equivalent to 31% of the country's adult population) just within 18 months after launch, with 1 million of them active as well as an annualized transaction volume valued at 22% of the country's GDP (Lal & and Sachdev, 2015).

In South Africa, Vodacom tried to replicate the model deployed in Kenya. However, service was launched as a mobile alternative to existing financial and payments infrastructure and was rolled out largely to better-off parts of the country, where there is robust banking environment. The launch plan was not prepared based on the identified target market or an analysis of financial flows/ potential use cases of such market. Therefore, the service effectively did not serve the large remittance corridors of the lower income and rural populations. In addition, the service experienced challenges relating to customer registration and sustaining usage for registered customers. This was due to poor marketing to consumers, which resulted in poor understanding and lack of trust in the service Furthermore, the registration process was lengthy and slow, and this resulted in weak adoption. The service used retail stores as agents, but it was only available at a limited number of locations after launch. Inadequate float management led to suspension of cash-out transactions by many outlets until a certain amount of sales had been registered. At the end, many retailers decided to discontinue acting as M-pesa agents as the service was disrupting their retail business. As a result of these problems the service only had 1.2 million registered users two years after launch, with 7% annual growth, and of which only 1% appeared active. With this mediocre performance, Vodacom opted to discontinue the service at the end of 2013. However, it has since been re-launched with a new banking partner and new model, with a focus on serving the unbanked and low income segments of the population (Lal and Sachdev, 2015). Consequently, the service was discontinued in 2016.

3 FINANCIAL EXCLUSION, MOBILE TELEPHONY AND MOBILE MONEY DEVELOPMENTS IN LESOTHO

3.1 Financial Exclusion

Lesotho has four licensed banks; namely Standard Lesotho Bank (SLB), Nedbank Lesotho, First National Bank Lesotho (FNBL) and Lesotho Postbank (LPB), which form the core of the financial system. Among these banks, SLB is the largest in terms of assets. In addition, there are 6 credit-only Micro Finance Institutions (MFIs) namely Letshego Financial Services, Alibaba Financial Services, Net Loans, Edu Loans, Lesana Lesotho Limited, Blessings Financial Services and Thusong Financial Services with Letshego Financial Services only the largest. There also 70 formal money lenders and approximately 250 savings and credit cooperatives (SACCOs) as well as one large financial cooperative i.e. Boliba Savings and Credit Cooperative. Furthermore, there are 30 licensed insurance brokers and 10 licensed insurance companies that generally specialize in both general insurance and life insurance. However, the analysis focuses on the banking sector as it forms the largest part of the financial sector in Lesotho and it has been the primary distributor of financial services products in the country.

Access to banking is relatively low in Lesotho[8] due to limited banking infrastructure- bank branches and devices infrastructure (ATMs and POSs). Table 1 shows that in 3 years, from 2013 to 2015, banking infrastructure has expanded by only 2 branches, 39 ATMs and 365 point of sales (POSs). Therefore, the country has not seen much change in terms of financial inclusion. This situation is exacerbated by the fact that large proportion of this banking infrastructure is also mainly situated in urban areas though two-thirds of the country's population resides in rural areas. This mismatch implies that 55% of the population travels more than an hour to get to a bank branch while only 24% of Basotho live within 30 minutes travel time from a bank branch. According to Jefferis and Manje (2014), only 29.5% of the rural population in Lesotho is banked compared to 57.9% in urban areas. The provision of financial services in Lesotho is made even more difficult by the mountainous terrain of the country, which makes the banking infrastructure difficult and expensive to distribute to most of Basotho. Despite the low banking access in Lesotho, it is unlikely that banks will significantly increase the number of bank branches and device infrastructure (ATMs and POSs) on account of low population densities, financial viability, small financial markets and mountainous terrain of the country (Ketly and Kasi, 2015).

[8] A This is the lowest in the Southern African Customs Union (SACU).

Table 1: Banking Infrastructure

Bias	Branches			ATMs			POS		
Bias	2013	2014	2015	2013	2014	2015	2013	2014	2015
SLB	17	17	17	73	82	86	307	448	529
FNBL	6	6	8	42	45	59	393	474	423
Nedbank	9	9	9	24	28	27	68	85	149
LPB	13	13	13	2	7	8	35	38	37
Total	45	45	47	141	158	180	803	1045	1168

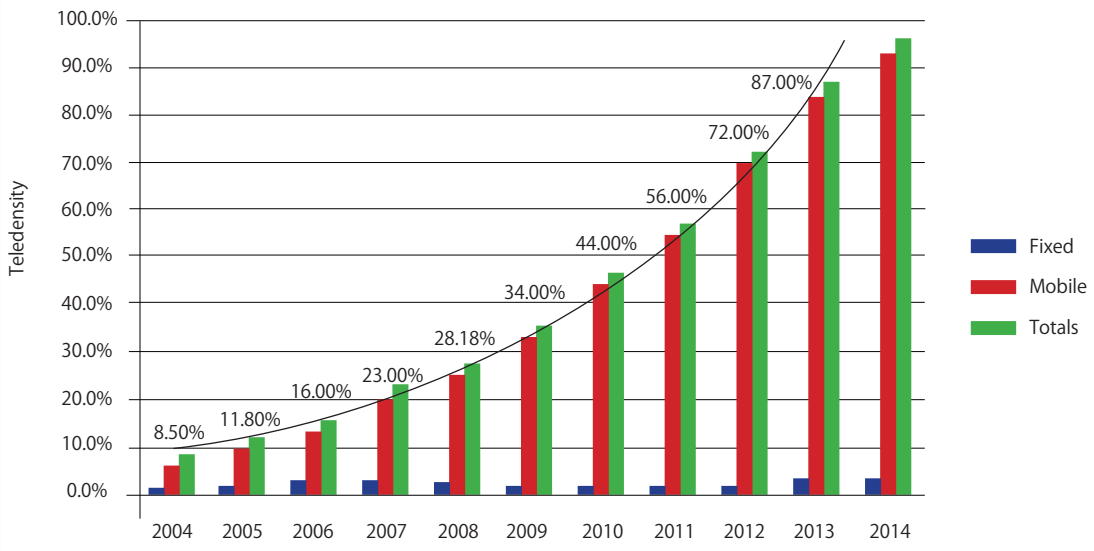
Source: **Central Bank of Lesotho**

According to the FinScope surveys conducted among 15 African countries, the level of financial inclusion in Lesotho stands as high as 80.9% of the adult population, using the traditional measure of financial inclusion. However, only 45.8% of the adult population uses bank and non-bank formal services, of which 38% has bank account with a financial institution. The use of informal services is relatively high, with 62.4% of the adult population using these services particularly funeral insurance, which is a limited product compared to the wide range of financial services needs of the people in the economy (Lesotho FinScope, 2011 and Jefferis and Manje, 2014). Within the Southern African Customs Union (SACU) and Southern African Development Community (SADC) regions, Lesotho has a high level of financial inclusion in the region; it is exceeded by only South Africa and Namibia (see Ketly and Kasi, 2015).

3.2 Mobile Telephone Industry

The launch of the first commercial mobile telephone services three decades ago saw a phenomenal growth in mobile communications around the world. According GSMA (2012b) the total mobile penetration has more than doubled in all regions of world since 2005. This can be attributed to a number of factors including a fall in handset and usage costs and an improvement in service quality and network. On the other hand the use of fixed lines has decreased as they remain undeveloped and unavailable to the majority of the population in developing countries. Low-income countries are experiencing faster growth rates– more than twice as fast as in high income countries in the 21st century (GSMA, 2012b). As of mid-2015; Sub-Saharan Africa (SSA) region had 367 million unique subscribers and 680 million connections (GSMA, 2015). This significant mobile phone penetration has increased the availability of basic mobile services such voice, texts and basic text-related services to millions of people across all income groups in SSA.

Figure 1 Sector Teledensity Trends 2004-2014



Source: Lesotho Communications Authority Annual Report 2013-2014

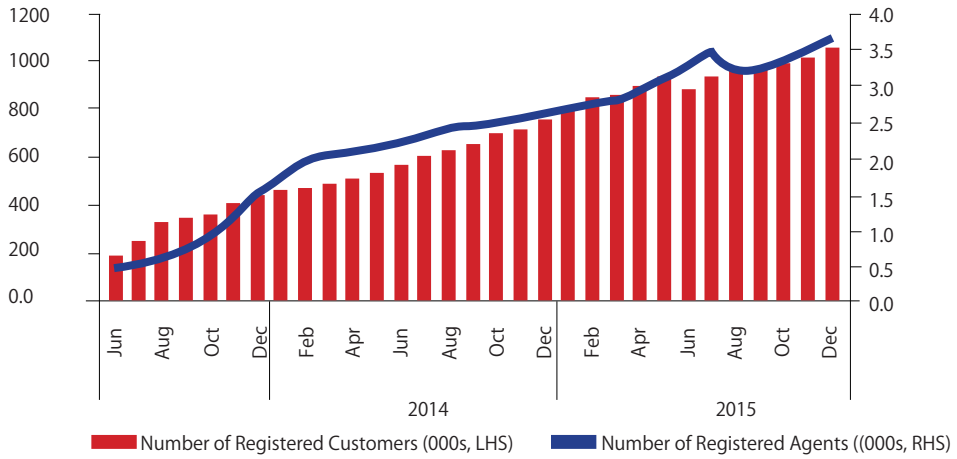
In the context of Lesotho the mobile phone industry is dominated by two mobile network operators (MNOs), namely Econet Telecom Lesotho (ETL) and Vodacom Lesotho (VCL). The former came into being following the merger between Telecom Lesotho and Econet Ezi ~ Cel Lesotho in April 2008 while the latter is a subsidiary of South Africa-based Vodacom and began operating in Lesotho in 1996. There is effective competition in the mobile sector between these two MNOs and they provide network services to their subscribers. Figure 1 shows the mobile sector teledensity trends over a period of ten years from 2004 to 2014. In 2014, the mobile subscribers reached a total of 1,753,323 from 1,580,713 reported in the previous year. This translates into a teledensity of approximately 93% of the population (98% of which are the prepaid subscribers while only 2% are post-paid subscribers). However, the fixed line subscriber base remained constant at 3% during the same year. The mobile subscribers accounted for 97% of telecommunication market share compared to fixed subscribers at 3%. Overall, based on the 2006 population census figure of 1,880,661 for Lesotho, the teledensity for both fixed and mobile subscribers increased from 87% to 96%. In addition, the geographic coverage area with access to communications service (most of which is driven by mobile services) has also increased. This is reflected in the coverage maps of the two major network operators, depicted in appendices, 1 and 2 (LCA Annual Report, 2013/2014).

