TOTAL EFFECTS OF BANK CREDIT ON ECONOMIC GROWTH IN MAURITIUS: A TIME-VARYING COEFFICIENT ESTIMATION OF THE QUANTITY THEORY OF DISAGGREGATED CREDIT

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Abstract

The empirical literature has found mixed evidence of the effects of finance on growth. A comprehensive review by Levine (2005) found that more finance is good for the economy, and countries which have a smaller share of private sector credit to GDP should attempt to increase it to promote investment and growth. However, a part of the literature has found a non-linear relationship between 'financial deepening' and economic growth, suggesting that too much finance could be harmful for growth (see Deidda and Fattouh, 2002; Huang and Lin, 2009; Arcand et al., 2012, 2015; Cecchetti and Kharroubi, 2012, 2013; Law and Singh, 2014). To the best of our knowledge, none of the studies investigated the reasons for the non-linear effects of finance on growth.

Empirical studies on finance and growth in Mauritius have found a positive link between different quantitative measures of financial development (FD) such as the ratio of liquid liabilities of banks to GDP and private sector credit to GDP on investment or economic growth (see Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010; Muyambiri and Odhiambo, 2018). Since the empirical literature has shown that the effects of private sector credit on economic growth have been declining in many parts of the world (See Arcand et al. (2012); Cechetti et al. (2012)), this thesis investigates if the positive effects of private sector credit on economic growth still hold in Mauritius. This investigation is particularly salient as during the past three decades there has been an increase in private sector credit but economic growth has remained relatively subdued, raising questions about the efficiency of aggregate credit in promoting productive investment in the country.

We start this research by performing a fixed coefficient estimation of the effects of two measures of FD: Private Sector Credit per capita[1] (PSC) and Commercial Bank Credit per capita (CBC) on Real GDP per capita (RGDP). The results of the ARDL model show strong evidence of negative long-run effects of PSC or CBC on RGDP, but the effects of the former

[1]The reason we use per capita in the first empirical study in Chapter 2 is to remain consistent with Chapters 3 and 4 in which we use a time-varying coefficient (TVC) estimation approach. In Chapters 3 and 4 on TVC we use PSC per capita and CBC per capita for the TVC estimation of the total effects of equation 4 without coefficient drivers. Swamy (2021) stated that if we use PSC to GDP and CBC to GDP as independent variables in doing this estimation, this might introduce a negative correlation over time with the dependent variable i.e. RGDP.

on the latter remain positive in the short-run. These results raise serious questions about the effects of aggregate credit on economic growth in the country in the long-run.

We argue that the relationship between PSC or CBC and RGDP in Mauritius might have changed over time due to different economic policies adopted and structural economic changes in the country since independence in 1968, and therefore the application of a time-varying coefficient (TVC) model would be more appropriate for the analyses. In contrast to existing fixed and variable coefficient models, which ignore the indirect effects of the regressor on the dependent variable, the TVC model of Swamy and Von Zur Muehlen (2020) measure the *total effects*[2] of PSC or CBC on RGDP from 1970 to 2019. Furthermore, as opposed to the existing empirical literature on the indirect effects of finance and growth (Sarwar et al., 2020), the TVC model uses coefficient drivers to measure more precisely the partial indirect effects[3] through which finance can affect growth. The results show that the direct effects of PSC or CBC on economic growth are positive while the indirect effects measured by Private Investment (PI), Gross Fixed Capital Formation (GFCF), Private Consumption (PC) and IMPORTS are all negative which partly explains the declining effects of finance on growth in Mauritius.

It is important to highlight the differences between the ARDL and TVC results. The results for the ARDL model show significant positive direct effects of PSC or CBC on RGDP in the short-run and significant negative direct effects of PSC or CBC on RGDP in the long-run. On the other hand, the results for the TVC model show that the total effects, including the direct effects of PSC or CBC on RGDP for the entire period, are always positive and in fact it is the indirect effects of PSC or CBC on RGDP which are negative. The indirect effects are significantly measured by the negative coefficient of the coefficient drivers, PI, GFCF, PC and IMPORTS which partially explains the decline in the positive total effects of private sector credit and commercial bank credit on economic growth in Mauritius over time. The ARDL model ignores the indirect effects and hence wrongly arrives at the conclusion that it is PSC or CBC which has negative direct effects on economic growth in the long-run. The TVC results suggest that banks in Mauritius have been allocating credit to sectors which are less productive during more recent times.

[2] The estimate of the total effects of a regressor on a dependent variable estimate the partial direct effects but also the partial indirect effects of a regressor on a dependent variable.
[3] The phrases “partial indirect effects” and “indirect effects” are used interchangeably in our TVC study. The same applies for the phrases “partial direct effects” and “direct effects”.

Therefore, we introduce the Quantity Theory of Disaggregated Credit (QTDC) in Africa and provide a new theoretical framework to show the explicit link between bank credit and nominal GDP (NGDP). In particular, we use QTDC to disaggregate commercial bank credit into bank credit for GDP transactions and bank credit for non-GDP transactions, and then measure the total effects of the former on NGDP in Mauritius. The empirical results show that bank credit for GDP transactions namely proxy 10[4] has stronger total effects on NGDP than proxy 11[5] throughout the period 1970 to 2019. This result suggests that bank credit to the construction sector has had major non-GDP effects.

The time path for the total effects of proxy 10 on NGDP shows that during the economic miracle period of the 1980s bank credit for GDP transactions played a significant role in stimulating GDP. However, from the late 1980s the total effects of bank credit for GDP transactions on NGDP start to decline as commercial banks gradually shifted their allocation of credit to non-GDP sectors, notably to finance and construction. Consequently, the total effects of proxy 10 on NGDP plummet and reach its minimum point in 2013[6]. The stronger deceleration in the time path of the total effects of proxy 11 on NGDP in comparison to the time path of proxy 10 on NGDP shows that as banks increased their allocation of credit to the construction sector, the link between bank credit and NGDP weakened considerably. The indirect effects of proxy 10 and 11 on NGDP are measured by the coefficient drivers - Private Investment (PI), Gross Fixed Capital Formation (GFCF), Private Consumption (PC) and IMPORTS are all significant and negative, which partially explains the decline in NGDP during recent decades.

In the final part of the empirical study, we use the proposition of Turner (2014, p. 28) and disaggregate Gross Fixed Capital Formation (GFCF) into three components: Residential and Commercial Real Estate Investment (RCREI), Investment in Machines (IM) and Investment

[4] Proxy 10 is calculated using total commercial bank credit minus bank credit to the construction sector minus bank credit to the financial sector.

[5] Proxy 11 is calculated using total commercial bank credit minus bank credit to the financial sector

[6] In 2013, the total effects of total bank credit excluding bank credit to the financial sector and bank credit to the construction sector on NGDP reached its minimum point before it turned around from 2015–2016 onwards and there is a reason for this. On 2nd April 2015, there was the collapse of a major commercial bank in the country, the Bramer Banking Corporation, which was subsequently taken over by a newly formed state owned bank, the MauBank, which itself comes from the defunct Mauritius Post Cooperative Bank. The newly established bank, MauBank, started its activities on 4th January 2016 with its core activity to provide financial support to small and medium enterprises (SMEs). Maubank introduced innovative and competing financing plans for SMEs who want to engage in agri-business, ICT, Blue Economy, innovation and research, among others (Government of Mauritius, 2016). The assets of MauBank increased from Rs 10 billion in 2015–2016 to reach more than Rs 15 billion in 2018–2019, which represents an increase of more than 50% within four years. We believe that these developments have led to a significant boost in bank credit for GDP transactions through SME loans and hence provide an explanation for the positive effects of proxy 10 on NGDP from 2015–2016 onwards.

in Infrastructure (II) to have a mesoscopic view of the indirect effects of bank credit for GDP transactions on NGDP and RGDP. We use the two disaggregated measures of bank credits for GDP transactions namely proxy 10 and proxy 11 as financing variables to measure their total effects on NGDP and RGDP. The findings show that irrespective of whether we use aggregate or disaggregate measures of investment, the total effects of proxy 10 on NGDP or RGDP outperforms the total effects of proxy 11 on NGDP or RGDP. The indirect effects of proxy 10 and proxy 11 measured by II, IM and RCREI remain always negative, which corroborates the previous findings that the *uses* of credit are important for strong economic performance.

The high growth rates of the country during 1970s and 1980s is accurately depicted by the time path of the total effects of proxy 10 on RGDP which shows strong total effects of bank credit on economic growth through IM from 1970 to 1979 and from 1984 to 1992. From 1984 to 1992, the total effects of proxy 10 on RGDP via IM have had stronger total effects on economic growth relative to the total effects of proxy 11 on RGDP via RCREI. The period of high growth rates coincides with the imposition of the credit ceiling on non-priority sectors from 1973 to 1993. We argue that the close monitoring of the sectoral composition of bank credit and the introduction of the credit ceiling in 1973 has been an important element in explaining the high economic growth of the country in the 1970s and 1980s. However, after the removal of all forms of credit controls in July 1993, the time path of the total effects of proxy 10 and proxy 11 on RGDP experienced a sharp decline due to the gradual shift in the composition of bank credit to non-GDP transactions.

In a nutshell, this study has brought to light five major findings. First, the fixed coefficient estimation of the effects of bank credit on economic growth has shown that the effects are significantly positive in the short-run but negative in the long-run. Second, the time-varying coefficient estimation shows that the effects of bank credit on economic growth are not constant but vary over time, and are non-linear which strongly challenges the findings of previous empirical studies that have used fixed coefficient models and hence assumed that the relationship between finance and growth is constant. More specifically, we find that the effect of bank credit for GDP transactions vary over time and are non-linear. This result also contrasts the findings of previous empirical studies on QTDC that have used fixed coefficient models and assumed that the positive effects of increases in bank credit for GDP transactions on NGDP growth are constant. Third, bank credit has had stronger effects on economic growth from 1970 to about 1990 but then the effects weaken due to increasing bank credit for

non-GDP transactions. Fourth, proxy 10 has had stronger effects on GDP in comparison to proxy 11 because the latter includes bank credit to construction whose non-GDP effects weaken the relationship between bank credit and GDP. Fifth, the indirect effects of proxy 10 on economic growth as measured by IM give a strong channel through which bank credit can stimulate economic growth.

We believe that it is possible to replicate the time path of the best model that shows sustained and strong positive total effects of proxy 10 on RGDP in Mauritius from 1973 to 1979 and notably from 1984 to 1992. Thus, we propose credit policy measures that would increase bank credit for GDP transactions and encourage investment to IM which today could include investment in agri-tech, high-tech manufacturing, renewable energy technology, information and communications technology devices and the operations of the blue economy amongst others. However, the reintroduction of a productive system of credit allocation is a necessary but not sufficient condition to reignite economic growth in the country. It should also be accompanied by an industrial policy like in 1980s which includes the production of higher value added goods mainly for the exports market.

Kernopsomming

Proefondervindelik is bewys dat finansiering ‘n gemengde uitwerking het op groei. ‘n Omvattende oorsig deur Levine (2005) toon dat die ekonomie by ‘n toename in finansiering baat en dat ‘n land waar die privaatsektor oor ‘n betreklik kleiner hoeveelheid krediet beskik, vergeleke met sy GDP, sy kredietvlakke behoort op te stoot ten einde belegging en groei te bevorder. Ander navorsing het egter bewys dat die verhouding tussen groei in die ekonomie en ‘n toename in finansiering nie-liniêr van aard is, wat daarop dui dat ‘n oormaat van finansiering skadelik kan wees vir groei (sien Deidda en Fattouh, 2002; Huang en Lin, 2009; Arcand et al., 2012, 2015; Cecchetti en Kharroubi, 2012, 2013; Law en Singh, 2014). Vir sover ons kennis strek, het geen van bogenoemde ondersoeke die redes agter die nie-liniêre uitwerking van finansiering op groei nagevors nie.

Volgens proefnavorsing oor finansiering en groei in Mauritius bestaan daar ‘n positiewe ooreenkoms tussen verskeie kwantitatiewe maatstawe vir finansiële ontwikkeling (FO) soos bv. die verhouding van die likiede verpligtinge van banke tot GDP en die krediet van die privaatsektor tot GDP t.o.v. belegging of ekonomiese groei (sien Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010; Muyambiri en Odhiambo, 2018). Aangesien navorsing bewys dat die uitwerking van privaatsektorkrediet op ekonomiese groei in vele wêrelddele aan die afneem is, (sien Arcand et al. (2012); Cechetti et al. (2012)), wil hierdie proefskrif vasstel of die positiewe uitwerking van privaatsektorkrediet op ekonomiese groei nog in Mauritius geld. Hierdie ondersoek is veral toepaslik aangesien daar tydens de afgelope drie dekades ‘n toename in privaatsektorkrediet was, terwyl ekonomiese groei betreklik stadig gebly het, wat vrae laat ontstaan oor die doeltreffendheid van aggregaatkrediet in die bevordering van produktiewe belegging in die land.

Hierdie navorsingstuk begin met ‘n skatting van die uitwerking van ‘n vaste koëffisiënt van twee FO-maatstawe, nl.Privaatsektorkrediet per capita[7] (PSC) en Kommersiële Bankkrediet per capita (CBC), op Reële GDP per capita (RGDP). Die uitwerking van die outo-regressiewe distribusie-vertraging (ARDL) toon sterk bewyse van die negatiewe

[7] Die rede waarom per capita in die eerste empiriese navorsingstuk in Hoofstuk 2 gebruik word, is om konsekwentheid te behou met Hoofstukke 3 en 4 waar TVC, ‘n tydwisselende koëffisiëntskattingsmetode, gebruik word.In Hoofstukke 3 en 4 word per capita PSC gebruik en CBC per capita vir die TVC-skatting van die totale uitwerking van vergelyking 4 sonder koëffisiëntaandrywers. Swamy (2021) beweer dat wanneer PSC tot GDP en CBC tot GDP tydens hierdie skatting as onafhanklike veranderlikes gebruik word, dit dalk met verloop van tyd t.o.v. die afhanklike veranderlike, nl. RDGP,‘n negatiewe korrelasie kan invoer.

langtermyngevolge van PSC en CBC op RGDP, maar die uitwerking van eersgenoemdes op laasgenoemde bly in die korttermyn positief. Hierdie bevindinge laat ernstige vrae ontstaan oor die langtermynuitwerking van aggregaatkrediet op ekonomiese groei in die land.

Hieronder word beweer dat the verhouding tussen PSC of CBC en RGDP in Mauritius met verloop van tyd dalk verander het as gevolg van verskeie beleide wat t.o.v. die ekonomie toegepas is, asook van strukturele ekonomiese wysigings in die land sedert onafhanklikwording in 1968. Dit is dus meer toepaslik om ‘n tydwisselende koëffisiënt-model (TVC) op die ontledinge te gebruik. In teenstelling met die bestaande vaste en wisselende modelle, wat die indirekte gevolge van die regressor op die afhanklike veranderlike miskyk, het die TVC-model van Swamy en Von Zur Muehlen (2020) die *totale gevolge*[8] van PSC of CBC op RGDP vanaf 1970 tot 2019 gemeet. In teenstelling met die huidige empiriese navorsingsverslae oor die indirekte uitwerking van finansiering en groei (Sarwar et al., 2020), gebruik die TVC-model koëffisiëntaanduiders om op presieser wyse die gedeeltelike gevolge[9] te meet waardeur finansiering groei kan beïnvloed. Die uitslae bewys dat die direkte gevolge van PSC of CBC op ekonomiese groei positief is, terwyl die indirekte gevolge, soos volgens Privaatinvestering (PI), Bruto Vaste Kapitaalskepping (GFCF), Privaatverbruik (PC) en Invoere gemeet, alles negatief is, wat dan die afnemende uitwerking van finansiering op groei in Mauritius verduidelik.

Dit is belangrik om klem te lê op die verskille tussen die uitslae van ARDL en TVC. Die uitslae van die ARDL-model toon in die kort termyn beduidende positiewe direkte gevolge van PSC of CBC op RGDP; langtermyn-direkte gevolge van PSC of CBC op RGDP is egter negatief. Aan die ander kant dui die uitslae vir die TVC-model dat die totale uitwerking, ingeslote die direkte gevolge van PSC of CBC op RGDP vir die volle tydperk, deurgaans positief is. Trouens dit is juis die indirekte gevolge van PSC of CBC op RGDP wat negatief is. Die indirekte gevolge is beduidend meetbaar aan die negatiewe koëffisiënt van die koëffisiënte aanduiders, nl. PI, GFCF, PC en Invoere, wat gedeeltelik die afname met verloop van tyd in die positiewe totale gevolge van krediet in die privaatsektor sowel as kommersiële bankkrediet op ekonomiese groei in Mauritius kan verduidelik. Die ARDL-model

[8] Die skatting van die totale uitwerking van ‘n regressor op ‘n onafhankilke veranderlike skat die gedeeltelik direkte uitwerking maar ook die gedeeltelik indirekte uitwerking van ‘n regressor op ‘n afhanklike” veranderlike.

[9] In hierdie TVC-navorsingstuk word die frases “gedeeltelik indirekte uitwerking” (of “gevolge”) en “indirekte uitwerking” (of “gevolge”) wisselbaar gebruik. Dieselfde geld vir die frases “gedeeltelik direkte uitwerking” en “direkte uitwerking”. Die indirekte uitwerking staan ook bekend as “weggelate regressorneiging”.

verontagsaam die indirekte uitwerking en kom gevolglik tot die verkeerde slotsom dat dit PSC of CBC is wat in die langtermyn ‘n negatiewe uitwerking op ekonomiese groei het. Uit die TVC-uitslae blyk dit asof banke in Mauritius krediet aan sektore verskaf het wat in die afgelope tyd minder produktief was.

Daarom word daar voorgestel dat die Kwantiteitsteorie van Gedesaggregeerde Krediet (QTDC) hier in Afrika gebruik word en dat ‘n nuwe teoretiese raamwerk verskaf moet word ten einde die duidelike verband tussen bankkrediet en nominale GDP (NGDP) te bewys. In die besonder word QTDC aangewend om kommersiële bankkrediet vir GDP-transaksies en bankkrediet vir nie-GDP-transaksies te desaggregeer; daarna word die totale uitwerking van eersgenoemde op NGDP in Mauritius gemeet. Die bewese uitslae in die hele tydperk 1970 tot 2019 toon dat bankkrediet vir GDP-transaksies, naamlik proxy 10[10], ‘n sterker uitwerking op NGDP het as proxy 11[11].Hierdie bevinding dui daarop dat bankkrediet in die konstruksiesektor nie ‘n daadwerklike uitwerking op GDP gehad het nie.

Die tydsverloop waarin die totale uitwerking van proxy 10 op NGDP gemeet is, toon dat bankkrediet tydens die ekonomiese wondertydperk van die tagtigerjare ‘n beduidende rol gespeel het om GDP aan te dryf. Vanaf die laat-tagtigerjare begin die totale uitwerking van bankkrediet van GDP-transaksies op NGDP egter afneem namate kommersiële banke geleidelik hul kredietoekenning aan nie-GDP-sektore, met name finansiering en konstruksie, aanskuif. Gevolglik kom daar ‘n dramatiese vermindering in die totale uitwerking van proxy 10 op NGDP voor en bereik dit in 2013[12] sy laagtepunt. Die sterker afname gedurende die tydsverloop van die totale uitwerking van proxy 11 op NGDP, vergeleke met die tydsverloop

[10] Proxy 10 word bereken met gebruik van totale kommersiële bankkkrediet min bankkrediet aan die konstrukiesektor min bankkrediet aan die finansiële sektor.

[11] Proxy 11 word bereken met gebruik van totale kommersiële bankkkrediet min bankkrediet aan die finansiële sektor.

[12] In 2013 bereik die totale uitwerking van totale bankkrediet op NGPD, afgesien van bankkrediet aan die finansiëlesektor en bankkrediet aan die konstruksiesektor, sy laagtepunt, en daarna, vanaf 2015-2016 keer dit opwaarts. Daar is ‘n rede hiervoor. Op 2 April 2015 het een van die land se grootste kommersiële banke, nl. die Bramer Banking Corporation, ineengestort. Vervolgens is die bank deur die pasgestigte staatsbank, MauBank, oorgeneem.MauBank het sy oorsprong in die ontbinde Mauritius Post Cooperative Bank. Die pasgestigte MauBank het op 4 Januarie 2016 met sy bedrywighede begin. Sy kernverantwoordelikheid was om finansiële ondersteuning aan klein en medium besighede, (SME’s) te verskaf. Maubank het innoverende en mededingende finansieringplanne ingevoer vir SME’s wat onder andere in agribesigheid, ICT, die Blou Ekonomie, innovering en navorsing, wou betrokke raak (Government of Mauritius, 2016). Die bates van MauBank styg van Rs 10 miljard in 2015–2016 tot meer as Rs 15 miljard in 2018–2019, wat ‘n toename van meer as 50% binne vier jaar verteenwoordig. Daar word geglo dat hierdie ontwikkelinge ‘n beduidende hupstoot in bankkrediet vir GDP-transaksies gegee het deur middel van SME-lenings en dus ‘n verduideliking verskaf vir die positiewe uitwerking van proxy 10 on NGDP van 2015–2016 vorentoe.

van proxy 10 op NGDP, toon dat die verband tussen bankkrediet en NGDP aansienlik verswak het namate banke hul krediettoekenning aan die konstruksiesektor opgestoot het. Die indirekte gevolge van proxy 10 en 11 op NGDP word deur middel van die koëffisiënt-aanduiders gemeet, nl. Privaatinvestering (PI), Bruto Vaste Kapitaalskepping (GFCF), Privaatverbruik (PC) en Invoere, waarvan elkeen beduidend en negatief is, wat gedeeltelik die afname in NGDP in onlangse dekades verklaar.

In die laaste gedeelte van die empiriese navorsingstuk word gebruik gemaak van die stelling van Turner (2014, p. 28) en word die Bruto Vaste-kapitaalskepping (GFCF) in die volgende komponente gedesaggregeer, nl. Belegging in Woonbuurte en Vaste Eiendom (RCREI), Belegging in Masjinerie (IM) en Belegging in Infrastruktuur (II), ten einde ‘n oorkoepelende blik op die indirekte gevolge van bankkrediet vir GDP-transaksies op NGDP en RGDP te verkry. Daar word gebruik gemaak van die twee gedesaggregeerde maatstawe van bankkrediet vir GDP-transaksies, nl. proxy 10 en 11, as finansieringsveranderlikes om die totale uitwerking daarvan op NGDP en RGDP te meet. Ongeag of aggregaat of desaggregaat as beleggingsmaatstaf gebruik word, toon die bevindinge dat die totale uitwerking van proxy 10 op NGDP of RGDP die totale uitwerking van proxy 11 daarop oorskry. Die indirekte uitwerking van proxy 10 en proxy 11, soos deur II, IM en RCREI gemeet, bly deurgaans negatief, wat die vroeëre bevindinge bevestig dat juis die *gebruik* van krediet belangrik is vir sterk ekonomiese prestasie.

Die land se hoë groeikoerse gedurende die 1970’s en 1980’s word noukeurig weerspieël in die tydsverloop van die totale uitwerking van proxy 10 op RGDP, en toon die sterk totale uitwerking van bankkrediet op ekonomiese groei vanaf 1970 tot 1979 asook van 1984 tot 1992 – as gevolg van IM. Tussen 1984 en 1992 toon die totale uitwerking van proxy 10 op RDGP a.g.v.IM sterker algehele gevolge op ekonomiese groei in vergelyking met die total uitwerking van proxy 11 op RDGP a.g.v. RCREI. Die tydperk van vinnige groeikoerse val saam met die toepassing van die kredietplafon op nie-prioriteitsektore tussen 1973 en 1993. Daar word gekonstateer dat die noukeurige monitering van die samestelling van bankkrediet in die verskeie sektore ‘n belangrike element uitmaak waarvolgens die sterk ekonomiese groei in die 1970’s en 1980’s in die land verduidelik kan word. Na die opheffing van alle vorme van kredietkontrole in Julie 1993, ondervind die tydsverloop van die totale uitwerking van proxy 10 en proxy 11 op RDGP egter ‘n skerp afname, as gevolg van die geleidelike skuif in die samestelling van bankkrediet ten gunste van nie-GDP-transaksies.

In ‘n neutedop saamgevat: hierdie navorsing het vyf belangrike bevindinge aan die lig gebring. Eerstens: die vaste koëffisiënt-skatting van die uitwerking van bankkrediet op ekonomiese groei toon dat die gevolge in die korttermyn beduidend positief is, maar dat dit op die lange duur negatief is. Tweedens: die skatting ten opsigte van tydwisselende koëffisiënte bewys dat die uitwerking van bankkrediet op ekonomiese groei nie konstant is nie, maar dat dit nie net met verloop van tyd verander nie, maar ook nie-liniêr van aard is. Hierdie bevindinge bevraagteken sterk die gevolgtrekkinge van vroeëre empiriese navorsing wat steun op vaste koëffisiëntmodelle en gevolglik aanneem dat die verhouding tussen finansiering en groei konstant is. Meer spesifiek nog: daar is bevind dat die uitwerking van bankkrediet vir GDP-transaksies met verloop van tyd wissel en dat dit nie-liniêr van aard is. Hierdie bevinding kontrasteer ook met dié van vroeëre empiriese navorsing oor QTDC wat vaste koëffisiëntmodelle gebruik en aanneem dat die positiewe gevolge op NGDP-groei van ‘n toename in bankkrediet vir GDP-transaksies konstant bly. Derdens: bankkrediet het vanaf 1970 tot om en by 1990 ‘n sterk uitwerking op ekonomiese groei gehad, maar daarna verswak die uitwerking as gevolg van die toenemende beskikbaarheid van bankkrediet vir nie-GDP-transaksies. Vierdens: in vergelyking met proxy 11 het proxy 10 ‘n sterker uitwerking op GDP, want proxy 11 sluit bankkrediet vir die konstruksiesektor in, waar die nie-GDP-gevolge die verhouding tussen bankkrediet en GDP verswak. Vyfdens: die indirekte uitwerking van proxy 10 op ekonomiese groei, soos deur middel van IM gemeet, verskaf ‘n sterk middel waarmee bankkrediet ekonomiese groei kan bevorder.

Daar word geglo dat dit moontlik is om die tydsverloop van die beste model te herhaal waarvolgens volgehoue, sterk positiewe totale uitwerking van proxy 10 op RDGP in Mauritius vanaf 1973 tot 1979 en veral weer vanaf 1984 tot 1992 bewys is.Daar word dus kredietbeleidmaatreëls voorgestel wat bankkrediet vir GDP-transaksies sal verhoog en investering in IM aanmoedig. Dit kan huidiglik ‘n toename in belegging meebring ten opsigte van agritegnologie, moderne vervaardiging, hernieubare energietegnologie, inligtings- en kommunikasie-tegnologietoestelle, asook onder andere die bedryf van die marine- of blou-ekonomie. Hoewel die herinstelling van ‘n produktiewe stelsel van krediettoewysing noodsaaklik is, is dit egter nie op sigself voldoende om ekonomiese groei in die land aan te wakker nie. Dit moet ook gepaard gaan met ‘n nywerheidsbeleid soortgelyk aan dié in die 1980’s wat die vervaardiging van goedere met hoër waarde met die oog veral op die uitvoermark insluit.

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Dedication

I dedicate this thesis to the memory of my late father, Vishnuprasadsing Achameesing, who showed me the importance of challenging conventional beliefs

Declaration: Language Editing

29th September, 2021

Stellenbosch Business School
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Dear Sir/Madam,

Declaration of language and technical editing

I, Sheila Hicks, hereby declare that I have personally read through the research assignment of Amit Achameesing and have highlighted language and technical errors.

Yours sincerely

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List of Abbreviations

ADF	Augmented Dickey–Fuller
ARDL	Auto Regressive Distributed Lag
BCGDP	Bank Credit for GDP transactions
BOM	Bank of Mauritius
CBC	Commercial Bank Credit per capita
CEXPI	Commodities Export Price Index
ECB	European Central Bank
ECT	Error Correction Term
EPZ	Export Processing Zone
FD	Financial Development
GBCs	Global Business Companies
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GFCF	Gross Fixed Capital Formation
GLS	Generalized Linear Least Squares
ICT	Information and Communications Technology
II	Investment in Infrastructure
i.i.d.	Identically and Independently Distributed
IRS	Integrated Resort Scheme
IRSGLS	Iteratively Rescaled Generalized Least Squares
IM	Investment in Machines
IMF	International Monetary Fund
LLB	Liquid Liabilities per capita
MFA	Multi Fibre Agreement
MHT	Medium and High-tech industry
MPRA	Munich Personal RePEc Archive
NFC	Non-financial Corporations
NGDP	Nominal GDP
OLS	Ordinary Least Squares
OMO	Open Market Operations
OMT	Openness of Mauritius Trade
PC	Private Consumption

PI	Private Investment
PSC	Private Sector Credit per capita
QTC	Quantity Theory of Credit
QTDC	Quantity Theory of Disaggregated Credit
RCREI	Residential and Commercial Real Estate Investment
REEXR	Real effective Exchange Rate
RES	Real Estate Scheme
RGDP	Real Gross Domestic Product per capita
SCEP	Stochastic Coefficient Estimation Program
SDR	Special Drawing Rights
SME	Small and Medium Enterprise
SSA	Sub-Saharan Africa
TVC	Time-Varying Coefficient
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
VAR	Vector Autoregressive
VECM	Vector Error Correction Model

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In Mauritius financial reforms in the 1990s were geared towards the liberalization of the financial system in order to enhance efficiency in the mobilization and allocation of funds in the economy. The shift to a free-market system took off in the early 1990s with the introduction of a host of financial liberalization policies, an important example being the abolition of credit ceilings for priority and non-priority sectors in July 1992 and 1993, respectively. After the relaxation of all credit controls in 1993, bank credit rose from 42.2% of GDP in 1993 to reach a peak of 81.9% of GDP in 2013, while at the same time private investment fell from 20.5% of GDP in 1993 to 15.9% of GDP in 2013. During the same period, real GDP growth slowed down from 5.1% p.a. in 1993 to 3.4% p.a. in 2013 (Statistics Mauritius, 1993, 2013). These facts tentatively suggest a serious disconnect between bank credit, private investment and economic growth post-liberalization, and we believe it is imperative to deepen our understanding of the link between finance, investment and growth in Mauritius.

Empirical studies on finance and growth in Mauritius have found a positive link between measures of financial development and economic growth (see Jouan, 2005; Jankee, 2006; Seetanah, 2008), while other studies have found that the effect of finance on growth is positive but minimal (see Nowbutsing et al., 2010). Given the significant rise in real estate and financial lending prior to the global financial crisis (GFC) (see Jordà et al., 2016), which created havoc in many developed economies, it is possible that the rise in bank lending towards the real estate and financial sectors could have played a role in weakening economic growth in Mauritius. Bank credit to the real estate and financial sectors increased to 58% of total bank credit in 2019, compared to 17% in 1993 (Bank of Mauritius, annual reports, 1993, 2019). It is possible that the effects of the acceleration of real estate and financial lending during the recent decades might have not been fully captured by earlier empirical studies on financial development and economic growth (such as Jouan, 2005; Jankee, 2006; Seetanah, 2008) while more recent studies have found that the link between credit and growth is minimal (Nowbutsing et al., 2010).

From a review of the empirical literature, we find that there are two broad types of models which have been used to estimate the relationship between finance and economic growth: (i) fixed coefficient models, and (ii) variable coefficient models (the variable coefficient models include threshold regime switching models, and state space models). The empirical literature on finance and growth has shown an overwhelming reliance on fixed coefficient models to estimate the effects of finance on growth (see review of Eschenbach, 2004; Levine, 2005; Pasali, 2013). A comprehensive review by Levine (2005) showed that more finance is good for the economy, while other authors such as Pasali (2013) have highlighted a weakening relationship between finance and growth, suggesting that too much finance can be harmful for economic growth. However, the problem with fixed coefficient models is that *they do not account for the time-varying relationship* between credit and economic growth.

The use of time-varying coefficient models has started to emerge gradually in the past two decades. A new category of time-varying coefficient models known as *state space models* has emerged in the past two decades in an attempt to measure the changing effect of finance on growth. One of the very few studies that applied a state space model in the finance and growth nexus in Africa is Awe et al. (2015), who explored the effects of money supply on economic growth from 1960 to 2009 for Nigeria. Interestingly, the authors found that money supply and capital expenditure have the highest predictive effect on economic growth. However, the crucial point is that both extant fixed and variable coefficient models suffer from the rarely challenged assumption that the error term of a regression is made up of the net effects of omitted variables and is *uncorrelated* with the included regressors.

In a seminal paper, Pratt and Schlaifer (1984, pp. 9–12) showed that the error term of each equation is typically made up of omitted relevant regressors that cannot be proved to be uncorrelated with the included variables. The correlation between the included regressors and each omitted relevant regressor lead to indirect effects because the included regressors affect each omitted regressor and each omitted regressor, in turn, affects the dependent variable. All existing fixed and variable coefficient models ignore the indirect effects of the regressor on the dependent variable but instead provide estimates of the direct effects of a regressor on the dependent variable. Therefore, to address the limitations of current empirical studies, *for the first time* in the empirical literature of finance and growth, we introduce the TVC model proposed by Swamy and Von Zur Muehlen (2020) to measure the *total effects*[13] of finance on

[13] The estimate of the total effects of a regressor on a dependent variable also estimates part of the indirect effects of a regressor on a dependent variable.

growth. Furthermore, in contrast to the existing empirical literature on the indirect effects of finance and growth (Sarwar et al., 2020) the TVC model uses private investment, gross fixed capital formation, private consumption, imports and exports as *coefficient drivers* to measure more precisely the *partial indirect effects* through which finance indirectly affects economic growth.

Existing empirical studies in Mauritius have also used fixed coefficient models (see Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010; Muyambiri and Odhiambo, 2018) to estimate the *direct effects* of finance on growth. However, the relationship between finance and growth might have changed over time because of different financial policies adopted in the country. In that respect, because the effect of policies on the relationship between finance and growth may not be constant, we believe that the TVC model of Swamy and Von Zur Muehlen (2020) is ideal to estimate time-varying parameters that will measure the *total effects* of finance on growth from 1970 to 2019. The TVC estimation technique is superior to extant models using fixed and variable coefficients because it does not ignore the correlation between the error term and the explanatory variables and therefore also estimates the *partial indirect effects* of the regressor on the dependent variable.

In our review of the empirical literature on finance and growth, we found that the relationship between finance and growth is *non-linear*, suggesting that *too much* finance beyond a certain point can contribute negatively to growth (see Arcand et al., 2012; Cecchetti and Kharroubi, 2012; Law and Singh, 2014). However, none of these studies have investigated the reasons behind these non-linear effects of finance on growth. To this end, this study also attempts to get to a better understanding of the time-varying relationship between finance and growth by looking at the effects of the change in the composition of credit on economic growth in Mauritius, which no prior study of the country has done. In this respect, we introduce the quantity theory of disaggregated credit (QTDC) for the first time in an African study. The QTDC was first introduced by Werner (1992) who provided a methodology to disaggregate bank credit into bank credit for GDP transactions and bank credit for non-GDP transactions and then tested the effects of increases of the former on Nominal GDP (NGDP) growth. The main insight of QTDC is that if banks have increasingly issued bank credit for non-GDP transactions (or financial transactions), then it will likely be that the effects of credit on GDP would wane over time.