3.3 Mobile Money

The success of mobile money in East Africa especially M-pesa in Kenya saw many countries around the globe adopting the same model to launch similar products in their jurisdictions. This is because M-pesa has allowed millions of people who were otherwise excluded from the formal financial system to perform financial

transactions relatively cheaply, securely, and reliably. In the same manner, ETL and VCL in Lesotho launched mobile money services in an effort to narrow financial exclusion and drive economic development in Lesotho. ETL launched its mobile money service, Eco-cash, in October 2012 while VCL launched M-pesa in July 2013. Since its launch until December 2015, M-pesa signed up to 745,242 customers with 1999 agents. On the other hand, Eco-cash has accumulated 318,786 customers and 1480 agents countrywide during the same period.

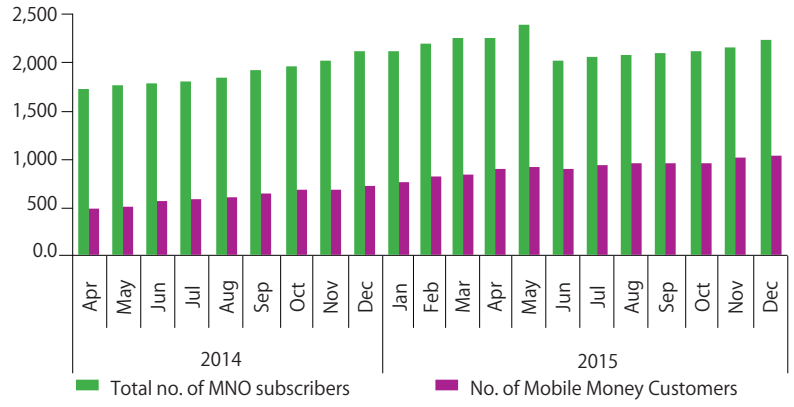
Figure 2 Number of Registered Mobile Money Customers and Agents



Source: Central Bank of Lesotho, 2015

The number of registered mobile money customers in Lesotho kept increasing since mobile money inception as indicated by Figure 2. Based on 2006 population census figure of 1,880,661 inhabitants, the number of registered mobile money customers increased from 10% in June 2013 to approximately 57% of the population in December 2015.On the other hand, the number of agents increased exponentially from 337 in June 2013 to 3654 in December 2015. Figure 2 indicates the number of registered mobile money customers and agents in Lesotho since June 2013. Based on 2006 population census figure of 1,880,661 inhabitants, the number of registered mobile money customers increased from 10% in June 2013 to approximately 57% of the population in December 2015. As a proportion of MNO subscribers, the two MNOs achieved approximately 48% market penetration in December 2015. This is reflected in Figure 3 below.

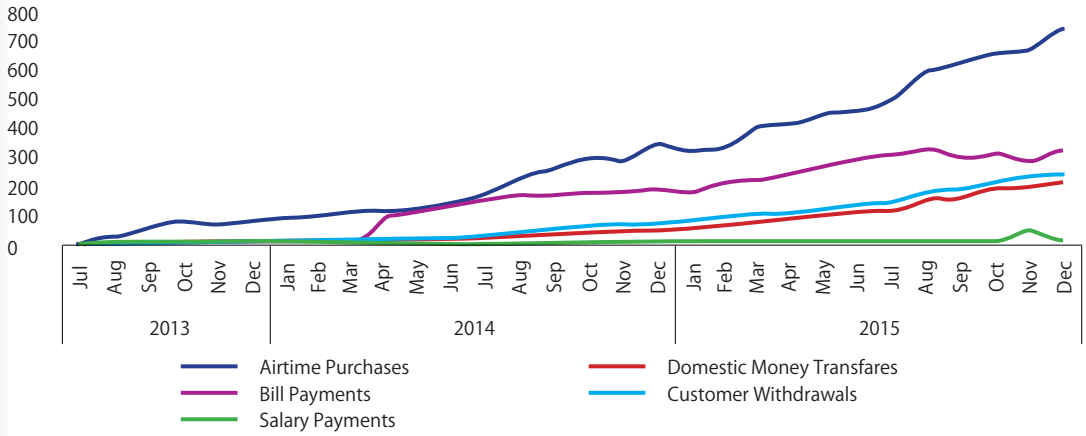
Figure 3 **Number of Subscribers and Mobile Money Users during April 2014- 2015** (in thousands)



Source: Central Bank of Lesotho, 2015

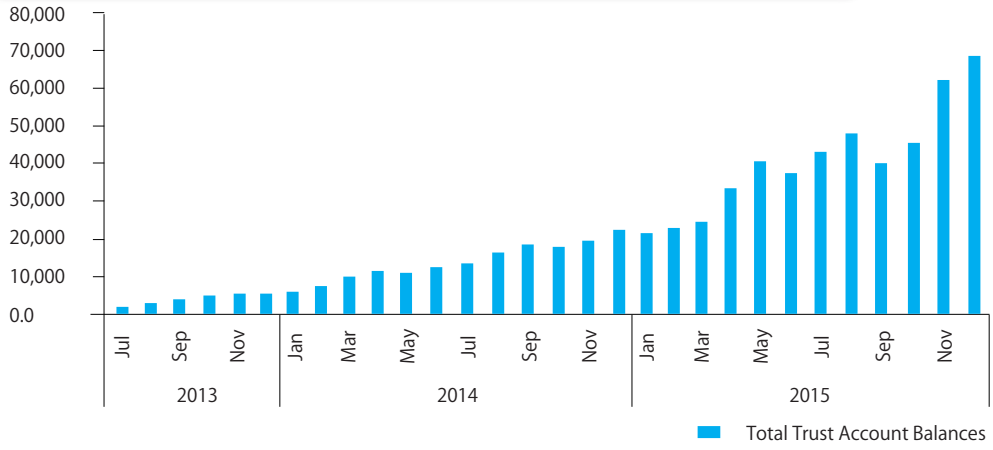
Consistent with the increasing market penetration, mobile money transaction volumes, especially customer's withdrawals, bill payments, domestic money transfers and airtime purchases, keep an upward trend since the inception this service. Figure 4 shows that as of December 2015, mobile money has processed a total of 751,743 airtime purchases, 243,169 customer cash withdrawals, 321,768 bill payments and 221,257 domestic money transfers. However, its use case in the processing of salaries has remained significantly limited despite its potential to reduce the hurdles of salaries processing of contract and casual workers by different organizations in the country including the Government of Lesotho (GoL). The high uptake and usage of mobile money is also consistent with the growth of trust account balances of the two MNOs (see Figure 5). The growth in adoption and usage of mobile money in Lesotho is attributed to the gradual appreciation of the product especially by the urban based users and heightened efforts by MNOs in advertising and educating customers about this product offering.

Figure 4 **Volume of Mobile Money Transactions** (in thousands)



Source: Central Bank of Lesotho, 2015

Figure 5 **Trust Account Balances** (in thousand Maloti)

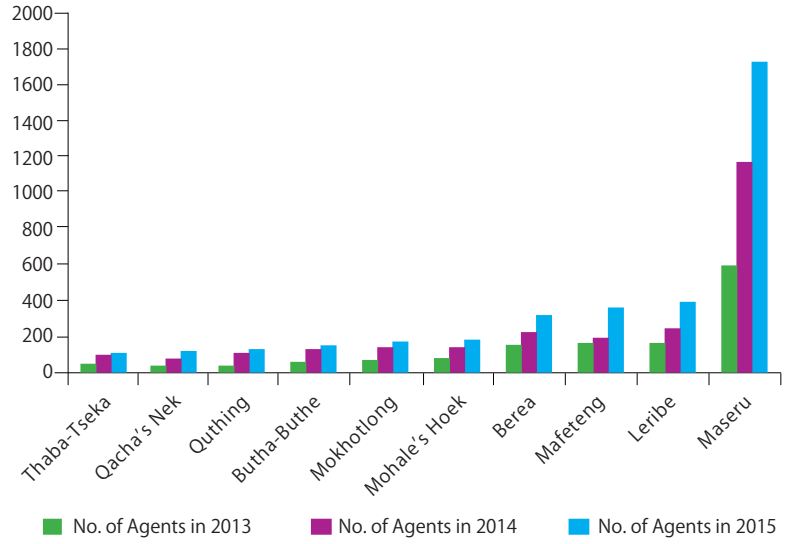


Source: Central Bank of Lesotho, 2015

However, as indicated in Figure 6 below, mobile money is used mainly in urban districts as opposed to rural districts[9], where there is high financial inclusion gap due to limited banking infrastructure. This is attributed to failure by MNOs to reach remote areas as a result of lack of customer education and poor agent network in rural areas and inaccessibility of some rural areas due to mountainous terrain. Therefore, there is need for more efforts on the part of MNOs scale up customer education on mobile money and increase agent recruitment in rural areas. In addition, MNOs should promote the use of mobile money in its electronic form in conducting transactions. This will solve agent liquidity problem as customers would not need to convert mobile money into cash prior to undertaking transactions.

[9] This is because the physical presence of agents in the vicinity not only actually drives knowledge about the product but could also increase its usage by customers. Product appreciation by customers increases its usage.

Figure 6 **Agent Network per District** (Number of Agents per district)



Source: Central Bank of Lesotho, 2015

As indicated before, approximately 48% of adult populations who own mobile phones use mobile money services. However, a large number of mobile phone users still do not use mobile money services. Therefore, there is potential for other mobile phone users who have not yet signed up for mobile money services to do so as time progresses. This is possible because the banking infrastructure is limited and primarily situated in urban areas, although the majority of Lesotho's population resides in rural areas. In addition, it is unlikely that banks will significantly expand their bank branches and devices (ATMs and POS) because establishing such infrastructure in rural areas would not be financially viable. Therefore, the difficulty of accessing financial infrastructure by the majority of rural population creates an opportunity for mobile money to provide a solution. This is because it provides lower cost and convenient alternative to traditional banking products, which the poor in rural areas can afford.

4 METHODOLOGY

4.1 Data Type and Sources

Financial inclusion and mobile money cannot be directly measured; therefore, they need to be measured by means of proxies. Table 2 below gives the description and measurement of variables. These data are available at the Central Bank of Lesotho (CBL) and covers the period 2013m7 through 2015m12. This sample period was chosen as comprehensive data on mobile money started to be collected in 2013,

Table 2: Description of Variables

Variable	Measurement	Description	Source
FI_t	Total deposits per 1000 adults	Aggregate deposits held by commercial banks divided by 1000 adult population.	CBL
	Total credit per 1000 adults	Total credit extended by commercial banks divided by 1000 adult population.	CBL
	Number of automatic teller machines(ATMs) per 1000 adults	Number of ATMs divided by 1000 adults	CBL
	Number of Point of sales(POSs) per 1000 adults	Number of POSs divided by 1000 adults	CBL
MM_t	Mobile money transaction (values) divided by 1000 adults	These include values of the following transactions; airtime purchases, domestic money transfers, customer withdrawals, and customers deposits and float[10] (each divided by 1000 adults)	CBL
	Trust account balance per 1000 adults	This is the current cumulative balance in the mobile money trust accounts held by commercial banks in the name of mobile money agents and customers divided by 1000 adults	CBL
	The number of registered mobile money customers	The total number of customers(users) who have registered for both M-pesa and Eco-cash	CBL
$M2_t$	Broad money	Broad money (M2) in Lesotho consists of M1 and quasi money.	CBL

4.2 Model Specification

This study adopts the approach followed Andrianaivo and Kpodar (2011, 2012) and Lundqvist and Erlandsson (2014) who examine the relationship between financial inclusion and mobile money by using the following bivariate econometric model:

$$FI_t = \alpha_0 + \alpha_1 MM_t + \varepsilon_t \qquad (1)$$

where FI_t denotes natural logarithms of financial inclusion, MM_t represents natural logarithms of indicators of mobile money and ε_t denotes the random error term.