Since Werner (1992) formulated QTDC in 1992, QTDC has also been put to test by several authors with data for various countries (see Bezemer and Werner, 2009; Voutsinas and

Werner, 2011; Lyonnet and Werner, 2012; Ryan-Collins, Werner and Castle 2016). However, Werner and others have relied on fixed coefficient models when testing the QTDC, so that they have estimated only the *direct effects* of increases of bank credit for GDP transactions on NGDP growth. Unlike the existing QTDC studies, this study is the first to produce an estimate the *total effects* of bank credit for GDP transactions on NGDP using a time-varying coefficient estimation technique. In addition, we use coefficient drivers to measure the partial indirect channels through which bank credit for GDP transactions affect NGDP, which no prior QTDC studies have done. In the final part of the empirical study, we continue to probe deeper using the proposition of Turner (2014) and disaggregate Gross Fixed Capital Formation (GFCF) to have a mesoscopic view of the indirect channels through which bank credit for GDP transactions affects NGDP and RGDP in Mauritius.

1.2 BACKGROUND AND RESEARCH PROBLEM

In the 1970s, the Bank of Mauritius (BOM) emphasized to commercial banks the need to cut back only on those lendings that did not support the development objectives of the real economy. The BOM annual report of 1972 echoed this fact by stating "One of the objectives of monetary policy, in a developing economy like that of Mauritius is the mobilization of resources for development. In this context, it becomes necessary to ensure that the additional resources generated are channeled to savings and investment, rather than being frittered away through consumption (Bank of Mauritius annual report, 1972, p. 23). In June 1973, in order to address the excessive demand for unproductive credit, the BOM introduced a credit ceiling on the expansion of credit which required that the volume of bank credit to the trade sector would not rise by more than 10 percent during the latter half of 1973 (Bank of Mauritius annual report, 1973, p. 23). This system of credit control in the expansion of credit to non-priority sectors stayed in place until 1993.

In the early years, the monetary authority stressed the importance of credit and its allocation for investment and economic growth. Unfortunately, fiscal management in the mid-1970s, in the form of high public expenditure financed by massive borrowing from the Central Bank, dramatically increased credit expansion, which provoked a balance of payments crisis in late 1970s (Bank of Mauritius annual report, 1980, p. 9). In 1979 and 1981, the Mauritian rupee was devalued to correct the balance of payments deficit and foster export-led growth. The devaluation was expected to restore the profitability and external competitiveness of Mauritian exports and to encourage import substitution in the economy.

Fry and Roi (1995, p. 2) argued that the crisis was resolved after the negotiation of a stand-by agreement with the IMF. Under the stand-by agreement and as part of demand management, bank credit was subject to quantitative controls from 1979 to 1986 and an annual credit ceiling remained in place. Incidentally, the period from 1983 to 1988 was marked by an unprecedented rate of economic growth, leading to full employment in the early 1990s. The shift to a free-market system became pressing with the global wave of financial liberalization in the late 1980s and early 1990s which hit the shores of Mauritius around that time. After the relaxation of all forms of credit controls in 1993, there was a major shift in the composition of credit by commercial banks to real estate, construction and offshore financial services. The focus of the BOM shifted from credit controls to inflation targeting in the mid 1990s. In an attempt to reduce variability in the inflation rate, from 1996 the central bank began announcing an aggregate inflation target[14]. Stone (2003) coined the phrase 'inflation targeting lite' for countries such as Mauritius that float their exchange rate and announce an inflation target but are not able to maintain the inflation target as the foremost policy objective. This is true for an open economy such as Mauritius as monetary policy also controls exchange rate fluctuations for the external balance of the country.

In 1996 the bank rate, which was linked to the weighted average of T-Bills auctioned weekly, was used to control inflation and exchange rate fluctuations. However, in the wake of the Asian crisis of 1998, the rise in the bank rate initiated by the central bank by deliberately increasing the supply amount of treasury bills on auction could not stop the depreciation of the currency which amplified inflationary pressures. In fact, a thin bond market was a weak channel to influence the bank rate and it took the Central Bank various interventions in the market to signal its monetary policy stance. As Punchoo (2004) explained, the facilities in place in 1998 were not conducive for quick and sharp increases in interest rates and the BOM's response to the crisis was delayed. This crisis led to a rethink of the monetary management framework.

In December 2006, the BOM reengineered its inflation targeting framework with a view to laying more emphasis on the Repo rate to control the rate of inflation which officially became its primary objective in 2004 (Bank of Mauritius, 2004, p. 6). Although, the BOM Act (2004, p. 6) clearly makes provision for the regulation of credit in the best interests of the economic development of Mauritius, the significant change in the composition of bank credit during the past decades has not been given due attention by the BOM. Also, the implication of the shift

[14] In the BOM's annual report for June-July 1996/1997, an inflation target of 8% was first announced.

in the composition of credits for economic growth in the economy has not been explored empirically. For instance, would the effects of financial sector development on economic growth remain the same over time given the shift in monetary and financial policies and the consequent changes in the composition of credit in Mauritius?

1.3 RESEARCH QUESTIONS

Based on the research problem presented above, the main research question addressed in this study is: How are the commercial banks in Mauritius performing? To answer this question, the following questions are invoked:

(i) What are the effects of financial development on economic growth in Mauritius?

(ii) Have the effects of commercial bank credit changed over time? If yes, what are the possible drivers of the change in the effects of bank credit on GDP?

(iii) What are the indirect channels through which bank credit affects economic growth?

(iv) What are the indirect channels through which disaggregated bank credit affects economic growth?

1.4 RESEARCH OBJECTIVES

The objective of this research is to investigate the effects of aggregate and disaggregate bank credit on economic growth in Mauritius. The following specific objectives will be pursued:

(i) Analyze the effects of financial development on economic growth;

(ii) Analyze the time-varying total effects of private sector credit and commercial bank credit on economic growth;

(iii) Analyze the indirect effects through which private sector credit and commercial bank credit affect economic growth;

(iv) Analyze the time varying total effects of disaggregated bank credit (or bank credit for GDP transactions) on GDP growth; and

(v) Analyze the time varying total effects of dissagregated bank credit and disaggregated investment on economic growth.

1.5 THE STRUCTURE OF THE THESIS

This thesis is divided into five chapters. Chapter 1 introduces the background of the study for Mauritius and the gap in the existing literature, and then formulates the research questions and research objectives before concluding with the structure of the thesis. Chapter 2 investigates the effects of FD on RGDP using an ARDL model and we check for causality

using an ARDL-ECM framework. Chapter 3 presents the TVC model and uses it to measure the total effects of credit on RGDP. Chapter 4 introduces the QTDC and measures the total effects of two disaggregated measures of bank credit for GDP transactions on NGDP. In the last part of Chapter 4, we use two disaggregated measures of bank credit for GDP transactions and three disaggregated measures of investment to measure the total effects of bank credit for GDP transactions on NGDP and RGDP. The policy implications and conclusions of this study are discussed in Chapter 5.

To elaborate, Chapter 2 estimates a fixed coefficient model that investigates the efficiency of bank lending in Mauritius. The specific objectives addressed in Chapter 2 are: (i) to determine if there are both short-run and long-run causal flows from measures of FD namely, Liquid Liabilities per capita (LLB), Private Sector Credit per capita (PSC) and Commercial Bank Credit per capita (CBC) to RGDP; (ii) to provide an ARDL estimation of the impact of the measures of FD on short-run and long-run economic growth, and hence assess the efficiency of aggregate credit in Mauritius; (iii) to determine if there is any significant difference between the impact of private sector credit and commercial bank credit on economic growth.

Chapter 3 provides an estimate of the TVC estimation of the total effects of PSC or CBC on RGDP in each year of the sample period 1970–2019 and hence measures the precise functional form of the relationship between PSC or CBC and RGDP in Mauritius. The specific objectives addressed in this chapter are: (i) to measure the total effects of PSC or CBC on RGDP and assess the efficiency of aggregate credit on growth; (ii) to determine whether PSC or CBC has non-linear effects on RGDP and detect any threshold effect between them; and (iii) to measure part of the indirect effects of PSC or CBC on RGDP and get additional insights into the relationship between credit, investment, consumption, imports, exports and economic growth in the country.

Chapter 4 disaggregates total bank credit using the methodology of QTDC and identifies which types of credit likely contribute to GDP growth in Mauritius. This chapter addresses these issues: (i) to disaggregate commercial bank credit into bank credit for GDP transactions and bank credit for non-GDP transactions; (ii) to add to the local and global empirical literature on QTDC by estimating the total effects of bank credit for GDP transactions on NGDP in Mauritius; (iii) to estimate part of the indirect effects of bank credit for GDP transactions on NGDP and get additional insights into the relationship between bank credit for GDP transactions and NGDP in the country; and (iv) to disaggregate investment (as

measured by Gross Fixed Capital Formation (GFCF)) into three types and estimate the investment channels through which bank credit for GDP transactions has had the highest impact on NGDP and RGDP in Mauritius from 1970 to 2019.

Chapter 5 concludes with the policy implications of the study.

To reiterate: This study contributes to the literature in two main respects (i) it uses a TVC model to estimate the total effects of bank credit on economic growth in Mauritius, which has the properties of being dynamic and including indirect effects, which we believe make it superior to extant econometric methods used by other authors studying analogous problems, and (ii) it is underpinned by a relatively unknown and empirically robust theory (Quantity Theory of Disaggregated Credit), which informs the empirical test and helps interpret its results (as is well known, empirical testing *alone* is quite limited without theory).

CHAPTER 2

DOES FINANCIAL DEVELOPMENT PROMOTE ECONOMIC GROWTH IN MAURITIUS? AN APPLICATION OF ARDL BOUNDS TEST APPROACH

Abstract

This chapter explores the effects of financial development (FD) on economic growth in Mauritius using the ARDL bounds test technique. The analysis specifically focuses on the role of the banking sector for the period 1970 to 2019. The study estimates the effects of two measures of FD namely, private sector credit per capita (PSC) and commercial bank credit per capita (CBC) on real GDP per capita (RGDP). After controlling for the effects of other growth determining factors, the results show positive effects of PSC or CBC on economic growth in the short-run but we found strong evidence of negative effects of PSC or CBC on economic growth in the long-run. These results raise serious questions about the effects of aggregate credit on economic growth in the country despite the seeming well-developed banking sector.

"It has been ten years since the financial crisis dealt the biggest blow to the world economy since the Great Depression. While growth has returned, and the job market has by now tightened especially in the United States, where the crisis originated—the reverberations of the crisis continue to affect us in ways both large and small, both obvious and indirectly connected. The devastating damage to our economy calls for profound reflection and change, in economics, politics, the financial sector, among policymakers, and in our behavior." (Stiglitz, 2017a, p. 1)

2.1 INTRODUCTION

In Mauritius, the financial system has evolved significantly over time but has remained predominantly bank-based with commercial banks playing a key role in allocating private sector credit to support economic growth. Prior to 1991, monetary policy by the Central Bank was carried out primarily by establishing an annual ceiling for the expansion of bank credit (Fry and Roi, 1995, p. 1). After the relaxation of credit controls in June 1993, there was a significant rise in private sector credit (PSC) but during that time high and sustained real

GDP growth did not followed through. Private sector credit rose from 42.2% of GDP in 1993 to 89.6% of GDP in 2019, while economic growth has weakened from 5.1% p.a. in 1993 to 3% p.a. in 2019 (Bank of Mauritius Annual Reports 1993, 2019). The breakdown of the link between private sector credit and economic growth raises questions about the nature of the effects of FD on economic growth in Mauritius.

This chapter investigates the traditional argument that finance leads to growth. Economists, notably Bagehot (1873) and Schumpeter (1912), have long recognized the role of the financial system in economic development. Since banks dominate the financial system in developing countries, more bank credit allocated by banks as financial intermediaries implies higher levels of savings for investment and growth[15]. Therefore, higher liquid liabilities and credit to the private sector are seen as positive for economic growth as they measure the availability and intermediation of funds, notably for investment purposes. However, recently, after the GFC, Turner (2016) argued that modern macroeconomics focused little attention on the role of banks, and when economists and financial theorists did describe banks, they made a dangerously simplistic assumption that banks allocate capital resources between alternative investment projects. However, the majority of bank lending today is unrelated to new business investment but instead funds real estate and financial activities (Turner, 2016, p. 246). Indeed, the experience preceding the GFC has shown that the surge in bank lending to real estate and financial activities fuelled a housing bubble which has had detrimental effects on financial stability and economic growth.

In Mauritius, there has been a similar shift in the composition of bank credit towards real estate and financial companies and away from other types of productive lending. After the wave of financial liberalization of the late 1980s and early 1990s, commercial bank credit to GDP rose from 42.2% of GDP in 1993 to reach 76.5% of GDP in 2019. Importantly, bank credit towards real estate and financial activities more than tripled to rise from 17.1% of total bank credit in 1993 to reach 58.1% of total bank credit in 2019 (Bank of Mauritius Annual Report, 2019). In contrast to developed economies, which experienced a major financial crisis due to financial deepening, it is possible that the effects of the increase in bank credit and a change in its composition could have led to slower growth in the country.

[15] Economists such as Werner (2005) have argued that banks are not financial intermediaries but when making loans create new purchasing power that did not previously exist. In this thesis, we do not explore the debate whether banks are financial intermediaries or not but we focus on the uses of credit. Indeed, the crucial issue is not how precisely the spending power is created but whether it is well used.

Empirical studies in Mauritius have found a positive relationship between private sector credit to GDP[16] on investment and/or economic growth and hence provided support for the positive effects of bank credit on the real economy (see Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010; Muyambiri and Odhiambo, 2018[17]). However, in contrast to early studies on financial development and economic growth (Jouan, 2005; Jankee, 2006; Seetanah, 2008), more recent studies, such as Nowbutsing (2010), have found that that the positive effects of financial development on economic growth are fairly minimal. Jouan (2005) was among the first to investigate the implications of financial liberalization on the finance and growth nexus in Mauritius using a vector autoregressive (VAR) model. He found significant evidence that private sector credit as a share of GDP was positively related to economic growth from 1979 to 2002. Jouan (2005, p. 301) founds a positive coefficient of 0.21 for PRIVY (-1) i.e. lagged private sector credit to GDP on growth.

Jankee (2006) also investigated the implications of financial development on economic growth from 1970 to 2000. He concluded that banking sector development measured by bank deposits to GDP and credit to the private sector to GDP increased economic growth in the country. Seetanah (2008) used an ARDL model to investigate the empirical link between FD and economic growth using time series data from 1952 to 2004. The author used liquid liabilities to GDP and credit to the private sector to measure FD, and found a positive relationship between the two measures of FD and economic growth in both the short-run and long-run. Seetanah (2008, p. 812) found that an increase of 1% in FD development indicators caused a more than 1% increase in output level.

Nowbutsing et al. (2010) used a Vector Correction Model and found that from 1970 to 2009 the effects of FD as measured by the ratio of liquid liabilities to GDP and private sector credit to GDP were positive and significant on economic growth in Mauritius. From the Johansen cointegrating vector estimates, Nowbutsing et al. (2010, p. 11) found that a one percent increase in private sector credit leads to an increase of around 0.14% to 0.25% in the rate of economic growth. In comparison to the work of Seetanah (2008), it seems that the effects of financial development on economic growth during more recent times are weaker.

[16] The ratio of private sector credit to GDP used to measure financial development in existing studies in Mauritius is the same as commercial bank credit to GDP, since to the best of our knowledge data on credit from non-bank financial institutions have not been included in these studies. In fact, data from the Bank of Mauritius on credit from non-bank financial institutions have only become available from the financial year 2005–2006.

[17] Muyambiri and Odhiambo (2018) focused on the effects of financial development on investment dynamics in Mauritius. It is important to note that the impact of financial development on different marginal productivity investments can have different effects on economic growth.

Nowbutsing et al. (2010) concluded that although financial development has a positive impact on economic growth its effect is fairly minimal. Muyambiri and Odhiambo (2018) found a significant correspondence between bank-based financial development indicators, namely credit to the private sector and M3, on investment dynamics in Mauritius from 1976 to 2014[18]. The results show that the bank-based indicators of financial development Granger cause investment, both in the short-run and in the long-run. The study, therefore, recommends that policies in Mauritius should promote and strengthen the banking sector in order to encourage investment (Muyambiri and Odhiambo, 2018, p. 62). However, the authors did not consider the possibility of inefficient bank lending towards less productive investment which could have stunted economic growth in the country.

In this study, we focus on the experience preceding the GFC which brings to light the fact that bank lending to the real estate and financial sectors could have promoted less productive investments and played a role in weakening economic growth in Mauritius. This issue is especially pertinent since the effects of the acceleration of financial lending during the past two decades have not been captured by earlier empirical studies, while more recent studies have found that the effects of finance on growth are weaker. One of the benefits of financial intermediation is the allocation of credit for productive investment, but given that the sectoral allocation of bank credit has changed in the country this could have undermined the positive effects of financial development on economic growth. Therefore, the broad objective of this chapter is to adopt an empirical framework that will measure the efficiency of bank lending in Mauritius from 1970 to 2019.

The specific issues addressed in this chapter are: (i) to determine if there are both short-run and long-run causal flows from measures of FD namely, Liquid Liabilities per capita (LLB), Private Sector Credit per capita (PSC) and Commercial Bank Credit per capita (CBC) to RGDP; (ii) to provide an ARDL estimation of the impact of the measures of FD on short-run and long-run economic growth, and hence assess the efficiency of aggregate credit in Mauritius; (iii) to determine if there is any significant difference between the impact of private sector credit and commercial bank credit on economic growth. Note that existing studies in Mauritius have used liquid liabilities and private sector credit to measure FD. However, private sector credit used in these studies consisted solely of commercial banks' credit to the private sector. Thus, in addition to the two conventional measures of FD, we add

[18] Muyambiri and Odhiambo (2018) also investigated the effects of market-based indicators such as market capitalization on investment and found the effects were positive.

non-bank financial institutions credit[19] to commercial banks' credit to arrive at the "true" private sector credit. The rest of the chapter is organized as follows: Section 2.2 provides stylized facts about FD in Mauritius. Section 2.3 discusses the theoretical framework and Section 2.4 provides a survey of the empirical literature. Section 2.5 provides the analytical framework, explains the econometrics procedure and discusses the empirical results. Finally, Section 2.6 summarizes the study's major findings and makes policy recommendations.

2.2 STYLIZED FACTS

Prior to 1991, monetary policy by the Central Bank was carried out primarily by establishing an annual ceiling for the expansion of bank credit and from 1973–1979, bank credit was regulated and allowed to expand by 15 percent per annum (Fry and Roi, 1995, p. 1). Fry and Roi (1995, p. 2) argued that from 1979 to 1986, as the country went through the structural adjustment program, an annual credit ceiling continued to be established in consultation with the IMF, and after 1986, the Central Bank continued to control the annual credit ceiling for priority and non-priority sectors. During that time, the domestic credit ceiling proved to be a decisive element in underpinning the growth performance of the economy. In 1986–87, about 92 percent of total bank credit was extended to the productive sectors of the economy. The manufacturing sector alone accounted for nearly 50 percent of the overall increase in private sector credit (Bank of Mauritius annual report, 1987, p. 21). The credit system continued in the 1980s, and the period from 1983 to 1988 was marked by unprecedented high rates of economic growth leading to full employment in Mauritius in the early 1990s. At that time, Mauritius had a range of preferential access to trading partners, particularly with the European Union, in the sugar, textile and clothing industries. Zafar (2011, p. 2) explained that these preferential agreements helped to sustain total exports from the 1970s to the 1990s. The success of economic policies was also due to political stability, rule of law, and strong domestic institutions, with Mauritius reaching the first position in the World Bank Doing Business rankings in Africa (Svirydzenka and Petri, 2014, p. 57).

The early 1990s was a landmark in terms of the introduction of new monetary policy reforms, and the shift to a more market-based system became pressing with the advent of the Washington consensus. In June 1993, all restrictions on the expansion of bank credit were removed and from that time onwards there has been a major change in the behaviour of bank deposits, bank credit, savings and investment as can be seen in Figure 2.1.

[19] Data on non-bank credit is available from 2005 from the Bank of Mauritius.

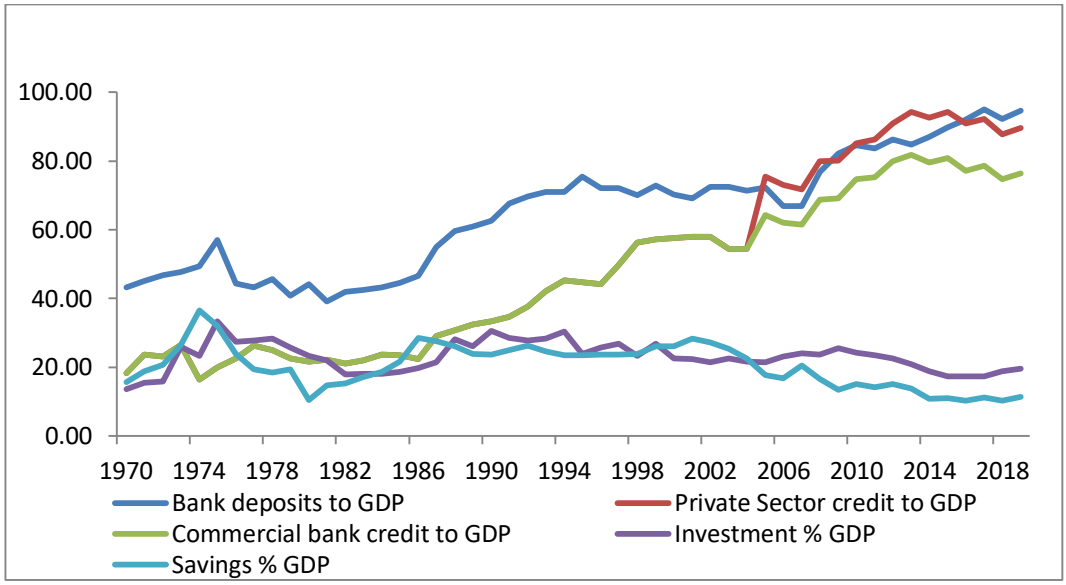


Figure 2.1: Growth in bank deposits to GDP, private sector credit to GDP, commercial bank credit to GDP, investment to GDP and savings to GDP from 1970 to 2019

Source: Author's compilation using data from Bank of Mauritius and Statistics Mauritius

From the mid-1990s, bank deposits and private sector credit, which are two widely used measures of financial development, have increased significantly over time. Commercial bank credit has also been rising, reaching a peak of 81.9% of GDP in 2013. In fact, while bank credit has been rising, private investment fell from a peak of 21.5% of GDP in 1994 to reach 14.2% of GDP in 2019, which casts doubt about the efficiency of banking intermediation in the country. No clear relationship between savings and investment during the post liberalization period can be perceived. Figure 2.1 shows that during the sugar boom of the early 1970s and the economic miracle of the 1980s the growth in savings and investment was high and sustained, but from early 1990s as the liberalization polices kicked in, there was a decline in the growth of the savings and investment rates while the growth in credit increased. Figure 2.2 shows the acceleration in the amount of bank credit relative to the liquid liabilities of banks especially from the mid 1990s. As predicted by proponents of financial liberalization, it shows that the level of banking intermediation has increased in the country. However, although the level of banking intermediation has increased, the decline in private investment suggests that bank credit could have been allocated to other uses.

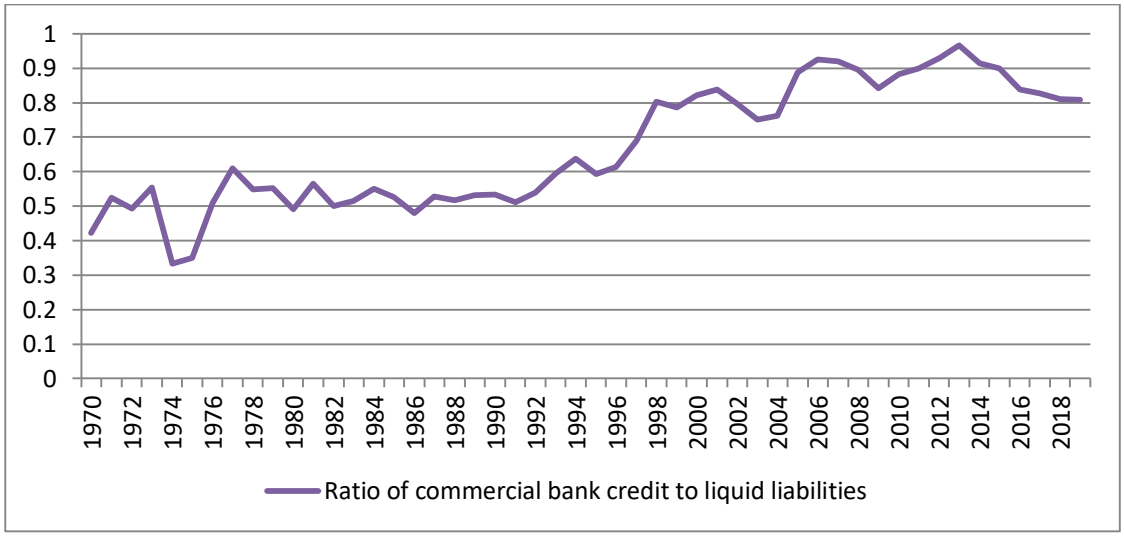


Figure 2.2: Ratio of commercial bank credit to liquid liabilities from 1970 to 2019

Source: Author's compilation using data from Bank of Mauritius and Statistics Mauritius

Figure 2.3 clearly shows the shift in the composition of credit mainly towards the construction, financial and tertiary sectors from the late 1990s. Werner (2005) distinguished bank credit for the construction of new real estate from bank credit for the purchase of existing real estate. He argued that the construction of new buildings promote real GDP growth while the buying and selling of existing ones do not have any effect on GDP. Therefore, it remains possible that a significant amount of the increase in bank credit to construction has encouraged non-GDP transactions which did not promote investment and economic growth in the country. Furthermore, bank credit to the financial sector which largely includes bank credit to offshore companies (companies which carry out most of their business activities abroad), also surged from mid 1990s onwards. Furthermore, bank credit to the tertiary sectors, which largely consists of bank credit to hotels, also increased substantially and this could have encouraged a large amount of existing transactions in land and dampened the positive effects of credit on growth. These changes mean that the liberalization of the financial system in the 1990s could have weakened the positive effects of bank credit on economic growth.

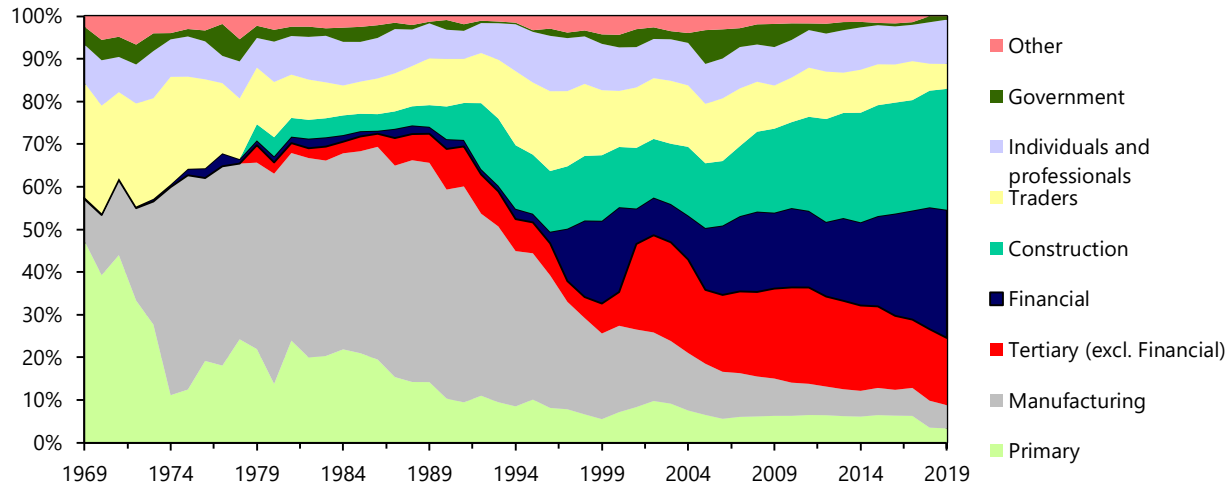


Figure 2.3: Sectoral composition of bank credit

Source: Author's own compilation using data from various issues of Bank of Mauritius annual reports

Figure 2.4 below shows that during the early years after independence in 1968 and in the 1980s, there seems to have been a positive correspondence between the growth in credit and the growth in real GDP. However, after the mid-1990s, the trend in the growth of credit and economic growth declined. One of the most important challenges facing Mauritius today is to put the country back on a path of sustained economic growth as it struggles to make the transition from middle to a high-income economy.

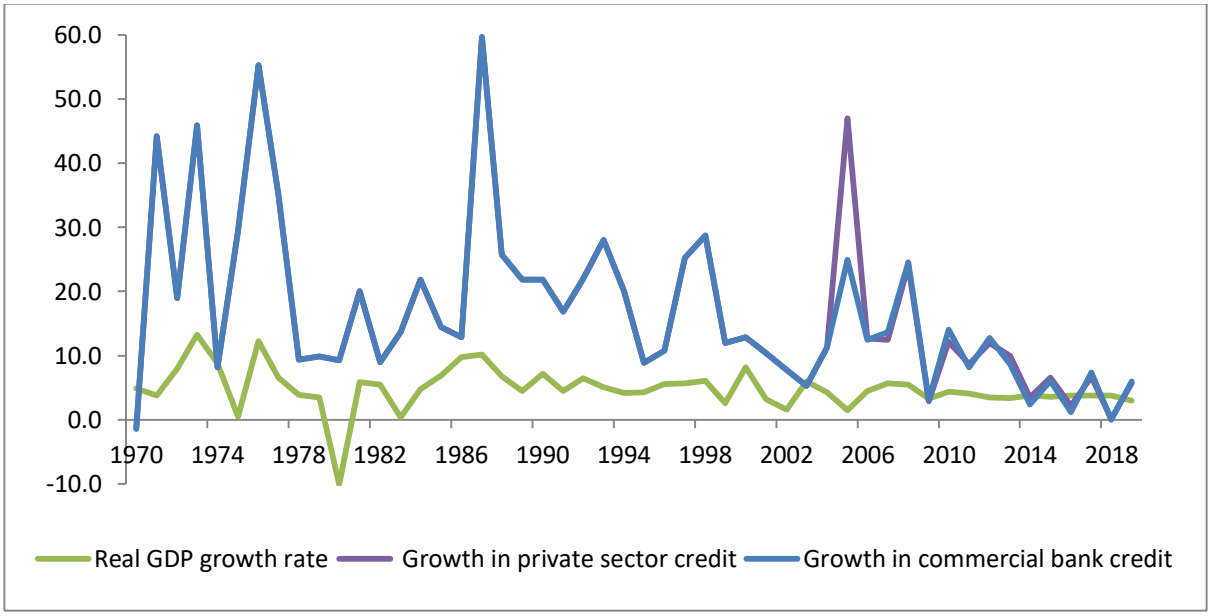
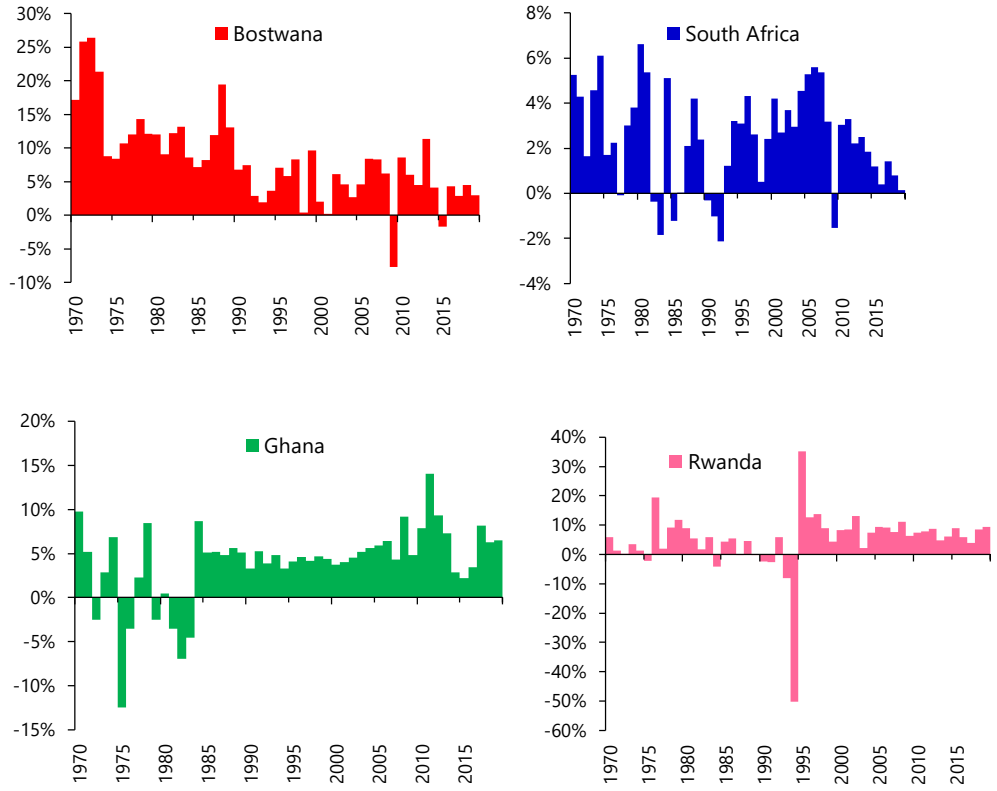


Figure 2.4: Real GDP growth vs Credit growth from 1970 to 2019

Source: Author's compilation using data from Statistics Mauritius

Figure 2.5 depicts a comparison with some selected countries in sub-Saharan Africa and shows the lukewarm performance of Mauritius lately. The economic performance of Mauritius seems to coincide quite well with Botswana in the mid 1980s, after which both countries experienced a decline in real GDP growth while Ghana, Zambia and South Africa had recent bouts of higher growth rates. Though there have been these significant policy reforms in the financial sector in Mauritius, these measures did not have the expected results as economic growth has remained relatively sluggish. Therefore, the main objective of this research is to reexamine the nature of the effect of bank lending and aggregate credit on economic growth in Mauritius from 1970 to 2019.