[10] The sum of customer withdrawals and deposits.

4.1 Estimation Strategy: Autoregressive Distributed Lag (ARDL) Bounds Testing Procedure and Granger Causality

4.3.1 Primary Model (Bivariate Model)

In examining the relationship between financial inclusion and mobile money, the study estimates equations (1). This is done in three steps. First, the paper determines the order of integration of the variables using the Augmented Dickey Fuller and Phillips and Perron (1988) tests. The latter test is also used in addition to the former as it caters for serial correlation, endogeneity of regressors and allows for the possibility of heteroskedastic disturbance terms (Hamilton, 1994). While acknowledging the fact that the autoregressive distributed lag (ARDL) bounds testing allows for the presence of *I*(0), *I*(1) or mixed integrated variables in the estimation, pre-testing of the order of integration of the variables to ensure the absence of *I*(2), whose presence would nullify the procedure.

Second, after establishing the integration properties of variables, the study employs ARDL bounds testing approach to cointegration developed by Pesaran and Shin (1999) and advanced by Pesaran et al (2001) to study the existence long-run relationship between mobile money and financial inclusion. This procedure is preferred to other cointegration techniques due to the several advantages. For example, ARDL bounds testing is applicable irrespective of whether the underlying regressors are *I*(0), *I*(1) or mutually cointegrated. In addition, this procedure still remains robust for cointegration analysis in empirical macroeconomic studies where small samples size is a common phenomenon. Furthermore, it also has finite-sample critical values as opposed to other cointegration approaches for which the distribution of the test statistics may be unknown in finite-samples. In particular, Narayan (2005) develops a set of sample-specific critical value bounds for the sample sizes ranging from 30 to 80 using the same approach and GAUSS code used by Pesaran *et al* (2001) in generating the asymptotic values. Furthermore, this technique generally provides unbiased estimates of the long-run model and valid -statistics even in the presence of endogenous regressors.

The paper transforms the financial inclusion model (equation 1) into an ARDL framework as follows:

$$\Delta FI_t = \beta_0 + \sum_{t=1}^{p} \beta_{1t} \Delta FI_{t-i} + \sum_{t=0}^{p} \beta_{2t} \Delta MM_{t-i} + \beta_3 FI_{t-1} + \beta_4 MM_{t-1} + \mu_t \qquad (2)$$

where all variables are as previously defined, Δ is the first difference operator, p is the lag length, β's are parameters to be estimated, and μ_t is a white-noise error term. Similarly, the other variable in equation (2) as a dependent variable, the other equation can also be estimated.

According to the ARDL bounds testing procedure, cointegration test between the variables is conducted using the Wald test (F-statistic). The test imposes restrictions on the estimated long-run coefficients of one period lagged level of the variables to be equal to zero. The two sets of critical *F*- values (lower and upper bound values) for a given level of significance are reported by Pesaran et al (2001) for large sample sizes and Narayan (2005) for small sample data. The lower bound values assume that all variables in the ARDL model are integrated of order zero, or I(0), while the upper bound values assume that the variables are integrated of

order one, or *I*(1). Therefore, if the computed F-statistic is below the lower bound value, *I*(0), the null hypothesis of no cointegration cannot be rejected. Conversely, if the computed *F*-statistic exceeds the upper bound value, *I*(1), the null hypothesis is rejected and it is concluded that the variables are cointegrated. Nevertheless, the result becomes inconclusive if the *F*-statistic falls between the two bounds. Once cointegration has been established between the variables using ARDL bounds testing procedure, then the next step is to estimate the long-run and short-run error correction models from the established cointegration regression. The long-run model and the associated error correction model are given by:

$$FI_t = \delta_0 + \sum_{t=1}^{m} \delta_{1t} FI_{t-i} + \sum_{t=0}^{m} \delta_{2t} MM_{t-i} + \mu_t \tag{3}$$

$$\Delta FI_t = \theta_0 + \sum_{t=1}^{p} \theta_{1t} \Delta FI_{t-i} + \sum_{t=0}^{p} \theta_{2t} \Delta MM_{t-i} + \theta_3 ECT_{t-1} + \mu_t \tag{4}$$

Where all variables are as previously defined, δ's and θ's are the parameters to be estimated, p and m are the lag lengths and θ_3 is the coefficient of the error correction term, which measures the speed of adjustment to the long-run equilibrium following a shock to the system.

According to Granger (1969 and 1988) cointegration among the variables may imply the existence of causality between the variables at least in one direction. However, it does not indicate the direction of causality between the variables. Therefore, once cointegration has been established between mobile money and financial inclusion using ARDL bounds testing procedure, then the third step is to employ a dynamic Granger causality test to determine the short-run and long-run causal effects between mobile money and financial inclusion. For this purpose, the error correction model (equation 4) is used to examine Granger causality from mobile money to financial inclusion. In this test, the short-run causality is implied by the significance of the t–statistic (or Wald statistic) on the first differences of lagged independent variables. On the other hand, the long-run causality is captured by the significance of the t-statistic on the coefficient of the lagged error correction term. Nevertheless, if there is no cointegration between the variables only short-run causality can be determined.

4.3.1 Robustness Checks (Trivariate Model)

In addition to estimating the bivariate relationship between financial inclusion and mobile money, the study also estimates this relationship in the context of a trivariate model where broad money (M2) is used as a control variable. This is done to avoid omission of variable bias inherent in a bivariate model, which may lead to unreliable results (Lütkepohl, 1982). The use of broad money (M2) is motivated by its high correlation with gross domestic product (GDP)[11] because data for the latter is only available annually in Lesotho. For this purpose, cointegration between financial inclusion, mobile money and M2 is established using the following ARDL model:

[11] The correlation between M2 and GDP is approximately 99%.

$$\Delta FI_t = \varphi_0 + \sum_{t=1}^{p} \varphi_{1t} \Delta FI_{t-i} + \sum_{t=0}^{p} \varphi_{2t} \Delta MM_{t-i} + \sum_{t=0}^{p} \varphi_{3t} \Delta M2_{t-i} + \varphi_4 FI_{t-1} + \varphi_5 MM_{t-1} + \varphi_6 M2_{t-1} + \mu_t \quad (5)$$

Where $M2_t$ denotes natural logarithms of broad money (M2), Δ is the first difference operator, p is the lag length, φ's are parameters to be estimated, and μ_t is a white-noise error term. This test is conducted using the steps discussed earlier. Once this is done, the following trivariate long-run and short-run models are estimated.

$$FI_t = \gamma_0 + \sum_{t=1}^{m} \gamma_{1t} FI_{t-i} + \sum_{t=0}^{m} \gamma_{2t} MM_{t-i} + \sum_{t=0}^{m} \gamma_3 M2_{t-i} + \mu_t \quad (6)$$

$$\Delta FI_t = \vartheta_0 + \sum_{t=1}^{p} \vartheta_{1t} \Delta FI_{t-i} + \sum_{t=0}^{p} \vartheta_{2t} \Delta MM_{t-i} + \sum_{t=0}^{p} \vartheta_{3t} \Delta M2_{t-i} + \vartheta_4 ECT_{t-1} + \mu_t \quad (7)$$

Where all variables are as previously defined, γ's and ϑ's are parameters to be estimated, and ν_4 is the speed of adjustment to the long-run equilibrium following a shock to the system. The estimated trivariate error correction model (equation 7) is also used to examine the short-run and long-run Granger causality from mobile money to financial inclusion.

5 ANALYSIS OF EMPIRICAL RESULTS

5.1 Unit Root Test Results

As a standard practice in time series analysis, the unit root properties of the each series are studied. The test results are presented in Table 3. The results show that all the variables used in the study are integrated of order one, that is *I*(1) except the log of the number of mobile money customers, log of domestic money transfers per 1000 adults and log of airtime purchases per 1000 adults, which are *I*(0). Therefore, the case of a mixed order of integration of the variables, *I*(1) and *I*(0), has been established.

Table 3: ADF and PP Unit Root Test Results

Variable	Variable in levels		Variable at first differences		Conclusion on order of integration
	ADF statistic	PP statistic	ADF statistic	PP statistic	
ltc	-1.1503 (0.6817)	-1.1247 (0.6922)	-6.6015* (0.0000)	-6.8463* (0.0000)	I(1)
ltd	-1.7384 (0.4022)	-1.4626 (0.5379)	-6.7076* (0.0000)	-12.0432* (0.0000)	I(1)
latm	-0.0362 (0.9474)	0.1257 (0.9623)	-8.0843* (0.0000)	-7.8044* (0.0000)	I(1)
lpos	-1.0243 (0.7309)	-0.7022 (0.8309)	-4.9448* (0.0005)	-9.3211* (0.0000)	I(1)
ltab	-2.2781 (0.1853)	-3.2690** (0.0260)			I(0)
lmc	-4.4050* (0.0017)	-4.3937* (0.0017)			I(0)
ldmc	-1.3231 (0.6045)	-2.1980 (0.2112)	-5.6164* (0.0001)	-5.7529* (0.0001)	I(1)
lap	-3.7548* (0.0083)	-4.1114* (0.0035)			I(0)
lcd	-1.9792 (0.2936)	-1.9792 (0.2936)	-7.6065* (0.0000)	-8.9371* (0.0000)	I(1)
lcw	-2.4652 (0.1340)	-2.4652 (0.1340)	-6.0511* (0.0000)	-6.5952* (0.0000)	I(1)
lflt	-1.6307 (0.4537)	-1.6307 (0.4537)	-6.3914* (0.0000)	-7.0360* (0.0000)	I(1)
lm2	-2.0451 (0.2689)	-7.4735 (0.0000)	-1.9559 (0.3035)	-11.3808 (0.0000)	I(1)

Note: Values in parentheses are probability values. * and ** denote the level of statistical significance at 1 and 5% , respectively. The variables *ltc* = log of total credit per 1000 adults, *ltd* = log of total deposit per 1000 adults, *latm* = log of the number of ATMs per 1000 adults, *lpos* = log of the number of POSs per 1000 adults, *ltab* = log of trust account balances per 1000 adults, *lmc* =log of mobile money customers, *ldmt* = log of domestic money transfers per 1000 adults, *lap* = log of airtime purchases per 1000 adults, *lcd* = log of customer deposits per 1000 adults, *lcw* = log of customers withdrawals per 1000 adults, *lflt* = log of amount of float per 1000 adults. In addition, *lm2* denotes the log of M2.