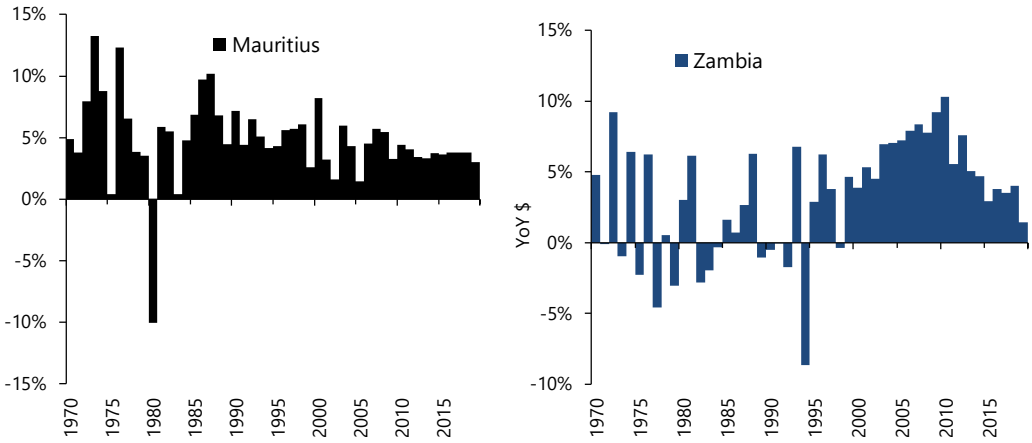


Figure 2.5: Real GDP growth for six selected African countries from 1970 to 2019

Source: Author's own compilation using data from World Bank

2.3 THEORETICAL FRAMEWORK

In this section, we present a theoretical framework from Dornbusch et al. (2014, p. 63) to show how the financial intermediation theory of banking argues that resources are channelled from savers to borrowers to promote investment and growth. Dornbusch et al. (2014) assumed that the investment required to maintain a given level, *k*, of capital per capita depends on the growth of population and the depreciation rate. Population is assumed to grow at a constant rate, *n* and therefore capital *nk* is needed to provide capital for the new workers. Furthermore, depreciation is assumed to be constant at *d* percent of the capital stock which adds *dk* to the requirement of new capital. Hence, the investment required to maintain a constant level of capital per capita is *(n+d)k*. Dornbusch et al. (2014, p. 63) also assumed savings is a constant fraction, *s*, of income, so per capita saving is *sy*. Equation 2.1 below shows that the net change in capital per capita, Δk, is the excess saving over required investment:

$$\Delta k = sy - (n + d)k \qquad \ldots(2.1)$$

Using the fact that the growth in capital equals the growth in output (see derivation in appendix 2), we rewrite Equation 2.1 below to show that an increase in savings can influence the growth in capital and growth in output:

$$g = \frac{\Delta k}{k} = \frac{sy}{k} - (n + d) \qquad \ldots(2.2)$$

Dornbusch et al. (2014, p.80) argued that the endogenous growth model of Romer (1986) assumes a production function with a constant marginal product of capital given by Y= *a*K, where output Y is proportional to the capital stock, K, and the marginal product of capital is denoted by the constant *a*. Romer (1986) extended Arrow's reasoning to explain that there are other types of learning which are not internal to the firm. When a firm invests in capital (K), the aggregate output (Y) of the firm rises but so does the productivity (*a*) of other firms making Y, *a* and K endogenous in the growth model. Using the fact that $y/k \equiv a$ (see derivation in appendix 1), we can rewrite Equation (3.2) as follows:

$$g = \frac{\Delta k}{k} = sa - (n + d) \qquad \ldots(2.3)$$

An interpretation of Equation 2.3 reveals that FD can affect economic growth through (i) amount of savings, *s*, that flows to investment, and (ii) the magnitude of the increase in *g* depends on the strength of *a* i.e. the marginal product of capital. Point (i) implies that the financial system raises the saving rate by mobilizing more saving *s* for investment (see Fischer, 1989; Levine, 1997, 2004; Aziakpono, 2011). This perspective is well described in Aziakpono (2011, p. 9) who stated "the dominant view held by many authors is that an efficient financial system helps to mobilise saving from disparate savers, which makes large investment possible." In principle, the financial system can strengthen the overall savings mobilization process and channel financial resources to fuel economic development, as highlighted by Kelly and Mavrotas (2008) and Maimbo and Mavrotas (2008).

Point (ii) implies that if banks increasingly allocate savings to *high marginal productivity investments*[20] represented by *a*, the financial system will amplify its positive effects on *g*. In a widely acclaimed paper, Boyd and Prescott (1986) demonstrated that financial intermediaries face lower screening and monitoring costs and therefore it is best for lenders to delegate the acquisition of information to financial intermediaries who can effectively screen "good" borrowers and improve resource allocation.

Therefore, if financial intermediaries are performing their savings mobilization function and savings allocation function efficiently as described by (i) and (ii), it implies that an increase in savings *s* mobilized leads to an increase in loans for productive investment *a*, and hence to

[20] The phrases 'marginal productivity investment' and 'marginal product of capital' are used interchangeably and measure the extra amount of output a firm gets from an extra unit of capital.

a *sustained* increase in *g*. Based on this economic reasoning, the traditional literature on financial development and growth investigated the positive effects of liquid liabilities e.g. bank deposits and the amount of bank credit issued to the private sector on economic growth to determine the efficiency of banking intermediation.

In this study, if commercial bank credit shows strong effects on *g*, we use it as confirmation of the positive effects of aggregate bank credit on economic growth in the country. If the aggregate credit measures have weak effects on growth, it is likely that the financing of relatively lower marginal productivity investments, *a*, could explain the weak effects on *g*. If funds are allocated to industries which experience increasing returns, then increasing the stock of capital in these industries will increase productive investment and increase the effects of aggregate credit on economic growth. Interestingly, the buying and selling of existing assets, such as land, housing and property, does not contribute to *g*. In the hypothetical case that all funds by banks and non-banks are allocated to the mere buying and selling of assets, then it follows that the marginal product of capital, *a*, in Equation 2.3 will be zero. This in turn would not lead to any impact of aggregate credit on *g*.

It is important to mention that the transaction activities of a commercial bank are different from those of other financial intermediaries such as an insurance company in that the former, when transacting with the latter, discharges its payment obligations to the latter by issuing deposits, whereas when agents belonging to the latter group transact with each other, they do so by transferring existing deposits. When an insurance company lends to a household, it pays by transferring money it holds with a bank (an asset to the insurance company), thereby leaving the total stock of money unaffected. In contrast, when the bank extends a loan to a household, it discharges its obligation to pay by crediting the household's account, thereby increasing the total stock of money (issuance). The stark difference between the lending mechanics of a commercial bank and an insurance company can be shown using basic accounting and simple t-accounts. In Figure 2.6 below, an insurance company lends to a household, and the figure shows a decrease in the deposits of the insurance company with a corresponding increase in the assets of the household.

	Insurance company (lender)		Household (borrower)	
	Assets	Liabilities	Assets	Liabilities
Δdeposits	−$1mn		+$1mn	
Δ loans	+$1mn			+$1mn

Figure 2.6: T-accounts: the borrowed "funds" take the form of bank deposits[21]

Source: Stigum (1990, p. 200)[22]

In the case of lending by a bank to a household, consider a bank extending a mortgage loan to a household, who uses the funds to build a house for $500,000. Notice that the funds "lent" by the bank in Figure 2.7 constitute the lender's *liabilities*, which register an *increase.*

	Bank (lender)		Household (borrower)	
	Assets	Liabilities	Assets	Liabilitie
Δ deposits		+$500k	+$500k	
Δ loans	+$500k			+$500k

Figure 2.7: The "funds" (in this case bank deposits) are shown with grey background

Source: Stigum (1990, p. 18)

The difference between Figures 2.6 and 2.7 lies in the fact that bank's liabilities (at least the liquid ones) are considered money, so they can be used to settle payments between non-banks.[23] In Figure 2.6 the lender's holdings of fund *assets* show a *decrease*. Therefore, banks can fund the asset directly by *issuing* the funds themselves 'out of nothing', in effect by creating their funding.

[21] Deposit holdings as an asset are held by insurance companies, households and financial firms. On the other hand, the expression "deposit-taking" actually means "deposit issuance" (as a liability), and only credit institutions and some postal banks have licence to issue deposits.

[22] This way of presenting information has various names: "t-account", "financial account".A T-account shows changes in assets and liabilities that result from a given financial transaction" (Stigum, 1990, p. 200). See also Dufey and Giddy (1994, p. 19), Balbach and Resler (1980, p. 4), and Bernes et al. (2014, p. 10). "The financial accounts (flows) together with the financial balance sheets (stocks) form the full Financial Accounts, which belong to the System of National Accounts (SNA)" (Giovannini, 2008, p. 167). Bindseil (2014, p. 15) argue that "this chapter introduces a system of financial accounts to allow for a representation of monetary policy implementation at the basic level of economic transactions." See also Bindseil and König (2011, p. 4) and BIS (2018, p. 24, Annex B).

[23] It makes perfect sense that what bank loans create are *demand* deposits, since the borrower will normally borrow the funds in order to be able to spend them, which, unless the issuing bank has a complete monopoly, will involve their transfer to some other bank. A person would normally not want to borrow in the form of a longer-term (non-transferable) liability issued by its bank (e.g. a debt security), simply because the spread between the interest rate he would pay on the loan and the interest rate he would receive from holding the security (i.e. a positively-sloped yield curve, the very thing that makes banking profitable; see, for example, Kohlscheen et al., 2018; McKinsey & Co., 2016, p. 23) would work *against* him. This would also probably not be in conformity with regulations. For example, the *Companies Act 2006*, Sect. 678, prohibits publicly listed companies from lending money to firms for the purpose of buying their stocks (Werner, 2014b, p. 76).

The implications of the new purchasing power created by banks on the overall level of economic activity were explored by Werner (2012), who argued that in order for GDP to expand, more money is needed to settle those transactions. Werner (2012, p. 7) provided the technical reasoning: "nominal GDP growth this year means that more transactions (that are part of GDP) have taken place this year than last year….we know that this is only possible if more money has also exchanged hands to pay for these transactions…the next question therefore is: how can the amount of money used for transactions increase in our modern financial system?" It follows that, generally speaking, in order for GDP to expand, bank lending has to expand. This implies that when banks create money, credit and new purchasing power, they contribute not only sectorally to GDP but, more importantly, to the expansion of GDP. In contrast, the lending of financial intermediaries such as insurance companies and mutual funds contributes towards GDP at a rate which can only increase if their sectoral contribution to GDP increases. Therefore, in this study, we distinguish between the effects of commercial bank credit and private sector credit (which includes credit from non-bank financial institutions) on economic growth. A negative effect of commercial bank credit on economic growth would suggest that banks could have increasingly allocated credit to less productive investment which has led to a decline in the effects of financial development on economic growth in the country.

2.4 EMPIRICAL REVIEW

In this section, we provide a brief overview of the empirical literature on the effects of finance on growth. The majority of empirical studies seek to establish whether or not there is a significant causal relationship running from financial development to economic growth. The evidence shows that the impact of financial development on economic growth is largely inconclusive. In fact, the majority of the panel data and cross-sectional studies tend to produce evidence of a significant positive relationship between an indicator of financial development and economic growth (see Jung, 1986; King and Levine 1993a; Ndikumana, 2000; Kiran et al., 2009; Bist, 2018; Guru and Yadav, 2019). In contrast, the opposing literature consists of a large number of time series country-specific studies which find insignificant and/or significant negative effects of financial development indicators on economic growth (see Demetriades and Hussein, 1996; Ram, 1999; Ndlovu, 2013; Adusei, 2013; Iheanacho, 2016).

In measuring financial development, the indicators have gradually evolved over time. In the 1970s the debate focused on the issue of financial repression, a policy conducted by many

governments to generate growth through artificially low interest rates. In 1973 both Ronald McKinnon and Edward Shaw (MS model) independently introduced two frameworks which advocated for the abolition of financial repression policies to encourage more savings and spur investment. At the time, the traditional practice, e.g. McKinnon (1973), was to use the size of the financial intermediary sector relative to economic activity to measure "financial depth".

However, the expansion to other indicators of financial development was inevitable as financial intermediaries provide other services from mobilizing savings, evaluating projects, managing risk, monitoring managers, and facilitating transactions which are essential for technological innovation and economic development (King and Levine, 1993a, p. 717). To reflect the multi-dimensional features of financial intermediaries, King and Levine (1993a) introduced four indicators of financial development that were designed to measure the different services provided by financial intermediaries[24]. Their first measure of "financial depth" equals the ratio of liquid liabilities (represented by M3) of the financial system to GDP, which they term LLY.

However, since the pure size of the financial system may not be closely related to financial services such as risk management and information processing, the authors introduced a second measure of financial development called BANK which measures the ratio of deposit money bank domestic assets to deposit money bank domestic assets plus central bank domestic assets. A higher BANK implies that banks are more likely providing the type of risk sharing and information services than central banks (King and Levine, 1993a, p. 721).

The third and fourth measures partially address concerns about the allocation of credit. The third measure, PRIVATE, equals the ratio of credit allocated to private enterprises to total domestic credit (excluding credit to banks). The fourth measure, PRIVY, equals credit to private enterprises divided by GDP. The assumption underlying these measures is that financial systems that allocate more credit to private firms are more productive than financial systems that simply channel credit to public enterprises (King and Levine, 1993a, p. 721).

The paper by King and Levine (1993a) provided the starting point for intensified research on the effect financial development on economic growth. King and Levine (1993b, p. 720) performed a cross-country study from 1960 to 1989 using the four financial development measures – the ratio of the liquid liabilities of banks and non-bank institutions to GDP, the

[24] For a discussion of the limitations of all the four indicators, the reader should refer to King and Levine (1993a, pp. 5–6).

ratio of bank credit to the sum of bank and central bank credit, the ratio of private credit to domestic credit, and the ratio of private credit to GDP – and found that the level of financial development predicts future economic growth. One of the major contributions of King and Levine (1993a) is that it shows the importance of using appropriate indicators of financial development, notably those that measure how the financial system allocates credit rather than just using simple proxies that measure "financial depth". King and Levine (1993a) used cross-country regressions and simple correlations analysis and found that higher levels of financial development are strongly and significantly correlated with physical capital accumulation and economic growth. Based on their findings, King and Levine (1993a, p. 730) concluded that the relationship between financial development and growth is such that "finance seems to importantly lead economic growth".

After the pioneering work of King and Levine (1993a), the empirical literature became increasingly grounded on the foundation that banks are a key part of the financial system, and countries which have low ratios of liquid liabilities and private sector credit should aim to increase it to stimulate economic growth. Following the work of King and Levine (1993a), an increasing number of cross-section and panel studies have used bank-based measures as the main proxy for FD and found a consistently positive contribution on economic growth. The chronological summary of a number of empirical studies is presented in Table 2.1 below. It shows that after the work of King and Levine (1993a), most studies have increasingly used bank-based measures to proxy for FD. It also shows that cross-sectional and panel data studies, irrespective of whether they use liquid liabilities or private sector credit, tend to produce significant evidence of a positive relationship between FD and economic growth.

However, Arestis and Demetriades (1997) highlighted the limitations of the cross-country regressions upon which the King and Levine (1993a) studies were based. Arestis and Demetriades (1997) argued that the question of causality from finance to growth remains a country-specific issue and hence strongly doubt whether the question of causality can satisfactorily be addressed using cross-country regressions. A cross-country regression measures the mean effect of financial development on economic growth across different countries it cannot measure the precise nature of the causal effect of finance on growth in a country. This is especially the case given the fact that causality changes from country to country and largely depends on the intricacies of financial institutions and financial policies implemented in each country.

Ndlovu (2013, p. 435) argued that peculiar institutional characteristics and capital allocation differences between and within economies make it very hard to generalize findings, thus increasing the need for more country-specific studies. The fact that causality might vary across countries has been a major justification for using country-specific studies to investigate the link between financial development and economic growth. Demetriades and Hussein (1996) provided evidence from 16 developing countries using time-series analysis applied to individual countries. The authors applied cointegration techniques and ECM causality tests and found that the ratio of bank liabilities to GDP and private sector credit to GDP had weak effects on economic growth. Instead, their results show considerable evidence of bi-directional causality and reverse causation from economic growth to financial development.

From the evolution of the empirical literature an important lesson can be drawn. The causal effect of financial development on economic growth is peculiar to each country because of country variation in financial policies, and therefore country-specific studies are warranted (see Rousseau and Wachtel, 2011, p. 287). In Africa, there have been a number of country-specific studies which have examined the relationship between finance and growth but also found mixed results. Abu-Bader and Abu-Qarn (2008) found that from 1960 to 2001, FD strongly improved economic growth in Egypt. The empirical results significantly support the view that financial development measured by private sector credit to GDP and M2 to GDP Granger-causes economic growth either through increasing investment efficiency or through increasing resources for investment. The finding suggests that the financial reforms launched in Egypt in 1990 can explain the rebound in economic performance since that time.

Adusei (2013) studied the relationship between FD and economic growth in Ghana from 1971 to 2010. The findings suggest that whereas domestic credit to GDP ratio as well as broad money supply as a ratio of GDP hampers economic growth in both the short run and the long run, credit to private sector as a share of GDP ratio has a positive but statistically insignificant relationship with economic growth. On the other hand, M2/GDP has a significantly negative effect on economic growth. The author argued that FD undermines economic growth and therefore cautions against financial liberalization in Ghana. A number of empirical studies, including the main ones discussed in this section, are summarized in Table 2.1 below.

Empirical studies for Mauritius have found a positive relationship between different quantitative measures of financial development (FD) namely ratio of liquid liabilities to GDP and private sector credit to GDP[25] on investment and/or economic growth and hence supported the positive effects of FD on economic growth (see Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010; Muyambiri and Odhiambo, 2018). Jouan (2005) investigated the implications of financial liberalization on the finance and growth nexus in Mauritius using a Vector Autoregressive model. He finds significant evidence that private sector credit as a share of GDP is positively related to economic growth from 1979 to 2002 and that there is bidirectional causality between them. Jouan (2005, p. 301) finds a positive effect of 0.21 of lagged private sector credit to GDP (PRIVY (-1)) on economic growth. Yet the author finds that the evidence does not support the McKinnon and Shaw predictions concerning the role of interest rate in the mobilization of savings.

[25] The ratio of private sector credit to GDP used to measure financial development in existing studies in Mauritius is the same as commercial bank credit to GDP since to the best of our knowledge data on credit from non-bank financial institutions have not been included in these studies. In fact, data from the Bank of Mauritius on credit from non-bank financial institutions have become available since the financial year 2005–2006.

Table 2.1: Empirical studies of financial development and economic growth

Study	Sample	Estimation Methods	Main Measures	Main Findings
PANEL AND CROSS-COUNTRY STUDIES				
King & Levine (1993a)	80 developed and developing countries, 1960–1989	Cross-country OLS	Liquid liabilities to GDP & Private sector credit to GDP	Strong positive effects of both measures on economic growth
Levine and Zervos (1998)	47 developed and developing countries, 1976–1993	Cross-country OLS	Private sector credit to GDP	Financial development significantly and positively leads to growth
Ram (1999)	95 developed and developing countries, 1960–1989	Cross-Country OLS	Liquid liabilities to GDP	Weak relationship between finance and growth
Ndikumana (2000)	SADC countries, 1970–1996	Pooled data analysis	M3/GDP, Private sector credit to GDP	Some evidence of positive correlation between finance and growth
Benhabib and Spiegel (2000)	4 developing countries, 1965–1985	GMM/Panel data analysis	Liquid liabilities to GDP	No significant impact of financial development on growth
Christopoulos and Tsionas (2004)	10 developing countries including Kenya, 1970–2000	Panel cointegration	Liquid liabilities to GDP	Long-run positive uni-directional causality from finance to growth, no short-run effects
Kiran et al. (2009)	10 emerging countries including Tunisia and Egypt, 1968, 2007	Panel cointegration	Liquid liabilities to GDP, Private sector credit to GDP	Financial development positively and significantly affects economic growth for all measures
Demetriades and James (2011)	18 SSA countries, 1975–2006	Panel data techniques	LLB, Private sector credit to GDP	The link between bank credit and growth is absent
Bist (2018)	16 low-income countries, 1995–2014	Panel cointegration	Private sector credit to GDP	Private sector credit to GDP positively and significantly affects growth in the long-run
Guru and Yadav (2019)	BRICS countries: Brazil, China, Russia, South Africa, India, 1993–2014	GMM/Panel data analysis	Credit to deposit ratio, GDP Private sector credit to GDP	Credit to deposit ratio and private sector credit to GDP positively and significantly affect growth

COUNTRY-SPECIFIC STUDIES				
Gupta (1984)	14 developing countries, 1961–1980 (quarterly data)	VAR and Granger causality	M2/GDP	Causality runs mostly from finance to growth
Jung (1986)	56 developed and developing countries, 1950–1980	VAR and Granger causality	M1/GDP & M2/GDP	More supply leading effects of finance on growth than demand following effects of growth on finance
Demetriades and Hussein (1996)	16 developing countries 1961–1993	VECM/Granger causality	Bank deposits to GDP, Private sector credit to GDP	Weak evidence of a causal effect of finance on growth. Considerable evidence of bi-directional causality between finance and growth.
Arestis and Demetriades (1997)	Germany & USA, 1979–1991, quarterly data	VECM/Granger causality	Liquid liabilities to GDP, Private sector credit to GDP	Banking system mostly causes growth in Germany, no such effect for USA
Rousseau and Wachtel (1998)	5 developed countries, 1870–1929	VECM/Granger causality	Private sector credit to GDP, Liquid liabilities to GDP	Financial development leads economic growth with no feedback effects
Arestis et al. (2001)	5 developed countries, 1968–1998	VAR cointegration analysis	Private sector credit to GDP, and stock market development indicator e.g. market capitalization	Both bank-based and market-based indicators of FD support long-run growth but the effect of the former is stronger
Waqabaca (2004)	Fiji, 1970–2000	VAR/Granger causality	Liquid liabilities to GDP, Private sector credit to GDP	Positive of financial development on growth with causation predominantly from growth to financial development
Abu-Bader and Abu-Qarn (2008)	Egypt, 1960–2001	VECM/Granger causality	M2/GDP, Private sector credit to GDP	Positive direct causality of finance on economic growth and positive indirect causality through investment
Ang and McKibbin (2007)	Malaysia, 1960–2001	PCA/VECM/Granger causality	PCA measure using M3/GDP, Private sector credit to GDP	Financial development does not granger cause growth in the short-run and output growth granger causing financial development in the long-run with no feedback effect
Jalil et al. (2010)	China, 1977–2006	ARDL/PCA	Private sector credit to GDP, Liquid liabilities to GDP	Financial development positively and significantly affects growth
Ndlovu (2013)	Zimbabwe, 1980–2006	VECM/Granger causality	Private sector credit to GDP and Liquid liabilities to GDP	Financial development does not lead to growth. There is reverse causality from growth to finance
Adusei (2013)	Ghana, 1971–2010	ECM & Granger causality	Private sector credit to GDP & M3/GDP	Private sector credit to GDP has insignificant effects on growth but negative significant uni-

				directional causality of M3/GDP on growth
Iheanacho (2016)	Nigeria, 1981–2011	ARDL cointegration	Private sector credit to GDP & Liquid liabilities to GDP	Both have significant negative effects on growth in the short-run but insignificant negative effects on growth in the long-run

Source: Author's own compilation

Jankee (2006) also investigated the implications of financial liberalization by looking at the effects of banking controls and financial repression on economic growth from 1970 to 2000. The author used bank deposits to GDP and credit to the private sector to GDP to analyze the effects of banking controls and financial repression on economic growth. Using the method of principal components, different measures of banking controls were constructed and used in estimating whether financial repression is positive for financial depth and economic growth. The results showed no firm evidence that some forms of financial repression have contributed to financial depth and economic growth. The results also showed a significant bi-directional causality between banking sector development indicators and economic growth from 1970 to 2000. The author concluded that the major policy implication of his findings was that the pursuit of financial liberalization and banking sector development is no doubt the right strategy to increase economic growth in the country. An important finding is that non-interest factors such as bank branches have promoted rapid growth in bank deposits, even during the period of financial repression which went on throughout the 1970s until the early 1990s: this concurs with the findings of Jouan (2005) that non-interest factors could have played a major role in mobilizing deposits in the banking system.

Seetanah (2008) used the ARDL test to investigate the empirical link between FD and economic growth using time series data from 1952 to 2004. The author used liquid liabilities to GDP and credit to the private sector to measure FD and found a significant relationship between these two measures of FD and economic growth in both the short-run and the long-run. Seetanah (2008, p. 812) found that an increase of 1% in FD development indicators caused a more than 1% increase in output level. The author argued that the well-functioning of financial intermediaries played a significant role in economic growth in the country. Nowbutsing et al. (2010) used a Vector Correction Model and found that from 1970 to 2009 the effect of FD as measured by the ratio of liquid liabilities to GDP and private sector credit to GDP was positive and significant on economic growth in Mauritius. From the Johansen cointegrating vector estimates, Nowbutsing et al. (2010, p. 11) found that a one percent increase in private sector credit leads to an increase of around 0.14% to 0.25% in the rate of economic growth. The authors concluded that although financial development has a positive impact on economic growth its effect is fairly minimal (Nowbutsing et al., 2010, p. 11). It is important to mention that there is a stark difference between the findings of Seetanah (2008) and Nowbutsing et al. (2010) which suggests that the magnitude of the effects of FD on economic growth could have been stronger in the earlier years after independence.

More recently, Muyambiri and Odhiambo (2018) found a significant correspondence between bank and market-based financial development indicators, namely credit to the private sector and M3 on investment dynamics, in Mauritius from 1976 to 2014. The study assumed that investment and financial development have an accelerator-enhancing relationship and to account for this relationship the indicators for bank-based and market-based financial development were multiplied by per capita GDP. The study made use of the ARDL approach and found that the bank-based indicators and market-based indicators of financial development granger cause investment, in both the short-run and the long-run. The study, therefore, recommended that policies in Mauritius should promote and strengthen banking sector and stock market development in order to increase investment. However, the authors did not focus on the allocation of credit for alternative investment purposes and hence ignored the possibility of inefficient bank lending towards less productive investment which could adversely affect economic growth in the country.

Table 2.2 below shows a chronological summary of the empirical studies for Mauritius. It also shows the dominance of M2/GDP ratio and credit to the private sector to GDP as measures of FD. In contrast to early studies on financial development and economic growth (Jouan, 2005; Jankee, 2006; Seetanah, 2008), more recent studies such as Nowbutsing (2010) found that the effect of financial development on economic growth is minimal (Nowbutsing et al., 2010, p. 11). In this study, we argue that it is possible that bank lending to real estate and financial sectors could have promoted less productive investments and played a role in weakening economic growth in Mauritius. This issue is especially pertinent since the effects of the acceleration of financial lending during the past two decades have not been captured by earlier empirical studies on finance and growth. Furthermore, the existing studies estimated the separate effects of private sector credit and commercial bank credit on economic growth, and empirical tests to identify strong causal effects using an ARDL model have not been performed by prior studies.

Against this backdrop, the specific issues addressed in this chapter are: (i) to determine if there are both short-run and long-run causal flows from measures of FD namely, Liquid Liabilities per capita (LLB), Private Sector Credit per capita (PSC) and Commercial Bank Credit per capita (CBC) to RGDP; (ii) to provide an ARDL estimation of the impact of the measures of FD on short-run and long-run economic growth, and hence assess the efficiency of aggregate credit in Mauritius; (iii) to determine if there is any significant difference between the impact of private sector credit and commercial bank credit on economic growth.

Table 2.2: Empirical studies of financial development and economic growth in Mauritius

Study	Sample	Estimation Methods	Main Measures	Main Findings
Jouan (2005)	Mauritius, 1979–2002	ECM/Granger causality	Private sector credit to GDP	PSC significantly and positively related to economic growth and bi-directional causality between finance and growth
Jankee (2006)	Mauritius, 1970–2000	ECM/Granger causality	Bank deposits to GDP, Private sector credit to GDP	Positive bi-directional causality between banking sector development and economic growth
Seetanah (2008)	Mauritius, 1952–2004	ARDL/ECM	Private sector credit to GDP and M2/GDP	Positive and significant short-run and long-run effects of finance on growth
Nowbutsing et al. (2010)	Mauritius, 1970–2009	VECM/Granger causality	M2/GDP, Private sector credit to GDP	Positive long-run causal effects of M2/GDP and Private sector credit to GDP on economic growth

Note: Muyambiri and Odhiambo (2018) investigate the effects of financial development on investment in Mauritius. The authors use an ARDL and Granger causality model and find that the effects of different measures of financial development namely, private sector credit to GDP, M3, claims on government and market capitalization have positive effects on investment in the short and long-run.

Source: Author's own compilation

2.5 ANALYTICAL FRAMEWORK

2.5.1 The measures of financial development

Typically, authors who have studied the effects of FD in Mauritius have used the ratio of private sector credit and liquid liabilities of banks to proxy for FD (see Seetanah, 2008; Nowbutsing et al., 2010). It is important to mention that existing studies in Mauritius have used the ratios of M2 and M3 to GDP and private sector credit to GDP to measure FD. However, we use liquid liabilities to measure the amount of deposits that are available for commercial banks to make loans. In that respect, we exclude M0 and include only demand deposits, savings deposits and time deposits as our measure of liquid liabilities. Furthermore, the ratio of private sector credit to GDP used in previous empirical studies in Mauritius in fact consists solely of commercial banks' credit to the private sector. Therefore, in addition to the two conventional measures of FD used in Mauritius, we add non-bank financial institutions' credit to commercial banks' credit to arrive at the "true" private sector credit. It is appropriate to mention that in this study, instead of using the conventional measures of FD as a fraction of GDP, we divide our FD measures by the population figures and hence arrive at per capita measures[26].

[26] The reason we use per capita in the first empirical study in Chapter 2 is to remain consistent with Chapters 3 and 4 in which we use a time-varying coefficient (TVC) estimation approach. In Chapters 3 and 4 on TVC we use PSC per capita and CBC per capita for the TVC estimation of the total effects of Equation 4 in Chapter 3

2.5.2 Control variables

This paper uses five control variables as measures of openness: exports (EXPORTS), imports (IMPORTS), real effective exchange rate (REEXR), commodities export price index (CEXPI) and openness of Mauritius trade (OMT). As Ram (1987) argued, EXPORTS might improve economic growth while IMPORTS could lead to negative effects on economic growth. For an open economy such as Mauritius, a high REEXR makes exports less competitive while imports become more attractive, and this adversely affects growth. Rodrik (2008) analyzed 188 countries and found that an undervalued currency significantly improves the growth prospects of an open economy, while a high CEXPI measures the effects of higher export prices on economic growth. A higher elasticity of demand for exports can lead to a fall in demand for exports following an increase in prices which would adversely affect economic growth. For a more open economy, rising OMT can also improve growth. Open economies also have greater access to cheap imported intermediate goods, advanced technologies, and larger markets. If those benefits are reaped, an increase in OMT can improve economic growth (De Gregorio and Lee, 1999; Sachs and Werner, 1995; Rodríguez and Rodrik, 2001).

In terms of inflation (INF), it has been shown that low INF reflects sound macroeconomic policies which have positive effects on economic growth. In contrast, high INF may signal macroeconomic instability due to poor macroeconomic policies, which increases uncertainty and reduce private investment and economic growth (Roubini and Sala-i-Martin, 1992; De Gregorio, 1996; Chaturvedi et al., 2008). Hence, we include INF as a measure of the soundness of macroeconomic policies. Other explanatory variables such as private investment to GDP control for the positive effects of private investment on economic growth. There is wide evidence of the benefits of gross fixed capital formation (GFCF) and private investment (PI) on growth (De Long and Summers, 1991, 1993; Ongo and Vukenkeng, 2014). Finally, we include private consumption expenditure (PC) to control for the effects of private consumption on economic growth. There is recent evidence that GDP growth has been led by PC around the world (Kharroubi and Kohlscheen, 2017; Lombardi et al., 2017). However, though credit growth boosts PC in the short-run, it has been shown that the incidence of PC-led growth with rising debt service ratios significantly dampens economic growth in the medium to long term Kharroubi and Koschleen, 2017).

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without coefficient drivers. Swamy stated that if we use PSC to GDP and CBC to GDP as independent variables in doing this estimation, this might introduce a negative correlation over time with the dependent variable i.e. RGDP.

2.5.3 Model specification

A general model including 12 competing regressors is originally specified as follows:

$$lnRGDP = f(lnFD \text{ and control variables}) \quad \ldots(2.4)$$

Where the dependent variable is lnRGDP or log of real gross domestic product per capita, and the three measures of lnFD are namely, ln LLB is log of liquid liabilities per capita, lnPSC is log of private sector credit per capita and lnCBC is log of commercial bank credit per capita. The control variables are: lnGFCF is log of gross fixed capital formation as % GDP, lnPI is log of private investment as % of GDP, lnPC is log of private consumption as % of GDP, lnEXPORTS is log of exports as % of GDP, lnIMPORTS is log of imports as % of GDP, lnOMT is log of exports plus imports as % of GDP, lnREEXR is log of real effective exchange rate index, lnCEXPI is log of commodities export price index, INF is the inflation rate. This paper estimates three groups of models (Models A, B and C) based on the three measures of FD. Model A uses the LLB, Model B uses PSC and Model C uses CBC. To avoid multicollinearity problem, a pairwise correlation test was carried out among the control variables (see Appendix 2. Variables that were strongly correlated (we drop variables which have a correlation coefficient higher than 0.75) were not included in the same regression. Hence, for each group of models (A, B, and C) we estimated several models that included only relatively weakly correlated independent variables. The general model can be written in the following form:

$$\ln RGDP_t = \beta_0 + \beta_1 \ ln\, FD_t^* + \beta_2 \ INF_t + \beta_3 \ lnINV_t^* + \beta_4 \ \ln PC + \beta_5 lnO_t^* + \varepsilon_t \quad \ldots(2.5)$$

FD* denotes the measure of financial development which can be LLB, PSC or CBC, INV* denotes the measure of investment, which is either PI or GFCF, O* denotes the measure of openness which can be EXPORTS, IMPORTS, OMT, REEXR or CEXPI, β_0 is the intercept and ε_t is the white noise error term. Only models which pass the tests for serial correlation and heteroscedasticity are presented in this paper. Note that the models presented in this chapter have been grouped into three categories: A, B and C. *For model A, we have A1, A2, A3 and A4, for Model B we have B1, B2, B3, B4 and B5, and for Model C, we have C1.*

2.5.4 Data and source

The study covers the period from 1970 to 2019 which makes a total of 50 observations. With the exception of the inflation rate, all the variables used for the models were transformed into

natural logarithms. Data on REEXR from UNCTAD and IMF covers only the periods 1998 to 2012 and 1976 to 2016 respectively. Therefore, we use REEXR data from the European think tank, the Bruegel Institute, which is available for Mauritius from 1963 to 2019. The REEXR data measures the evolution of the real value of the Mauritian currency against a basket of up to 66 trading partners. The Bruegel Institute calculates the REEXR by using the nominal exchange rate of the country of study, the consumer price index of the country of study and a geometrically weighted average of consumer prices indices of up to 66 trading partners. Data on CEXPI for Mauritius was obtained from the International Financial Statistics of the IMF. CEXPI includes the change in the international price of up to 45 individual commodities and is weighted by the ratio of exports to GDP[27]. Data on OMT, i.e. total exports plus imports (as% of GDP), was retrieved from the various issues of the Bank of Mauritius annual reports. Data on private consumption, gross fixed capital formation and private investment, nominal and real GDP was obtained from Statistics Mauritius. Data on liquid liabilities[28] and credit to the private sector by banks and non-banks was gathered from various issues of the Bank of Mauritius annual reports. Data on population has been obtained from the United Nations World population prospects database (2019).

2.6 MODEL ESTIMATION AND RESULTS

We start by performing a unit root test to ensure that all variables in this study are integrated of order zero or one. After this is done, in the next section, we use the ARDL bounds test to check for cointegration. In the following part, we use causality testing to ascertain the causal impact from FD to economic growth. Finally, we provide long-run and short-run results notably on the effects of FD on economic growth after controlling for other variables.

2.6.1 Unit root test and results

We begin the estimation by performing a unit root test using the Augmented Dickey–Fuller (ADF) test and stationarity test using Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. We use two tests to verify the robustness of our results. As a rule of thumb, we accept a variable is I(0) only if both ADF and KPSS tests confirm the stationarity of a series at level form. *The results in Table 2.3 show that the variables used in this study are either integrated of order*

[27] Country-specific commodity price indices include exports, imports, and terms of trade indices. For each country, the change in the international price of up to 45 individual commodities is weighted using commodity level trade data. See Gruss and Kebhaj (2019) for further details. In this study, we use commodity export price indices as one measure of openness.