5.2 The Relationship between Financial Inclusion and Mobile Money

5.2.1 The Long-run Relationship – Cointegration Results

Appendix 3 presents the results of ARDL bounds testing between financial inclusion and mobile money tested in the context of a bivariate model. The results indicate that the calculated F-statistic is greater than the upper bound critical value at either 1% or 5% levels of significance when financial inclusion is a dependent variable in each model. Hence, the null hypothesis of no cointegration is rejected in all models. Similarly, the existence of long-run relationship is also obtained even in the case of trivariate models; four models where log of total credit is a dependent variable and two models where the log of the number of POSs is a dependent variable (see appendix 5)[12]. Therefore, there is a strong evidence of long-run steady state relationship between financial inclusion and mobile money both in a bivariate and trivariate setting in Lesotho.

The results of the long-run estimates of the bivariate models are presented in Tables 4 and 5 (also see Appendix 4) and those from a trivariate model are presented in Appendix 6. The results show that the long-run coefficients are not only positive but also statistically significant at 1% level of significance in all models, and, therefore, consistent with a priori expectations. Thus, this finding suggests that all explanatory variables representing mobile money determine financial inclusion in the long-run in Lesotho in the bivariate model. For instance, an increase in trust account balances avails more funds to the banking industry, which can be used for credit extension. In addition, the higher the proportion of mobile money users in the country, the higher the number people with access to some form of financial services. The long-run estimates of a trivariate model support the established long-run relationship with positive and statistically significant coefficients.

[12] However, the rest of the trivariate models where the logarithms of total credit and number of POSs are dependent variables, which were reported in the bivariate case, did not produce robust results and therefore are not reported in the paper. In the same manner, the trivariate models where logarithms of total deposit and number of ATMs are dependent variables are not reported by the paper because did not produce robust results.

Table 4: Total Credit Models (bivariate case)

Relation Horizon	Explanatory	Dependent Variable, Log of total Credit (*ltc*)						
Short-run	*ECM(-1)*	-0.3387 *(0.0010)	-0.2881** (0.0105)	-0.2933** (0.0165)	-0.2993* (0.0018)	-0.2819* (0.0004)	-0.5872* (0.0021)	-0.3659* (0.0011)
	d (ltab)	0.0243** (0.0913)						
	d (lmc)		0.1151* (0.0026)					
	d (ldtm)			0.0257** (0.0797)				
	d (lap)				0.0172** (0.0200)			
	d (ltc (-1)				0.0404 (0.7738)			
	d (ltc(-2)				-0.2993* (0.0018)	-0.2819* (0.0004)		
	d(lcd)					0.0131** (0.0215)		
	d(lcw)						0.0463 *(0.0029)	
	d (lflt)							0.0129* (0.0042)
	D2014M2	-0.0309* (0.0000)	-0.0293* (0.0000)	-0.0267* (0.0000)	-0.0312* (0.0000)	-0.0299* (0.0000)	-0.0274* (0.0000)	-0.0283* (0.0000)
	D2014M5	-0.0232* (0.0000)	-0.0212* (0.0000)	-0.0208* (0.0000)	-0.0249* (0.0000)	-0.0239* (0.0000)	-0.0290* (0.0000)	-0.0229* (0.0000)
	c			1.1881** (0.0163)				

Table 4: Total Credit Models (bivariate case) (continued)

Relation Horizon	Explanatory	Dependent Variable, Log of total Credit (*ltc*)						
Long-run	ltb	0.0764* (0.0000)						
	lmc		0.1976* (0.0000)					
	ldmt			0.0545* (0.0000)				
	lap				0.0788* (0.0000)			
	lcd					0.0594* (0.0000)		
	lcw						0.0654* (0.0000)	
	lflt							0.0316* (0.0000)
	D2014M2	-0.0743* (0.0000)	-0.0653* (0.0034)	-0.0522* (0.0010)	-0.0862* (0.0001)	-0.0751* (0.0021)	-0.0329 (0.0043)	-0.0579* (0.0005)
	D2014M5	-0.0564* (0.0000)	-0.0489* (0.0062)	-0.0423* (0.0001)	-0.0728* (0.0000)	-0.0611* (0.0002)	-0.0383*	-0.0488* (0.0000)
	C	6.3061* (0.0000)	5.4774* (0.0000)		6.3609* (0.0000)	6.3739* (0.0000)	6.3485 (0.0000)	6.3591* (0.0000)
Diagnostics	JB	0.3807 (0.8267)	0.4087 (0.8152)	1.2081 (0.5465)	0.3588 (0.8358)	0.5760 (0.7498)	0.6145 (0.7355)	0.8277 (0.6611)
	BG-LM test	1.7161 (0.4240)	7.7595 (0.1008)	10.5822 (0.1022)	0.8073 (0.6679)	1.2754 (0.5285)	2.4491 (0.2939)	3.2395 (0.1979)
	RESET test (F-statistic)	0.2733 (0.6061)	0.3278 (0.5725)	1.8590 (0.1859)	0.8073 (0.6679)	0.2162 (0.6465)	1.0866 (0.3103)	0.0596 (0.8093)

Note: *, ** and ***denote the level of statistical significance at 1%, 5% and 10%, respectively. The variables *ltab, lmc,ldmt, lap, lcd, lcw,* and *lflt* are defined as previously. D2014M2 and D2014M5 are dummy variables representing decline in total credit owing to stringent requirements by some banks. The values in parentheses are the probability values.

Table 5: ATMs & POS Models (bivariate case)

Relation Horizon	Explanatory *y* Variable	Dependent Variable, Log of the number of ATMs (latm)			Dependent Variable, Log of the number POSs per 1000 adults(lpos)		
Short-run	*ECM(-1)*	-0.3964* (0.0007)	-0.1635* 0.0000)	-0.2925* (0.0025)	-0.4349** (0.000)	-0.4034* (0.0000)	-0.3374* (0.0001)
	d(ldmt)	0.0248** (0.0361)			0.0345* (0.0071)		
	d(lcd)		0.0131** (0.0168)				
	d(lcd(-1))		-0.0174* (0.0038)				
	d(lcw)			0.0292** (0.0336)		0.0356** (0.0198)	
	d(lpos(-1))				0.0469 (0.7306)	0.1441 (0.3264)	0.0651 (0.6811)
	d(lflt)						0.0141** (0.0112)
Long-run	*D2015M9*				-0.0356* (0.0000)	-0.0344* (0.0000)	-0.0329* (0.0094)
	ldmt		0.0698* (0.0000)			0.1184* (0.0000)	
	lcd			0.0858* (0.0001)			
	lcw				0.0797* (0.0000)		0.1347* (0.0000)
	lflt						0.0697* (0.0000)
	D2015M9				-0.1077* (0.0005)	-0.0999* (0.0042)	-0.1109* (0.0094)
	c	-1.0876* (0.0000)	-1.1598* (0.0000)	-0.1378* (0.0000)	-0.4780* (0.0000)	-0.5678* (0.0000)	-0.5948* (0.0000)
Diagnostics	JB	3.3114 (0.1910)	1.2398 (0.5380)	4.2663 (0.1185)	1.8559 (0.3954)	1.2775 (0.5280)	2.5985 (0.2727)
	BG-LM Test	5.7391 (0.1250)	2.2872 (0.3187)	6.6705 (0.1544)	2.5594 (0.1096)	1.7548 (0.4159)	2.1869 (0.3351)
	RESET Test	1.2528 (0.1300)	1.6367 (0.1250)	1.3367 (0.1150)	1.6804 (0.2083)	0.0066 (0.9359)	0.1451 (0.7071)

Note: *, ** and ***denote the level of statistical significance at 1%,5% and 10%, respectively. The variables *latm* = log of the number of ATMs, *lpos* = the log of the number of point of sales (POS) devices and other variables are as previously defined. D2015M9 is the dummy variable representing the decline in the number of POS as a result of cancellation of contract between some merchants and one commercial bank, which owned the POSs. The values in parentheses are the probability values..

5.2.2 Diagnostic Tests Results

Following the establishment of long-run estimates in each model, the next step involves the estimation of the error correction model (ECM). The results of short-term elasticities estimated within the ARDL framework together with their associated diagnostic tests also are presented in Tables 4 and 5 (also see Appendices 4 and 6). Diagnostic tests were applied to the estimated ECMs to ensure the reliability of the estimated parameters. The results show that all estimated ECMs pass all specification tests. For example, the findings show absence of serial correlation, normality of residuals and no heterokesdasticity (as the models were estimated using White's heteroskedasticity standard errors). In addition, Ramsey's RESET test for the stability of the models together with CUSUM and CUSUMQ tests (though not presented here) suggest that the models are stable over the sample period.

5.2.3 The Short-run Relationship

Consistent with the long-run dynamics, the results of estimated short-run elasticities show that mobile money influences financial inclusion in Lesotho. This is supported by the positive and statistically significant coefficients of the explanatory variables in all bivariate error correction models and triavariate error correction models that passed the robustness checks. This finding provides evidence that in addition to influencing the dynamics of financial inclusion in the long-run, mobile money also has significant impact on the dynamics of financial inclusion in the short-run. The findings also show that the coefficient of the lagged error correction term, which indicates the speed of adjustment to long-run equilibrium in the event of a shock to the system, is negative and statistically significant at either 1% or 5% level of significance. This suggests that in the bivariate setting, on overage, 16% to 85% (depending on proxies that are used) of the disequilibrium of financial inclusion is corrected in the current month following a shock in the previous month on the one hand. On the other hand, the speed of adjustment in the trivariate error correction models implies that, on average, 14% to 50% of the disequilibrium from the previous month is corrected in the current month. In addition, the fact that the coefficient of the lagged error correction term is statistically significant and bears a correct sign (i.e. negative) in all models implies that the series are non-explosive and that long-run equilibrium is attainable. Therefore, this is consistent with the cointegration relationship between the variables in each model.

5.2.4 Granger Causality Between Financial Inclusion and Mobile Money

The existence of a cointegrating relationship between the variables may suggest that there must be Granger causality in at least one direction, but does not show the direction of temporal causality between the variables (see Granger, 1969 & 1988). Therefore, the paper employs the estimated error correction models to also examine both short-run and long-run Granger causality between financial inclusion and mobile money. The short-run causality can be determined by the significance of the Wald F-test (or t-statistic) on the first differences of the explanatory variables on one hand. On the other hand, the long-run causality can be examined by the significance of the t-statistics on the coefficient of the lagged error correction term. Granger

causality can be unidirectional in either directions or bidirectional. However, this paper specifically focuses on establishing unidirectional Granger causality from mobile money to financial inclusion, which answers the research question in this study.