[28] Liquid liabilities have been calculated by summing up demand deposits + savings deposits + time deposits. Note that M0 has been excluded from LLB since it includes currency in circulation and bank reserves. Our main interest lies in the use of deposits by banks for credit allocation.

zero or one. The objective is to ensure that the variables are not I(2) so as to avoid spurious results. In the presence of variables integrated of order two, we cannot interpret the ARDL cointegration bound test values of F statistics provided by Pesaran et al. (2001).

Table 2.3: Unit root test results

	ADF RESULTS				KPSS RESULTS		Order of integration
	Level		First Difference		Level	First Difference	
Variable	**T-stats**	**p-value**	**T-stats**	**p-value**	**LM-stats**	**LM-stats**	
INF. RATE	-2.58	0.29	-3.74	0.03[b]	0.06 [c]	0.29	I(1)
lnEXPORTS	-1.54	0.80	-6.68	0.00[a]	0.18	0.06[c]	I(1)
lnPI	-3.54	0.05[c]	-8.47	0.00[a]	0.08[c]	0.08 [c]	I(0)
lnGFCF	-4.02	0.01[a]	-9.06	0.00[a]	0.12	0.06 [c]	I(0)
lnIMPORTS	-2.7	0.24	-6.62	0.00[a]	0.16	0.06 [c]	I(1)
lnLLB	-0.93	0.94	5.94	0.00[a]	0.23	0.06 [c]	I(1)
lnPC	-2.34	0.40	-5.49	0.00[a]	0.13	0.04[a]	I(1)
lnPSC	-0.54	0.98	-6.49	0.00[a]	0.22	0.06 [c]	I(1)
lnRGDP	-3.69	0.03[b]	-5.15	0.00[a]	0.06[b]	0.04[b]	I(0)
lnOMT	-1.92	0.63	-6.31	0.00[a]	0.20	0.05[b]	I(1)
lnCEXPI	-5.25	0.00[a]	-9.64	0.00[a]	0.19	0.11	I(0)
lnREEXR	-1.94	0.62	-7.34	0.00[a]	0.13	0.04[b]	I(1)
lnCBC	-0.48	0.98	-6.45	0.00[a]	0.23	0.06 [c]	I(1)

Note: Significance of the coefficients at the 1%, 5% and 10% level are denoted by the superscripts a, b and c respectively. We use the trend and intercept option when we perform the unit root test for ADF and stationarity test for KPSS. The KPSS results are the LM-Stats and the significance level are based on the asymptotic critical values provided by Kwiatkowski-Phillips-Schmidt-Shin (1992, table 1).

Source: Estimation results by author

2.6.2 ARDL bounds cointegration test

We used the autoregressive distributed lag (ARDL) bounds approach to test for cointegration as proposed by Pesaran et al. (2001). The ARDL bounds cointegration technique was selected to determine the relationship between ln LLB, ln PSC, ln CBC and lnRGDP. The choice of this method is based on a number of considerations as highlighted by Pesaran and Shin (1995) and Pesaran et al. (2001). First, the ARDL models yield consistent estimates of the long-run coefficients that are asymptotically normal irrespective of whether the underlying variables are I(1) or I(0). Second, the ARDL approach, also known as the Pesaran et al. (2001) bound test, has higher statistical power than other cointegration approaches, especially in small samples. Third, the ARDL model provides enough flexibility to choose the number

of lags that solve the serial correlation problem while allowing a sufficient number of explanatory variables in the regressions.

Following Pesaran et al. (2001), we employ an ARDL model to estimate the log-linear Equation 2.5. The model is specified in an ARDL framework as below:

$$\Delta \ln RGDP_t = \beta_0 + \sum_{i=1}^{n} \beta_{ei}\, \Delta \ln RGDP_{t-i} + \sum_{i=1}^{n} \beta_{fi}\, \Delta \ln FD^*_{t-i} + \sum_{i=1}^{n} \beta_{gi}\, \Delta INF_{t-i} + \sum_{i=1}^{n} \beta_{hi}$$

$$\Delta INV^*_{t-i} + \sum_{i=1}^{n} \beta_{ji}\, \Delta \ln PC_{t-i} + \sum_{i=1}^{n} \beta_{ki}\, \Delta \ln O^*_{t-i} + \emptyset_1\, \Delta \ln RGDP_{t-1} + \emptyset_2\, \Delta \ln FD^*_{t-1} +$$

$$\emptyset_3\, INF_{t-1} + \emptyset_4\, \ln INV^*_{t-1} + \emptyset_5\, \ln PC_{t-1} + \emptyset_6 \ln O^*_{t-1} + \varepsilon_t \qquad \ldots(2.6)$$

Δ is the first difference operator β_0 is a drift component and ε_t is the white noise error term. The long-run multipliers are represented by the coefficients of the lagged level variables, $\emptyset's$, while β^s represents the short-run impact on RGDP.

The first step in estimating the ARDL model is to test for the presence of long-run relationships among the variables by using the Bounds F-Test. To implement the bound test procedure, we test the presence of cointegration by restricting all estimated coefficients of lagged level variables in Equation (2.6) to zero. The null hypothesis of no cointegration is as follows:

$$H_0: \emptyset_1 = \emptyset_2 = \emptyset_3 = \emptyset_4 = \emptyset_5 = \emptyset_6 = 0$$

And we test it against the alternative hypothesis of cointegration which is as follows:

$$H_1: \emptyset_1 \neq 0, \emptyset_2 \neq 0, \emptyset_3 \neq 0, \emptyset_4 \neq 0, \emptyset_5 \neq 0, \emptyset_6 \neq 0$$

The value of the F-statistic is compared with the critical values for the lower and upper bounds to determine whether to accept or reject the null hypothesis. The lower bound assumes that all the regressors are *I*(0), and the upper bound assumes that they are *I* (1). If the computed F-statistics lies above the upper band, the null is rejected, indicating cointegration. When the F-statistics is between the lower and upper bounds, the test is indeterminate. If the calculated F-statistics lies below the lower bound, the null hypothesis should be accepted which mean that there is no cointegration (Pesaran et al., 2001). Once the long-run relationship has been established through the ARDL bounds test, the second step is to estimate the ARDL model which includes the short-run coefficients and error correction term (ECT). It is important to mention that the ECT only exists if there is evidence of a long-run

relationship between the variables. We construct a lagged ECT to substitute the whole set of lagged level variables. The error correction model can therefore be rewritten as follows:

$$\Delta \ln RGDP_t = \beta_0 + \sum_{i=1}^{n} \beta_{ei}\ \Delta \ln RGDP_{t-i} + \sum_{i=1}^{n} \beta_{fi}\ \Delta \ln FD^*_{t-i} + \sum_{i=1}^{n} \beta_{gi}\ \Delta INF_{t-i} + \sum_{i=1}^{n} \beta_{hi}$$

$$\Delta INV^*_{t-i} + \sum_{i=1}^{n} \beta_{ji}\ \Delta \ln PC_{t-i} + \sum_{i=1}^{n} \beta_{ki}\ \Delta \ln O^*_{t-i} + \varphi ECT_{t-1} + \sigma_t \qquad \ldots(2.7)$$

Equation 2.7 represents the error correction model and it estimates the speed of adjustment to equilibrium in a cointegrating relationship. The short-run dynamics in the model are expressed through the β^s. ECT is included among the regressors in Equation 2.7. The coefficient of ECT φ is expected to be less than one, negative and statistically significant. The coefficient is typically interpreted as the speed of adjustment to equilibrium, Apostolidou et al. (2014).

2.6.3 ARDL bounds cointegration test and results

Table 2.4 below shows the results of the bounds F test procedure where the critical values are reported at the 5% significance level to confirm the long-run relationship between the dependent and independent variables. For all model specifications, the bounds F test rejects the hypothesis of no cointegration and hence confirms that there is long-run relationship between the dependent and independent variables.

Table 2.4: ARDL bounds test results

MODEL SPECIFICATION	CRITICAL VALUES		F-STATISTIC	ACCEPT/REJECT H0 (H0: no cointegration)
	I(0)	I(1)		
A1	3.48	4.78	13.63	Reject
A2	3.48	4.78	23.60	Reject
A3	3.48	4.78	23.01	Reject
A4	3.48	4.78	17.63	Reject
B1	3.48	4.78	24.70	Reject
B2	3.48	4.78	27.04	Reject
B3	3.48	4.78	27.15	Reject
B4	3.48	4.78	27.42	Reject
B5	3.48	4.78	26.78	Reject
C1	3.48	4.78	13.07	Reject

Notes: The critical values used are at the 5% significance level from Pesaran et al (2001).
Model A1 includes INF., lnPI, lnPC and lnEXPORTS as control variables.
Model A2 includes INF., lnGFCF, lnPC and lnIMPORTS as control variables.
Model A3 includes INF., lnGFCF, lnPC and lnOMT as control variables.
Model A4 includes INF., lnGFCF, lnPC and lnCEXPI as control variables.
Model B1 includes INF., lnPI, lnPC and lnREEXR as control variables.
Model B2 includes INF., lnGFCF, lnPC and lnIMPORTS as control variables.

Model B3 includes INF., lnGFCF, lnPC and lnOMT as control variables.
Model B4 includes INF., lnGFCF, lnPC and lnREEXR as control variables.
Model B5 includes INF., lnGFCF, lnPC and lnCEXPI as control variables.
Model C1 includes INF., lnPI, lnPC and lnEXPORTS as control variables.

Source: Estimation results by author

2.6.4 ARDL-ECM granger causality test

The existence of a long-run relationship between financial development and economic growth does not suggest causality from the former to the latter and vice-versa. We use a bivariate framework test for causality between FD and RGDP using the following steps:

(i) In the short-run ARDL-ECM framework, we follow the methodology of Apostolidou et al. (2014) who used the F-statistic from the Wald test to check if the coefficients of the regressor on the dependent variable are jointly significant. We test if the coefficients of FD on RGDP i.e δ_{2i} in Equation 2.8 or the coefficients of RGDP on FD i.e λ_{2i} in Equation 2.9 are jointly significant. If the regressors are jointly significant, then short-run causality running from FD to economic growth or vice-versa can be inferred.

$$\Delta \ln RGDP_t = \delta_0 + \sum_{i=1}^{k} \delta_{1i} \Delta \ln RGDP_{t-i} + \sum_{i=1}^{k} \delta_{2i} \Delta FD_{t-i} + \psi ECM_{t-1} + \mu_t \quad \ldots(2.8)$$

$$\Delta \ln FD_t = \lambda_0 + \sum_{i=1}^{k} \lambda_{1i} \Delta \ln FD_{t-i} + \sum_{i=1}^{k} \lambda_{2i} \Delta \ln RGDP_{t-i} + \varphi ECM_{t-1} + \mu_t \quad \ldots(2.9)$$

(ii) In the long-run, we use the F-statistics from the Wald test to test if the coefficients of FD on RGDP i.e β_{2i} in Equation 2.10 or α_{2i} in Equation 2.11 are jointly significant. However, a necessary condition for long-run causality relationship from FD to economic growth is the significance of the estimated coefficient of ECM_{t-1} in Equation 2.8.

$$\ln RGDP_t = \beta_0 + \sum_{i=1}^{k} \beta_{1i} \ln RGDP_{t-i} + \sum_{i=1}^{k} \beta_{2i} FD_{t-i} + \mu_t \quad \ldots(2.10)$$

$$\ln FD_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \ln FD_{t-i} + \sum_{i=1}^{k} \alpha_{2i} RGDP_{t-i} + \mu_t \quad \ldots(2.11)$$

Apostolidou et al. (2014) pointed out that the t-statistic on the coefficient of the lagged error correction term represents the long-run causal relationship. The estimated coefficient of ECM_{t-1} in Equations 2.8 and 2.9 show how quickly or slowly variables return to their equilibrium values. A negative and significant coefficient of the ECM shows that any deviation from the long-run equilibrium relationship between FD and economic growth is adjusted.

Therefore, the joint significance of the coefficients of FD in Equations 2.8 and 2.10 and a negative and significant coefficient of the ECM imply short-run and long-run causal flows from FD to economic growth. The results which are presented in Table 2.5 show that there are only short-run and long-run flows running from PSC or CBC to RGDP. The causality results suggest that there is no causality running from LLB to RGDP.

Therefore, though the ARDL Bounds test in Table 2.4, suggests possible cointegration between LLB, other control variables and RGDP, the bivariate results between LLB and RGDP in Table 2.5 suggests there are no cointegration and no causality from LLB to RGDP. Since there is no cointegration, to test for short-run causality between LLB and RGDP, we estimate the short-run difference equations (i.e Equation 2.8 without the ECM term) and use the Wald test to check for the joint significance of the coefficients. These causality results imply that in the next section we shall only estimate the long-run and short-run parameters of the effects of PSC or CBC on RGDP.

Table 2.5 Causality test results

Causal flow	F-Stat and (p-value) of Wald test for SR coefficients	F-Stat and (p-value) of Wald test for LR coefficients	ECM coefficient and (p-value)	Conclusion
LLB --->RGDP	1.93 (0.14)	NA	NA	There is no cointegration and no short-run causal flow from LLB to RGDP
RGDP--->LLB	4.49 (0.01)[b]	NA	NA	Short-run causal flow from RGDP to LLB
PSC --->RGDP	5.51 (0.00)[a]	2.18 (0.09)[c]	-0.40 (0.00)[a]	Both short-run and long-run causal flows from PSC to RGDP
RGDP --->PSC	3.47 (0.07)[b]	1.06 (0.39)	-0.03 (0.44)	Short-run causal flow from RGDP to PSC
CBC --->RGDP	7.56 (0.00)[a]	2.35 (0.07)[c]	-0.43 (0.00)[a]	Both short-run and long-run causal flows from CBC to RGDP
RGDP --->CBC	5.38 (0.03)[b]	1.12 (0.36)	-0.02 (0.47)	Short-run causal flow from RGDP to CBC

Note: Significance of the coefficients at the 1% 5% and 10% level are denoted by the superscripts a,b and c respectively.

NA: Not Applicable

Source: Estimation results by author

2.6.5 ARDL model and long-run results

The long-run results are presented in Table 2.6 which reports the ARDL long-run results for Models B and C. Models B and C report the results according to two measures of FD, namely, lnPSC and lnCBC respectively.

Table 2.6: ARDL long-run results

Dependent variable: ***real GDP per capita***	**Model B**					**Model C**
	B1	B2	B3	B4	B5	C1
Measures of FD						
lnPSC	-0.17 (0.01)[a]	-0.23 (0.02)[b]	-0.22 (0.03)[b]	-0.24 (0.01)[a]	-0.25 (0.02)[b]	-
lnCBC	-	-	-	-	-	-0.1 (0.00)[a]
Other control variables						
INF	-0.01 (0.03)[b]	-0.01 (0.03)[b]	-0.01 (0.03)[b]	-0.01 (0.01)[a]	-0.01 (0.01)[a]	-0.01 (0.00)[a]
lnPI	0.20 (0.00)[a]	-	-	-	-	0.21 (0.00)[a]
lnGFCF		0.27 (0.00)[a]	0.26 (0.00)[a]	0.26 (0.00)[a]	0.25 (0.02)[a]	-
lnPC	-0.59 (0.00)[a]	-0.67 (0.02)[b]	-0.70 (0.01)[a]	-0.76 (0.01)[a]	-0.73 (0.01)[a]	-0.55 (0.00)[a]
lnexports	-	-	-	-	-	-0.02 (0.65)
lnimports	-	-0.08 (0.56)	-	-	-	-
lnREEXR	-0.14 (0.41)	-	-	0.15 (0.42)	-	-
lnOMT	-	-	-0.08 (0.49)	-	-	-
lnCEXPI	-	-	-	-	0.03 (0.84)	-
Serial correlation	0.294 (0.055)	0.305 (0.121)	0.307 (0.122)	0.233 (0.080)	0.325 (0.133)	0.681 (0.187)
Heteroscedasticity	0.427 (0.382)	0.948 (0.909)	0.942 (0.899)	0.748) (0.672)	0.915 (0.865)	0.853 (0.713)
R^2	0.94	0.88	0.88	0.88	0.88	0.97

Note: Significance of the coefficients at the 1%, 5% and 10% level are denoted by the superscripts a, b and c respectively.
The p value for F and Chi square tests for serial correlation and heteroscedasticity are given in parentheses. All exceed 5% and we reject the null hypotheses of serial correlation and heteroscedasticity.
Model B1 includes INF., lnPI, lnPC and lnREEXR as control variables.
Model B2 includes INF., lnGFCF, lnPC and lnIMPORTS as control variables.
Model B3 includes INF., lnGFCF, lnPC and lnOMT as control variables.
Model B4 includes INF., lnGFCF, lnPC and lnREEXR as control variables.
Model B5 includes INF., lnGFCF, lnPC and lnCEXPI as control variables.
Model C1 includes INF., lnPI, lnPC and lnEXPORTS as control variables.

Source: Estimation results by author

Models B investigate the efficiency of banking intermediation by using lnPSC as the main explanatory variable for FD. *When we use lnPSC as our main measure for FD, the effects of FD on economic growth remain significant and negative. This can be seen by the negative sign and the magnitude of the long-run elasticities and p-values of the coefficients of lnPSC in Model B1, B2, B3, B4 and B5, where all the models show the coefficient of lnPSC is*

significant at the 5% level. This is a robust result as it shows that the effect of PSC on RGDP remains significant and strongly negative across different model specifications. The result suggests that PSC negatively affects RGDP in Mauritius in the long-run, which contrasts with the previous studies done in Mauritius (see Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010). In an attempt, to further explore the effect of aggregate credit on economic growth, we remove non-bank credit from PSC to capture its largest component, CBC, which consists of around 85% of PSC: this ratio has remained quite stable despite the emergence of a large number of non-banking financial institutions. *In Model C, when lnCBC is used as the main measure of FD, the results remain negatively significant. This can be seen by the coefficient of lnCBC in Model C1 which is strongly significant at the 1% level*[29]. Overall, the long-run empirical results suggest that PSC and CBC have strong negative effects on economic growth in Mauritius. It seems that the shift in the composition of bank credit after late 1980s could have played a role in causing negative effects of finance on growth. Figure 3.3 shows that bank credit has increasingly been issued to the construction and financial sectors at the expense of the manufacturing sector which in fact was the main sector to drive high growth rates in the country in the 1980s. Our findings generally suggest that commercial bank credit in Mauritius has not supported high rates of economic growth in the country from 1970 to 2019.