Based on the estimated error correction models presented in Tables 4 and 5 (also see Appendices 4 and 6), the coefficients of all the first differences of explanatory variables in each model appear with expected positive signs and are also statistically significant at either 5% or 1% levels of significance. This result provides evidence of short-run Granger causality from mobile money to financial inclusion. Similarly, the negative and statistically significant coefficient of the lagged error correction term in the same models supports long-run Granger causality from mobile money to financial inclusion. Thus, in general the findings imply that indeed mobile money Granger causes financial inclusion both in the short-run and long-run in Lesotho.

6 CONCLUSION AND POLICY RECOMMENDATIONS

The acquisition and use of mobile telephone in Sub-Saharan Africa has grown significantly in recent years and now covers a large proportion of the region's population. This has led to emergence of financial innovations such as mobile money, which has expanded the grid of financial services to include the previously unbanked and underbanked sections of population, who could not access formal financial services on account of limited banking infrastructure. Empirical evidence has shown that this new development has increased financial intermediation with positive spill-overs in terms of credit growth to entrepreneurs and consequently leads to faster economic growth and perhaps broader economic development. This study employs ARDL bounds testing approach to cointegration and Granger causality test based on ECM to examine the impact of mobile money on financial inclusion and the direction of causality between these variables in Lesotho using monthly data from July 2013 to December 2015.

The findings suggest a strong evidence of long-run steady state relationship between financial inclusion and mobile money in Lesotho with positive and statistically significant long-run coefficients, which are consistent with apriori expectations. In addition, the estimated ECM models provide evidence that mobile money also has significant impact on the dynamics of financial inclusion in the short-run in Lesotho. For instance, the results suggest that, on overage, 16% to 85% of the disequilibrium of financial inclusion is corrected in the current month following a shock in the previous month. Furthermore, the findings show that mobile money Granger causes financial inclusion both in the short-run and long-run in Lesotho.

The findings of this paper underscore the importance of mobile phone diffusion and hence mobile money in extending financial services in Lesotho. This is because it has resolved the hurdles of limited banking infrastructure by allowing the previously unbanked and under banked sections of the population to access financial services. This could also serve as a breakthrough for these people to build accounts history that would consequently help them to open formal bank accounts with the banking industry in Lesotho. Therefore, policy makers in Lesotho should promote and facilitate interaction and investments in mobile phone technology deployment and its related financial services. In addition, financial inclusion policies should be directed to leveling the playing ground for mobile money to flourish to create a more financially inclusive society in Lesotho. In this regard, the legal and regulatory framework should be friendly and accommodative to enable more innovation in mobile money and other digital financial services. This would contribute drastically to financial development and consequently faster economic growth.

MNOs should work hard to scale up the use of mobile money in remote areas of the country, where the majority of people still do not have access to financial services. This could be achieved through more customer education, improving network coverage in rural areas of the country and growing agent network in rural areas by negotiating with Chinese businesses, which have more reach in rural communities, to become agents and hence act as cash-in and cash-out points. More importantly, the MNOs should endeavor to promote the use of mobile money in its electronic form in carrying out transactions. These would help resolve many of the hurdles related to liquidity management by the MNOs. Lastly, MNOs should work towards forming many partnerships with all commercial banks and other financial institutions in Lesotho to ensure interoperability between MNOs and commercial banks[13]. This would lead to more access to banking services and allow innovation of more services.

[13] Of course, there are already interesting developments on the ground with Ecocash customers having access to their bank accounts with SLB.

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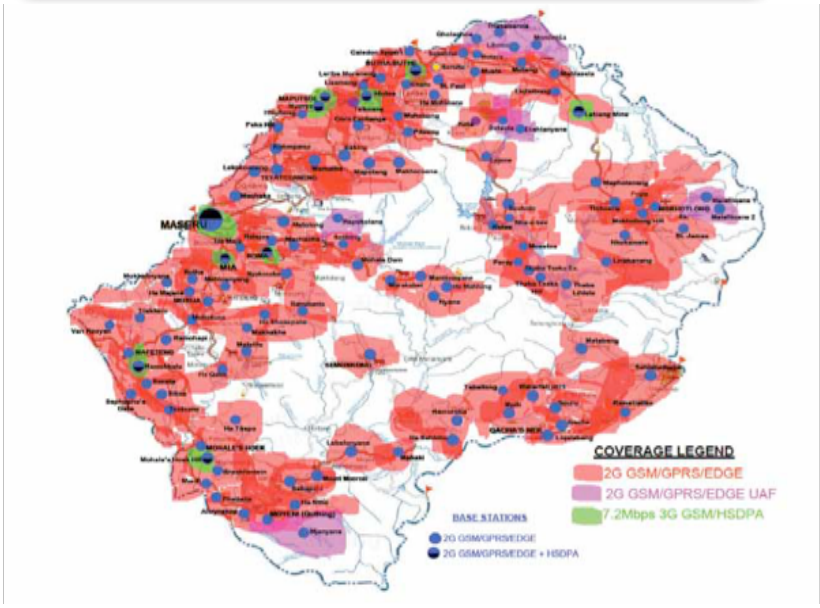
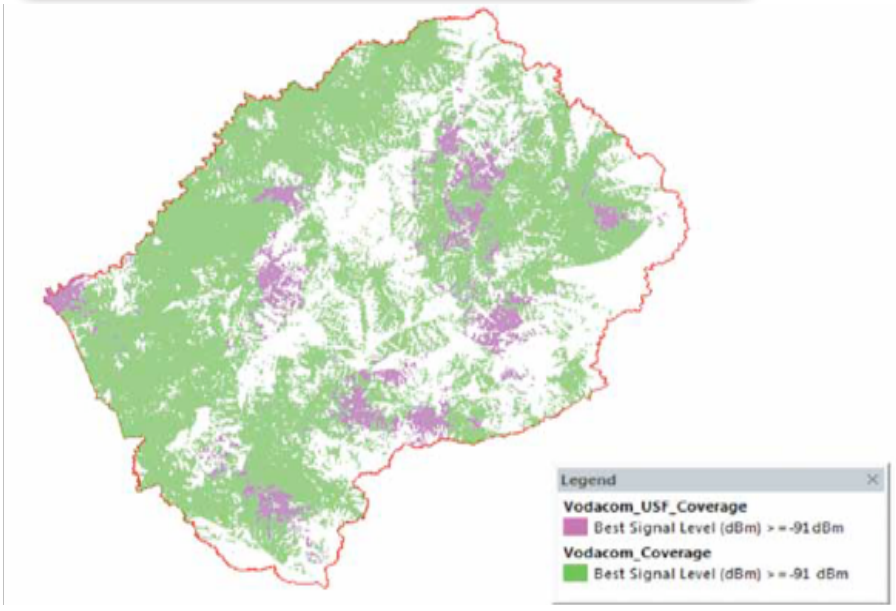
APPENDICES

Appendix 1 | Econet Telecom Lesotho (ETL) Coverage Map as at 31st March 2014



Source: Lesotho Communications Authority Annual Report, 2013-2014

Appendix 2 | Vodacom Lesotho (VCL) Coverage Map as at the 31st March 2014



Source: Lesotho Communications Authority Annual Report, 2013-2014

APPENDICES

Appendix 3: ARDL Bounds Testing to Cointegration Results (bivariate case)

Total Credit Models								
Model	F-statistic	Critical value bounds of the F-statistic						Evidence of Cointegration?
		99%		95%		90%		
$k = 1$		$I(0)$	$I(1)$	$I(0)$	$I(1)$	$I(0)$	$I(1)$	
$F_{ltc}(ltc\backslash ltab)$	17.57*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{ltc}(ltc\backslash lmc)$	14.67*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{ltc}(ltc\backslash lap)$	9.72*	8.170	9.285	5.395	6.350	4.290	5.080	Yes
$F_{ltc}(ltc\backslash lcd)$	16.20*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{ltc}(ltc\backslash lcw)$	12.26*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{ltc}(ltc\backslash lflt)$	14.04*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{ltc}(ltc\backslash lap)$	14.78*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
Total Deposit Models								
$F_{ltd}(ltc\backslash lcw)$	6.24**	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{ltd}(ltc\backslash ldmt)$	6.31**	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{ltd}(ltc\backslash lflt)$	5.16**	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{ltd}(ltc\backslash lmc)$	6.24**	6.027	6.760	4.090	4.663	3.303	3.797	Yes
ATMs and POS Models								
$F_{latm}(latm\backslash ldmt)$	9.47*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{latm}(latm\backslash lcd)$	9.37*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{latm}(latm\backslash lcw)$	7.76*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{latm}(latm\backslash ldmt)$	17.56*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{latm}(latm\backslash lcw)$	15.19*	6.027	6.760	4.090	4.663	3.303	3.797	Yes
$F_{latm}(latm\backslash lflt)$	13.34*	6.027	6.760	4.090	4.663	3.303	3.797	Yes

Note: k is the number of regressors and 2) * and ** denote the level of statistical significance at 1% and 5%, respectively.

APPENDICES

Appendix 4: Total Deposit Models (bivariate case)

Relation Horizon	Explanatory	Dependent Variable, Log of Total Deposits per 1000 adults *(ltd)*			
Long-run	*ECM (- 1)*	-0.8519* (0.0002)	-0.8063* (0.0002)	-0.7928* (0.0005)	-0.8003* (0.0004)
	d (lcw)	-0.0443 (0.1188)			
	d (ldmt)		0.0178 (0.4890)		
	d (lflt)			0.0128 (0.2759)	
	d (lmc)				0.1685*** (0.0552)
Long-run	*lcd*	0.0518* (0.0000)			
	ldmt		0.0446* (0.0000)		
	lflt			0.0258* (0.0000)	
	lmc				0.1700* (0.0000)
	c	3.7045* (0.0000)	3.7429* (0.0000)	3.7008* (0.0000)	2.9298* (0.0000)
Diagnostics	*JB*	0.3983 (0.8194)	0.2679 (0.8746)	0.3557 (0.8371)	0.3557 (0.8371)
	BG-LM test	0.8984 (0.6381	1.7444 (0.4180)	3.2587 (0.1961)	0.9878 (0.6102)
	RESET test (F-statistic)	0.0143 (0.9057)	0.0323 (0.8588)	0.1107 (0.7421)	0.0177 (0.8952)

Note: **, ** and *** denotes the level of statistical significance at 1%, 5% and 10%, respectively. The variables are as previously defined. The values in parentheses are the probability values..

Appendix 5: ARDL Bounds Testing to Cointegration Results (trivariate Case)

Total Credit Models								
Model	F-statistic	Critical value bounds of the F-statistic						Evidence of Cointegration?
		99%		*95%*		*90%*		
k = 2		*I(0)*	*I(1)*	*I(0)*	*I(1)*	*I(0)*	*I(1)*	
F_{ltc} *(ltc\lcd, lm2)*	9.65*	5.155	6.265	3.538	4.428	2.915	3.695	Yes
F_{ltc} *(ltc\lap, lm2)*	11.46*	5.155	6.265	3.538	4.428	2.915	3.695	Yes
F_{ltc} *(ltc\lmc, lm2)*	10.73*	5.155	6.265	3.538	4.428	2.915	3.695	Yes
F_{ltc} *(ltc\lflt, lm2)*	11.07*	5.155	6.265	3.538	4.428	2.915	3.695	Yes
POS Models								
F_{lpos} *(lpos\lcd, lm2)*	9.43*	5.155	6.265	3.538	4.428	2.915	3.695	Yes
F_{lpos} *(lpos\lap, lm2)*	16.28*	5.155	6.265	3.538	4.428	2.915	3.695	Yes

Note: *k* is the number of regressors and 2) * and ** denote the level of statistical significance at 1% and 5%, respectively.

APPENDICES

Appendix 6: Total Credit and POS Models (trivariate Case)

Relation Horizon	Explanatory	Dependent Variable, Log of total credit (*ltc*)				Dependent Variable, Log of the number POSs per 1000 adults (*lpos*)	
Short-run	*ECM (- 1)*	-0.3831* (0.0004)	-0.4959* (0.0001)	-0.3489* (0.0048)	-0.4406* (0.0009)	-0.2744* (0.0001)	-0.1355* (0.0000)
	d (lcd)	0.0118** (0.0316)				0.0171* (0.0086)	
	d (lap)		0.0158** (0.0281)				0.0083*** (0.0649)
	d (lmc)			0.1122* (0.0061)			
	d (lflt)				0.0115* (0.0088)		
	d (lm2)	0.1722** (0.0162)	0.1566** (0.0248)	0.0412** (0.0685)	0.1429** (0.0346)	0.1493** (0.0294)	0.1224*** (0.0668)
	d (lm2 (- 1)		-0.1478*** (0.0652)				
	d (lpos (- 1)					0.0004 (0.9979)	
	D2014M2	-0.0262* (0.0000)	-0.0288* (0.0000)	-0.0289* (0.0000)	-0.0247* (0.0000)		
	D2014M5	-0.0243* (0.0000)	-0.0285* (0.0000)	-0.0221* (0.0000)	-0.0235* (0.0000)		
	D2015M9					-0.0361* (0.0000)	-0.0367* (0.0000)
Long-run	*lcd*	0.0386* (0.0015)				0.1104* (0.0001)	
	lap		0.0364** (0.0387)				0.1055** (0.0250)
	lmc			0.1542* (0.0005)			
	lflt				0.0244* (0.0001)		
	lm2	0.4584** (0.0153)	0.6598* (0.0084)	0.2718*** (0.0894)	0.2949** (0.0102)	0.6433** (0.0294)	1.1955*** (0.0630)
	D2014M2	-0.0583** (0.0101)	-0.0598* (0.0014)	-0.0573* (0.0001)	-0.0477* (0.0000)		
	D2014M5	-0.0521** (0.0051)	-0.0578* (0.0003)	-0.0461* (0.0000)	-0.0436* (0.0000)		
	D2015M9					-0.0361* (0.0000)	-0.2930** (0.0172
	c	3.2710** (0.0108)	1.9126 (0.2223)	3.8384* (0.0037)	4.3659* (0.0013)	-4.9514** (0.0128)	-8.6480** (0.0474)
Diagnostics	*BG-LM test*	0.0889 (0.9565)	0.7029 (0.7037)	3.1935 (0.2026)	1.6178 (0.4453)	2.1697 (0.3380)	1.9632 (0.3747)
	RESET test (F-statistic)	0.0924 (0.7640)	1.82E-05 (0.996)	0.4036 (0.5318)	0.2120 (0.6497)	0.3896 (0.5396)	0.4011 (0.5328)

Note: *, ** and ***denote the level of statistical significance at 1%, 5% and 10%, respectively. The variables ***ltab, lmc,ldmt, lap, lcd, lcw***, and ***lflt*** are defined as previously. D2014M2 and D2014M5 are dummy variables representing decline in total credit owing to stringent requirements by some banks. The values in parentheses are the probability values.

SLOW GROWTH IN SOUTH AFRICA: SPILL-OVERS TO OTHER CMA COUNTRIES

Monaheng Seleteng (Ph.D)

Key words:
CMA, South Africa, Economic Growth, Spill-overs

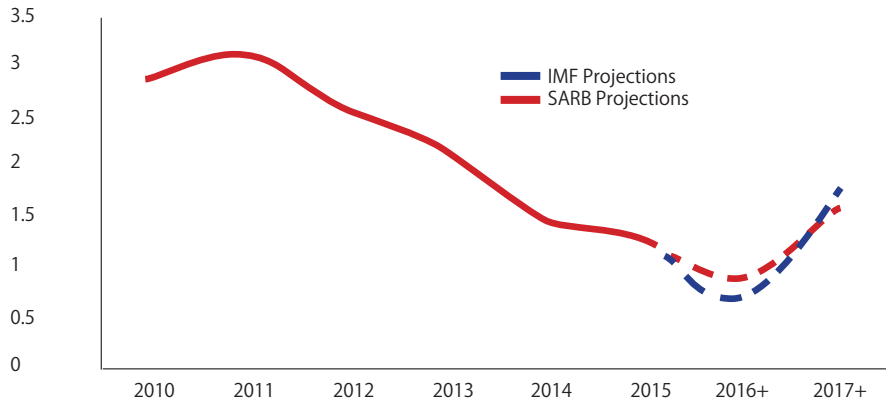
JEL Classification: C13, C33, C36, E60, O41, O47.

1 INTRODUCTION

INCREASING ECONOMIC integration among countries warrants increased exposure to shocks, either negative or positive. On the positive side, countries benefit from trading with fast-growing and relatively rich countries whereas on the negative side countries are affected detrimentally when trading with countries that are in recession and relatively poor (Arora & Vamvakidis, 2005). The magnitude of the spill-over effects depends largely on the degree of openness of the trading partners. A general conclusion from literature is that trade openness has a positive impact on growth (Baldwin, 2003). Given the fact that SA is relatively more advanced in terms of technological infrastructure, additional spill-overs could also be through technology transfers. Furthermore, SA's foreign direct and portfolio investment plays a significant role in the capital flows of some African countries. Moreover, SA plays a significant role in multi-country political and economic initiatives; therefore developments in SA could influence business and consumer confidence in the other African countries. These imply that developments in one country can spill-over to other countries through three main channels: trade linkages, financial linkages and institutional linkages (IMF, 2016).

In the Sub Saharan Africa (SSA), South Africa (SA) is the third largest economy (following Nigeria – after rebasing its GDP figures in 2013) and recently Egypt. SA's economy accounts for approximately 21 per cent of SSA's Gross Domestic Product (GDP) [Hanson and Kambou, 2016]. The relatively large economic size of SA and its growing linkages with other African economies suggest that SA economic growth could have a significant influence on the rest of Africa (Arora and Vamvakidis, 2005). As such, SA is an important export destination for its neighbouring countries such as Lesotho, Namibia and Swaziland. However, it is worth noting that, needless to say, much of trade in the SSA takes place with countries outside the region. Advanced Economies and Emerging Markets Economies remain the largest destinations of SSA's exports. For instance, Lesotho trades significantly with the United States (US) in terms of textiles and clothing under the Africa's Growth and Opportunities Act (AGOA) provision.

Figure 1 **South African Real Economic Growth Rate** (Annual Percentage Changes)



Source: IMF (2016) and SARB (2016)

Figure 1 depicts that in recent years, SA economic growth has been on a downward trajectory due to difficult global economic and financial environment (e.g. slow growth in major trading partners such as China and the European Union), coupled with domestic constraints such as electricity shortages, drought conditions and labour disputes, among other things. This slowdown in SA's economic growth is likely to retard growth performance in the LNS countries due to the close linkages[1]. Hence the objective of the paper is to assess scientifically the spill-over effects of SA's economic growth performance onto the rest of the CMA. The analysis does not attempt to isolate each of the channels through which SA economic growth could influence growth in the CMA, but focuses purely on quantifying the aggregate impact. Future research could assess the importance of alternative channels through which the growth spill-overs might be transmitted.

The rest of the paper is organized as follows: Section 2 discusses trade trends between SA and the LNS countries. Section 3 reviews the literature on spill-over effects while section 4 describes the data and presents the analytical framework. Empirical results are covered in section 5 and section 6 concludes.

1.2 South Africa's Linkages with the LNS Countries

Relatively large economic size of SA and its growing linkages with other SSA economies implies that South African economic growth could have a significant influence on the rest of the CMA through various channels as already mentioned.

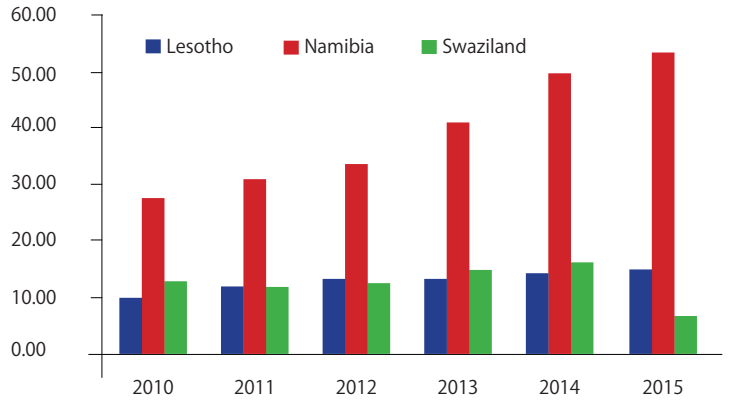
Trade Linkages

Literature has shown that there is positive relationship between openness and growth [for instance, Barro & Sala-i-Martin (1995); Sachs & Warner (1995) and Clemens & Williamson (2004)]. SA being the second largest economy in the SSA implies that it is an important export market for its immediate neighbouring countries such as Botswana, Lesotho, Namibia and Swaziland. In 2011, exports to SA accounted for more than 80 per cent of trade within the Southern African Customs Union (SACU) [Canales-Kriljenko, 2013]. Figure 2 depicts that in the CMA, around R50 billion worth of exports from SA were destined to Namibia in 2015, followed by Lesotho and Swaziland at lower levels of approximately R10 billion and R4 billion, in the same period, respectively. These exports from SA to LNS countries consist largely of prepared foods, mineral products, chemicals, machinery, and vehicles.

On the flipside, figure 3 shows that a significant value of imports from LNS countries to SA are largely from Swaziland at around R14 billion, followed by Namibia and Lesotho at approximately R6 billion and R3 billion, in 2015, respectively. Most of these exports to SA from LNS countries are in the form of live animals, prepared foods, textiles, footwear and machinery.

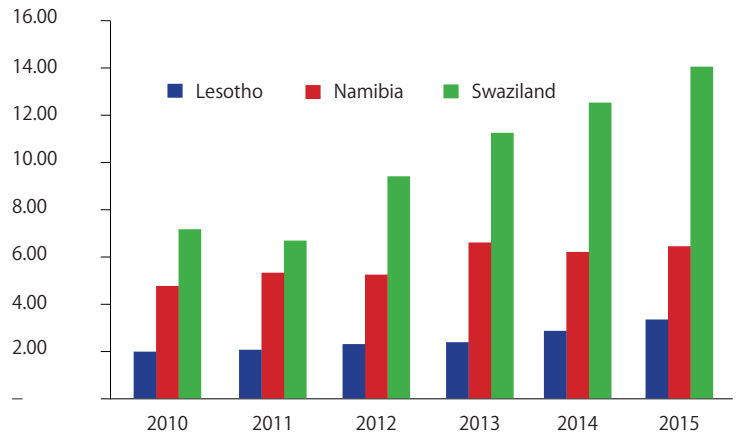
[1] When South Africa sneezes, the neighbouring countries catch cold.

Figure 2 **Value of South Africa's Exports to the CMA** (Billion Rands)



Source: South African Revenue Services (2016)

Figure 3 **Value of South Africa's Imports from the CMA** (Billion Rands)



Source: South African Revenue Services (2016)

Even though the focus of the paper is purely on the CMA region, SA is also an important export market for countries in the 15-member Southern African Development Community (SADC) region.

Financial Linkages

SA is mostly often described as an engine of growth in SSA in the sense that it is the largest source of foreign direct investment and portfolio investment for the CMA (IMF various reports). Most of the retail chain stores, commercial banks, insurance companies, mobile network companies[2] etc operating across most countries in SSA are predominately SA companies.

Furthermore, SA remains an important source of remittances for many countries in the Southern African region. For instance, between 2011 and 2014, Lesotho's remittances from SA accounted for approximately 20 per cent of GDP, reflecting a huge number of migrant workers employed in the South African mines, even though these have steadily declined in line with the persistent decline in SA's gold production. Several studies have shown that remittances have a positive impact on economic growth if they are channelled appropriately (Srivastava & Chaudhary, 2007; and Zuniga, 2011).

Institutional Linkages

The regional monetary and exchange rate agreement such as the CMA agreement warrants interest rate and exchange rate pass-through from SA to the rest of the CMA countries. Hence through interest rate and exchange rate movements, policy actions in SA immediately affect economic and financial conditions in the rest of the CMA. According to the CMA agreement, the LNS respective national currencies are pegged at one-to-one with the Rand and as such, SA monetary policy is easily transmitted to the LNS countries (Ikhide & Uanguta, 2010; and Seleteng, 2014).

On the fiscal side, the revenue sharing mechanism in the SACU warrants strong links between SA imports and revenue in the BLNS[3] countries. As indicated earlier, in 2011, SA accounted for approximately 80 per cent of trade within SACU. In Lesotho, SACU is an important source of government revenue accounting for about 42.3 per cent of total revenue in 2015 (CBL various publications, 2016).

[2] Such as: Shoprite, Pick n' Pay, Pep, Standard Bank, Nedbank, First National Bank etc.
[3] Botswana, Lesotho, Namibia and Swaziland.

2 LITERATURE REVIEW

Arora and Vamvakidis [2005(a)] used panel data estimation (Fixed Effects methodology) for 47 African countries for the period 1960 to 1999 in the context of standard growth model. The findings indicated that a 1 percentage point increase in South African economic growth is correlated with a 0.5 – 0.75 percentage point increase in growth in the rest of Africa.

On a similar token, Arora and Vamvakidis [2005(b)] investigated the extent to which a country's economic growth is influenced by the economies of its trading partners. Fixed Effects panel estimations for 101 industrial and developing countries over the period 1960-1999 were conducted. The findings revealed that a 1 percentage point increase in economic growth among a country's trading partner (ceteris paribus) is correlated with an increase in domestic growth of as much as 0.8 percentage points.

Another investigation into the spill-over effects by Arora and Vamvakidis (2010) used a unrestricted panel vector autoregression (PVAR) technique and error correction models (ECM) to estimate the role of China in the world economy. The analysis made use of panel data from 172 economies for the period 1960-2007. The findings revealed that a 1 standard deviation shock in Chinese growth reaches 0.4 percentage points over 3 years and 1 percentage point over 5 years. The results from ECM also confirmed these findings. Furthermore, the results depict that over the longer term, a 1 percentage point increase in China's growth is correlated with an average of 0.5 percentage point increase in growth of other countries.

Chen and Wu (2012) estimated a Solow-type growth model using a series of panel data methodologies[4] to examine the regional growth spill-overs in the 11 Pan Pearl River Delta (PPRD) provinces in China over the period 1985-2009. The estimation results confirm the existence of regional growth spill-over effects among these provinces. The findings showed that economic growth spill-overs of non-PPRD regions on the PPRD regions are greater than those among the PPRD members themselves. Furthermore, the findings depicted that world economic growth generates little spill-over effect on the economic growth of the PPRD regions.

Ćakir and Kabundi (2014) estimated a structural dynamic factor augmented vector autoregression (FAVAR) model to investigate the impact of China on Brazil, Russia, India and South Africa (BRIS) countries over a period 1995Q2-2009Q4. The findings show that China's (demand and supply) shocks do have different impact on each of the BRIS countries. Furthermore, the results depict that across China and BRIS countries, transmission channels of the shocks are mainly through trade rather than financial implying that China is a dominant powerhouse when it comes to trade, but financial integration with BRIS is still in its infant stage.

[4] i.e. Fixed Effects, Difference Generalised Methods of Moments and System Generalised Methods of Moments.

3 EMPIRICAL ANALYSIS

(a) The data

The analysis is based on annual data for four countries obtained from the World Bank Development Indicators (WDI) and IMF International Financial Statistics (IFS) for the period 1980 to 2014. This implies that $N = 4$ and $T = 34$, $T > N$, hence we have $N \times T = 136$ observations, therefore a use of panel time series is appropriate. The control variables are standard in the growth literature as discussed in Durlauf *et al*. (2005) and Levine and Renelt (1992) who used Leamer's extreme bounds analysis to analyse growth accounting regressions (see appendix for variable description).

(b) Methodology

The study makes use of panel time-series methodologies given the fact that they have several advantages. First, it allows us to specifically analyse the CMA case, amid all its idiosyncrasies and differences inherent within, without necessarily treating it as an outlier or as a dummy, and therefore enables us to get a clear picture of the region. Second, the issue of statistical endogeneity (unobserved individual effects which are nested in the error term might be correlated with the regressors), and heterogeneity of intercepts are dealt with by the two-way Fixed Effects (FE) with robust standard error estimator, which provides consistent estimates in dynamic models when $T \rightarrow \infty$. However, FE estimators are not reliable when the time dimension of the panel data is non-stationary because of the presence of unit roots, and when some of the regressors are endogenous.

Economic endogeneity (reverse causality) was found to be present between economic growth and investment. The Generalised Method of Moments (GMM) method is often used to deal with this problem (Arellano & Bond, 1991; Arellano & Bover, 1995; and Blundell & Bond, 1998). Theoretical and empirical evidence has also identified that spill-over effects are usually analysed using impulse-response functions generated from estimating a panel vector autoregression (PVAR) model (Sims, 1980; Holtz-Eakin *et al*., 1988; Fry & Pagan, 2005; Love & Zicchino, 2006). Hence as robustness check, the paper goes further and explores results from this technique. The PVAR analyses the impact of shocks to the SA economic growth rate on economic growth rate in the other CMA countries. This technique allows for country-specific heterogeneity and also has advantages over other methods because it accounts for dynamics in the system and endogeneity probmlems. Therefore the impulse-response functions derived from this technique shows the response of economic growth rate in the CMA to an orthogonal shock from a variable of interest (SA economic growth rate). Due to the limited time-span of the data for the CMA countries, using a single VAR model will not be appropriate since this compromises the degree of freedom. A PVAR allows us to overcome this problem.

Before any estimation can be carried out, several panel unit root tests[5] were carried out so as to check for stationary of the variables and only two variables; gross fixed capital formation as a share of GDP (inv) and a measure of financial development (broad measure of money supply as a share of GDP – $M2$) were found to be integrated of order one, I(1), and therefore used in first differences in the regressions.

(c) Estimation

A simple correlation analysis was carried out before any econometric estimation and the results are depicted in Table 1.

Table 1: Banking Infrastructure

	CMA_g	*LNS_g*	*LSO_g*	*NAM_g*	*SA_g*	*SWZ_g*
CMA_g	1					
LNS_g	0.94***	1				
LSO_g	0.41***	0.46***	1			
NAM_g	0.44***	0.47***	0.09	1		
SA_g	0.60***	0.29**	0.07	0.16	1	
SWZ_g	0.53***	0.55***	-0.27	-0.18	0.19	1

The results from the correlation analysis depict that there is a positive significant relationship between our variables of interest: SA economic growth and economic growth in the CMA. This is in line with *a priori* expectations give the linkages in the region. When taking individual LNS countries into consideration, the relationship is still positive, but statistically insignificant.

The estimated heterogenous dynamic Solow growth model is as follows[6]:

$$g_{it} = a_i + \beta\Gamma_{it} + v_{it}\ , \qquad \text{for country } i = 1,\ldots,N \quad \text{year } t = 1,\ldots,T \tag{1}$$

whereby g denotes real GDP growth rate for the CMA, a_i is the matrix of constant terms for each country i; β is a matrix of parameters to be estimated; Γ_{it} is the matrix of independent variables that includes the variables that are standard in growth regressions; and v_{it} is the stochastic error term. The growth determinates that are included in this growth model are: South African real economic growth rate (SAg), inflation rate (INF), broad measure of money supply ($M2$), gross fixed capital formation as a share of GDP (INV), openness to international trade ($OPEN$), and population growth rate ($POPG$).

[5] Levin, Lin and Chu (LLC); Im, Pesaran and Shin (IPS); Augmented Dickey Fuller (ADF)-Fisher; and Phillips-Perron (PP) –Fisher panel unit root tests were conducted.
[6] See, Barro and Sala-ì-Martin (1995)

3.1 Empirical Results

As indicated in the empirical framework, the analysis makes use of Fixed Effects (FE), two variants of Generalised Methods of Moments (Difference-GMM and System-GMM), and Panel Vector autoregression (PVAR) method. FE and GMM are estimated in a step-wise fashion.

(a) FE and GMM Regression Results

The findings from estimating the FE models depict that SA's real economic growth does not have a positive impact on economic growth in the rest of the CMA region, even though the impact is statistically insignificant. The other control variables are also not statistically significant (with an exemption of CMA economic growth lagged once). The F* test indicates the evidence of country FE. The results derived after having addressed the issue of endogeneity among the variables by use of GMM estimators are similar to the FE results. As a robustness check, the AR(1) test and the Sargan test indicate that there is no serial correlation and that the restrictions are not over-identified, respectively.

Table 2: Estimation Results

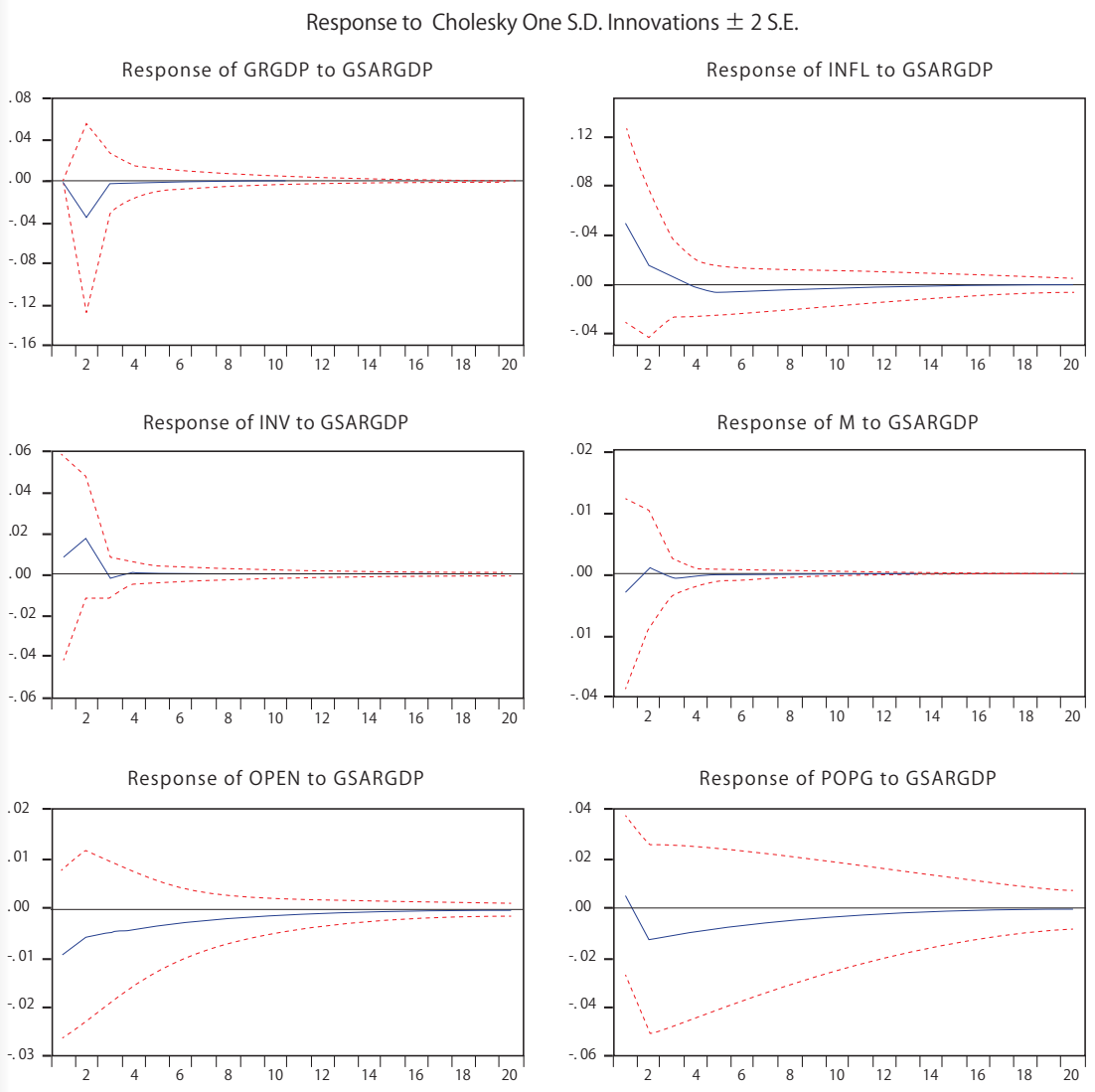
	Fixed Effects		Difference GMM		System GMM	
	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)
g(-1)	0.16** (1.82)	0.15* (1.72)	-0.09 (-0.97)	-0.09 (-0.94)	0.08 (0.69)	0.06 (0.62)
SAg	0.04 (0.32)	0.07 (0.44)	0.00 (0.02)	-0.02 (-0.23)	0.06 (0.54)	0.08 (0.77)
INF	0.12 (072)	0.03 (0.15)	-0.04 (-0.32)	0.05 (0.49)	0.13 (0.47)	-0.01 (-0.05)
M2	1.92 (1.05)	1.82 (0.98)	1.71* (1.65)	1.81** (1.75)	2.07*** (3.28)	1.97*** (3.45)
INV	-0.15 (-0.61)	-0.12 (-0.48)	0.14 (0.84)	0.10 (0.58)	-0.05 (-0.26)	-0.03 (-0.16)
OPEN	-0.25 (-0.44)	-0.09 (-0.13)	-0.12 (-0.21)	-0.51 (-0.98)	0.16 (1.18)	0.20* (1.75)
POPG		0.18 (0.71)		-0.26** (1.78)		0.24 (1.40)
- F* test [P-value]	1.33 [0.08]	0.78 [0.05]				
- Wald χ^2 [P-value]			3.11 [0.00]	8.49 [0.04]		
- AR(1) [P-value]					-1.78 [0.08]	-1.80 [0.07]
- Sargan Test χ^2 [P-value]					122.01 [0.01]	118.82 [0.01]

Note: */**/*** denotes significance at 10/5/1 per cent levels, respectively. T-ratios are in parenthesis.

b) PVAR Results

The graph on the top left corner of figure 4 shows that a one standard deviation shock to the SA economic growth results in an immediate decline in economic growth in the CMA economic growth for up to 2 periods (years) after the shock, even though the impact is statistically insignificant. The figure further shows that the impact of a shock to SA economic growth do not have significant impact on the other CMA variables such as inflation, investment, broad money, openness and population growth.

Figure 4 Impulse-Response Functions Derived From PVAR



In order to determine the ability of SA economic growth shocks to explain fluctuations in the economic growth in the rest of the CMA, a standard variance decomposition exercise is conducted and the results are presented in Table 3. Estimates represent the percentage of variation in the row variable explained by the column variable. The results depict that only 0.24 per cent of the variation in the CMA's economic growth can be attributed to shocks to SA's economic growth (both in the short-run and long-run)[7]. SA economic growth rate has more impact on inflation in the CMA region, accounting for about 1.49 per cent and 1.43 of its short and long run variance, respectively. This is then followed by the impact on trade, at about 1.2 per cent of both its short and long-run variance. The decomposition of SA growth rate indicates that it is most likely explained by its own variation at about 77.6 per cent and 76.1 per cent of its short-run and long-run variance, respectively.

Table 3: Variance Decompositions

Forecasting Horizon (Years)	Fraction of Variance That Can Be Attributed to Shocks to:						
	g	*SAg*	*Infl*	*Inv*	*M2*	*Open*	*Popg*
a) g							
10	99.01	0.24	0.08	0.41	0.04	0.13	0.06
20	98.98	0.24	0.08	0.42	0.05	0.14	0.08
b) Sag							
10	3.41	77.61	0.09	10.16	2.69	0.81	5.22
20	3.36	76.12	0.16	10.11	3.01	1.44	5.80
c) Inf							
10	0.68	1.49	78.55	1.06	6.09	1.10	11.01
20	0.69	1.43	74.72	1.37	6.81	2.59	12.38
d) Inv							
10	1.11	0.71	4.73	89.91	1.76	1.14	0.63
20	1.10	0.71	4.73	89.72	1.79	1.26	0.68
e) M2	M2						
10	7.87	0.21	1.27	1.63	88.15	0.78	0.08
20	7.87	0.20	1.27	1.62	88.14	0.79	0.08
f) Open							
10	4.09	1.17	5.11	3.50	0.83	82.98	2.28
20	4.17	1.18	5.03	3.49	1.20	81.54	3.36
e) Popg							
10	1.79	0.44	1.67	5.84	20.73	17.49	52.01
20	1.59	0.40	1.89	6.10	20.40	20.25	49.35

[7] Shaded in the table.

To test for stability of the PVAR model, a number of diagnostic tests were conducted. The results show no evidence of serial correlation and heteroscedasticity. Furthermore, the model also passes the normality test.

In a nutshell, the results from all the estimated models (FE, GMM and PVAR) depict no evidence of spill-over effects of SA economic growth to economic growth in the rest of the CMA. The reasoning behind this lack of evidence may be attributed to the fact that most of the LNS countries trade mostly with other countries abroad, rather than SA only. For instance, Lesotho's textiles and clothing materials as well as diamonds are destined to the United States (US) and Europe, respectively. In addition, the growth drivers in LNS countries are not directly linked to SA. For instance, in Namibia, the growth drivers are mining, agriculture and tourism (SADC, 2014), whereas in SA the growth drivers also include manufacturing, construction and financial services.

3 CONCLUSION

The purpose of the study was to assess the spill-over effects of low SA economic growth on the CMA. Econometrically, the estimated results from the three models estimated indicate that economic growth in SA does not appear to have significant spill-over effects on the CMA. These findings are in line with Canales-Kriljenko et. al., (2013). The reasons could be due to the fact that the CMA countries are trading significantly with other countries abroad, apart from SA. Second, the growth drivers in the LNS countries are not directly linked to SA's economic growth. Third, there is insufficient time-series data in the CMA countries to adequately estimate spill-over effects.

However, a simple correlation analysis shows that there is indeed a positive relationship between economic growth in SA and the entire CMA. Hence, implying that a slowdown in SA's economic growth is likely to have negative implications on the economic growth in the CMA. For future research, there is a need to conduct a detailed analysis of different channels through which the growth spill-overs might be transmitted, since this study just looks at the spill-over effects in a generalised fashion.

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APPENDIX

Annual data: 1980 - 2014		
Variable	Acronym	Description
Real GDP growth in CMA	*g*	Real GDP growth rate (annual % changes)
SA Real GDP growth	*SAg*	South Africa's Real GDP growth rate (annual % changes)
Inflation	*infl*	Consumer price inflation (annual % changes)
Investment	*inv*	Gross fixed capital formation (% of GDP)
Broad Money	*m2*	M2 (as % of GDP)
Trade	*open*	(Imports + Exports) of goods and services (% of GDP)
Population growth	*popg*	Annual population growth rate
Source: **Central Bank of Lesotho**		

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