Regarding the control variables, the long-run results are also reported in Table 2.6. All models show that lnPC is significant at the 5% level, which shows very strong negative effects of consumption on growth in the country. Kharoubbi and Koschleen (2017) showed that GDP growth has increasingly been led by consumption driven by credit. However, although credit growth boosts consumption in the short-run, it has been shown that the incidence of consumption-led growth with rising debt service ratios significantly dampens economic growth in the medium to long term[30]. All models from B1 to C1 show insignificant effects of openness on economic growth. The result is consistent across all model specifications, which shows that openness has not led to growth in the long-run in Mauritius. In fact, the consistently insignificant results from B1 to C1 suggest that policymakers have failed to create a vibrant export sector in the country. Interestingly, all models report a significant effect of lower inflation on economic growth. This is mainly because lower

[29] Model C1 which estimates the effects of CBC on RGDP also has the highest R^2.
[30] Consumption loans represent the remaining 40 percent of total bank credit to households. Housing credit represents around 60 percent of total bank credit to households (Bank of Mauritius financial stability report, February 2015, p. 1).

inflation reduces volatility and uncertainty and provides a more conducive environment for private investment and economic growth. This view is consistent with a large number of empirical studies (see Fischer, 1993: Barro, 1995; Costamagna, 2015). Furthermore, all models show strong significant effects of gross fixed capital formation and private investment on economic growth in Mauritius. These results support the observation that investment drives economic growth in developing countries (see Khan and Reinhart, 1989; De Long and Summers, 1991; Bayraktar, 2003).

2.6.6 ARDL model and short-run results

Table 2.7 reports the result of the ARDL short-run estimation for Models B and C. For all models, the coefficients of the ECT have the right sign and are statistically significant. The speed of adjustment of the ECT directly estimates the speed at which lnRGDP returns to equilibrium after a change in the other independent variables. Model C1 has the fastest speed of adjustment while model B5 has the slowest speed of adjustment. Models B1 to B5 shows that aggregate credit exerts positive effects on RGDP in the short-run as can be seen by the positive significant coefficients of PSC and its lagged terms in all models. The short-run effects of credit on growth are further confirmed by the positive effects of the coefficients of CBC and its lagged terms on RGDP in Model C1. Models B1 and C1 also consistently suggest that PI have negative effects on economic growth while Models B2 to B5 show that GFCF also weakens growth in the short-run. These findings seem to support the observation less productive investment weakened economic growth in the short-run. The results for the other control variables and their lagged values are mixed. For instance, current increases in INF and PC has negative effects on RGDP but their lagged values have positive effects on RGDP. Overall, the short-run empirical results suggest that both aggregate credit measures have positive effects on RGDP in Mauritius. These results are in line with all the previous empirical studies for Mauritius (see Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010) and suggest that credit has stimulated growth in the short-run in the country. *The results show that the effects of aggregate credit on economic growth in Mauritius are positive in the short-run but negative in the long-run.*

Table 2.7: ARDL short-run results

Dependent variable: *D(lnRGDP)*	**Model B**					**Model C**
	B1	B2	B3	B4	B5	C1
ECT_{t-1}	-0.43 (0.00)[a]	-0.32 (0.00)[a]	-0.33 (0.00)[a]	-0.30 (0.00)[a]	-0.29 (0.00)[a]	-0.80 (0.00)[a]
Lagged dependent variables						
$D(lnRGDP_{t-1})$	0.10 (0.17)	-0.23	-0.22	-0.24	-0.25	-

		(0.00)[a]	(0.00)[a]	(0.00)[a]	(0.00)[a]	
$D(lnRGDP_{t-2})$	-0.18 (0.00)[a]	-0.22 (0.00)[a]	-0.21 (0.01)[a]	-0.22 (0.00)[a]	-0.22 (0.00)[a]	-
$D(lnRGDP_{t-3})$	0.24 (0.00)[a]	-	-	-	-	-
$D(lnRGDP_{t-4})$	-	-	-	-	-	-
Measures of FD						
$D(lnPSC)$	0.06 (0.02)[b]	0.06 (0.01)[a]	0.06 (0.01)[a]	0.07 (0.01)[a]	0.06 (0.03)[b]	-
$D(lnPSC_{t-1})$	0.09 (0.00)[a]	0.20 (0.00)[a]	0.20 (0.00)[a]	0.21 (0.00)[a]	0.20 (0.00)[a]	-
$D(lnPSC_{t-2})$	0.06 (0.01)[a]	0.06 (0.03)[b]	0.05 (0.05)[b]	0.06 (0.02)[b]	0.05 (0.05)[b]	-
$D(lnPSC_{t-3})$	0.08 (0.00)[a]	0.15 (0.00)[a]	0.15 (0.00)[b]	0.16 (0.00)[a]	0.16 (0.00)[a]	-
$D(lnCBC)$	-	-	-	-	-	0.10 (0.00)[a]
$D(lnCBC_{t-1})$						0.14 (0.00)[a]
$D(lnCBC_{t-2})$						0.08 (0.00)[a]
$D(lnCBC_{t-3})$						0.11 (0.00)[a]
Other control variables						
$D(INF)$	NA	NA	NA	NA	NA	-0.001 (0.00)[a]
$D(lnINF_{t-1})$						0.003 (0.00)[a]
$D(lnINF_{t-2})$						0.002 (0.00)[a]
$D(lnINF_{t-3})$						0.001 (0.00)[a]
$D(lnPI)$	-0.01 (0.45)	-	-	-	-	0.03 (0.13)
$D(lnPI_{t-1})$	-0.03 (0.07)[c]	-	-		-	-0.13 (0.00)[a]
$D(lnPI_{t-2})$	-0.10 (0.00)[a]	-	-		-	-0.13 (0.00)[a]
$D(lnPI_{t-3})$						-0.04 (0.02)[b]
$D(lnGFCF)$	-	-0.03 (0.11)	-0.04 (0.09)[c]	-0.04 (0.07)[c]	-0.04 (0.04)[b]	-
$D(lnPC)$	-0.31 (0.00)[a]	NA	NA	NA	NA	-0.37 (0.00)[a]
$D(lnPC_{t-1})$	0.17 (0.00)[a]	-			-	0.31 (0.00)[a]
$D(lnPC_{t-2})$						0.13 (0.04)[b]
$D(lnPC_{t-3})$						0.12 (0.04)[b]
$D(lnexports)$	-	-	-	-	-	-0.04 (0.16)
$D(lnexports_{t-1})$						-0.08 (0.01)[a]
$D(lnexports_{t-2})$						0.06 (0.05)[b]
$D(lnimports)$	-	NA	-	-	-	-
$D(lnREEXR)$	0.10 (0.03)[b]	-	-	NA	-	-
$D(lnOMT)$	-	-	NA	-	-	-

D(lnCEXPI)	-	-	-	-	NA	-

Note: Significance of the coefficients at the 1%, 5% and 10% level are denoted by the superscripts a, b and c respectively.
Model B1 includes INF., lnPI, lnPC and lnREEXR as control variables.
Model B2 includes INF., lnGFCF, lnPC and lnIMPORTS as control variables.
Model B3 includes INF., lnGFCF, lnPC and lnOMT as control variables.
Model B4 includes INF., lnGFCF, lnPC and lnREEXR as control variables.
Model B5 includes INF., lnGFCF, lnPC and lnCEXPI as control variables.
Model C1 includes INF., lnPI, lnPC and lnEXPORTS as control variables.

Source: Estimation results by author

2.7 CONCLUSION AND POLICY RECOMMENDATIONS

This chapter shows that there are strong significant positive effects of PSC and CBC on RGDP in the short-run, but the results remained strongly significant and negative in the long-run. The long-run results support the observation that banks have increasingly been allocating credit to less productive sectors of the economy[31]. We argue that the current simplistic approach of inflation targeting is not enough, and the Bank of Mauritius should be much more proactive in managing the inefficiency of private credit allocation.

As Hayek (2008) and Minsky (1986) rightly argued, private credit allocation is inherently unstable and therefore regulatory policies can be used to shape the flow of funds, for instance, by putting restrictions on the maximum fraction of funds that can go into unproductive sectors of the economy, or on the minimum fraction of funds that can go into, say, the industrial sectors. Policy makers in Mauritius should design policies that would direct bank credit towards desirable areas with the greatest potential to drive growth as the country reengineers its growth engine in the 21st century.

The empirical results of this chapter have shown that the effects of PSC or CBC on RGDP in Mauritius are positive in the short-run but negative in the long-run. However, since the ARDL is a fixed coefficient model, it is unable to measure the precise functional form of the relationship between PSC or CBC and RGDP which might have changed over time due to different financial policies adopted in the country after independence since 1968 to today. In the next chapter, we use a time-varying coefficient estimation to measure the true functional form of the relationship between PSC or CBC and RGDP. The time-varying coefficient estimation technique that we shall use also addresses many limitations of conventional econometric techniques.[32]

[31] In Chapter 4, we explore the effects of bank credit on different types of investment and its implications for economic growth.
[32] We will show how we address the limitations of conventional problems of unknown functional form, non-stationarity and endogeneity. However, this list is not exhaustive, as the reader will appreciate in the next chapter.

CHAPTER 3

A TIME-VARYING COEFFICIENT ESTIMATION OF THE TOTAL EFFECTS OF PRIVATE SECTOR CREDIT AND COMMERCIAL BANK CREDIT ON REAL GDP

Abstract

This chapter presents estimates of the effects of private sector credit per capita (PSC) or commercial bank credit per capita (CBC) on real gross domestic product per capita (RGDP) in Mauritius. We argue that this relationship would have changed over time due to different economic policies adopted in the country since independence in 1968. We use the time-varying coefficient (TVC) model proposed by Swamy and Von Zur Muehlen (2020) to estimate the relationship between PSC or CBC and RGDP. In contrast to existing fixed and variable models, which ignore the indirect effects of the regressor on the dependent variable and instead provide estimates of the direct effects of a regressor on the dependent variable, the TVC model proposed by Swamy and Von Zur Muehlen (2020) measures the total effects[33] of PSC or CBC on RGDP from 1970 to 2019. Furthermore, as opposed to the existing empirical literature on the indirect effects of finance and growth (see Sarwar et al., 2020), the TVC model uses coefficient drivers to measure more precisely the partial indirect effects through which finance affects growth. Contrary to the claims made by Arcand et al. (2012) that existing models which study the effects of finance on growth are misspecified because they omit PC^2 (square of level of credit to the private sector) and hence cannot detect any threshold effects, we show that all fixed and variable coefficient models including the Arcand et al. (2012) model are misspecified because they ignore the indirect effects of the regressor on the dependent variable. The empirical results show a non-linear relationship between PSC or CBC and RGDP and no threshold effects are reached yet between PSC or CBC and RGDP growth from 1970–2019. The results for the coefficient drivers, Private Investment (PI), Gross Fixed Capital Formation (GFCF), Private consumption (PC) and IMPORTS prove their crucial role in measuring part of the negative indirect effects of PSC or CBC on RGDP. These indirect effects would otherwise go unidentified and be lumped into a false representation of "direct" effects of PSC or CBC on RGDP.

[33] The estimate of the total effects of a regressor on a dependent variable estimates part of the direct and indirect effects of a regressor on a dependent variable.

"It has been argued that whenever regression models involve nonstationary and trending variables, estimation methods appropriate to stationary series cannot be applied to such models and instead requires cointegration techniques. Unfortunately, extant methodologies applied to cointegration are a trap: if the error term of a cointegration regression consists of omitted relevant regressors…" (Swamy and Von Zur Muehlen, 2020, p. 1)

3.1 Introduction

In estimating the effects of FD on RGDP, two broad modelling approaches have been used in the empirical literature: (i) fixed coefficient models and (ii) TVC models. Examples of techniques used to estimate fixed coefficient models have ranged from VAR and VECM to ARDL and cointegration tests[34], while regime switching models and state space models are example of TVC models. Unlike the previous chapter, which used ARDL, a fixed parameter model, in this chapter we employ a variant of the TVC model proposed by Swamy and Von Zur Muehlen (2020) to estimate the effects of PSC or CBC on RGDP.

Both extant fixed coefficient and time-varying modelling approaches used in previous studies suffer from the deeply ingrained assumption that the error term of a regression is made up of the net effects of omitted variables and is uncorrelated with the included regressors. Pratt and Schlaifer (1984, pp. 9–12) showed that the error term of each equation is typically made up of omitted relevant regressors that cannot be proved to be uncorrelated with the included variables. The correlation between the included regressors and each omitted relevant regressor leads to indirect effects because the included regressors affect each omitted regressor and each omitted regressor, in turn, affects the dependent variable. Hence, extant models ignore the indirect effects of the regressor on the dependent variable but instead provide estimates of the direct effects of a regressor on the dependent variable. Therefore, any sound econometric procedure should not ignore the indirect effects but instead estimate the total effects[35] of a regressor on the dependent variable.

Indeed, the TVC model proposed by Swamy and Von Zur Muehlen (2020) estimates the total effects of a regressor on the dependent variable. The TVC model uses coefficient drivers[36] to measure part of the indirect effects of PSC or CBC on RGDP. This TVC model is ideal for

[34] See the literature reviewed in Chapter 2.
[35] The total effects of an independent variable on the dependent variable comprise its partial direct and partial indirect effects and an error term captures all remaining effects. In this chapter, we estimate the total effects of the measures of FD namely PSC and CBC on RGDP.
[36] A pair of coefficient drivers is used for each coefficient of the TVC model. The coefficient driver for the coefficient of the regressor is used to measure part of the indirect effects of PSC or CBC on RGDP. The coefficient of the regressor in the TVC model measures the total effects of PSC or CBC on RGDP.

Mauritius as during the past 50 years the Bank of Mauritius (BOM) has implemented a series of economic policies which have influenced the effects of PSC or CBC on RGDP. Compared to the growth in aggregate credit and real GDP growth in the 1980s, more recent trends show that the growth rates in these two variables has remained sluggish while at the same time private investment, which remains a key driver of real GDP growth, has fallen quite sharply (see Figure 3.2 below). According to economic theory, we can expect the indirect effects of PSC or CBC to affect RGDP through investment and hence the TVC model can provide additional insights into the nature of the relationship between credit, investment and growth in Mauritius.

Much of the empirical literature on fixed coefficient models has shown positive effects of credit to the private sector on RGDP and encouraged countries with low credit to the private sector to increase it to stimulate economic growth (see Levine, 1997, 2005). However, from early 2000s, several empirical researchers have challenged the view that more financial deepening is necessarily good for economic growth (see Deidda and Fattouh, 2002; Huang and Lin, 2009; Arcand et al., 2012; Cecchetti and Kharroubi, 2012; Law and Singh 2014). This literature has found a non-linear relationship between finance and growth which has raised questions about the effects of aggregate credit on economic growth.

For instance, Arcand et al. (2012) studied 100 developed and developing countries and showed the existence of threshold effects in the finance–growth relationship where finance starts having negative effects on economic growth. They found that the threshold effects for countries which have large financial sectors occur when credit to the private sector reaches around 80–100% of GDP. Arcand et al. (2012, p. 10) imposed a curvature onto the estimated relationship between PSC and RGDP by adding a polynomial term for PSC in the regression. They found that the bias due to omitting this regressor is negative and increases in absolute value over time, as PSC increases.

The use of TVC models, though quite sparse in the empirical literature, has started to emerge in the recent decades. The TVC models used in the empirical literature of finance and growth include threshold and regime switching models and state space models. One of the very few studies that applied a state space model in the finance and growth nexus in Africa is Awe et al. (2015) who used a time-varying parameter dynamic linear regression model to estimate the time-varying effects of money supply on economic growth from 1960 to 2009 for Nigeria. Interestingly, the authors found that money supply has strong predictive effects on economic growth.

In the previous chapter, we used an ARDL model to investigate the effects of PSC or CBC on RGDP. Like other fixed coefficient models, the ARDL suffers from a severe limitation in that its error term and included regressors are correlated. This assumption is well described by Greene (2012) who stated that the error term of a regression is made up of the net effect of omitted variables and is uncorrelated with the included regressors (Greene, 2012, p. 12). The assumption that the error term is uncorrelated with the included regressors in fixed coefficient models leads to the estimation of direct effects[37] of a regressor on the dependent variable. In this chapter, we use a TVC estimation technique that resolves this problem by estimating the total effects of the regressor on the dependent variable.

Empirical studies for Mauritius so far have found a *positive* relationship between different measures of financial development (FD), investment and/or economic growth in the long run (see Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing, 2010; Muyambiri and Odhiambo, 2018). However, none of them measured the time-varying total effects of finance on growth. It will be recalled that in Chapter 2, we also used a fixed coefficient model to estimate the effects of FD on RGDP, and found that the effects of aggregate credit on economic growth in Mauritius are positive in the short run but *negative* in the long run. In contrast to the ARDL model in Chapter 2 which provided estimates of the direct effects of PSC or CBC on economic growth, the TVC estimation approach of Swamy and Von Zur Muehlen (2020) will provide a TVC estimation of the total effects of PSC or CBC on RGDP and hence identify the precise functional form of the relationship between finance and growth in the country. In addition, in estimating the ARDL model in Chapter 2, we had to ensure that our variables were stationary, and all our models exhibited causality from PSC or CBC to RGDP. The TVC model does not need any stationary transformations and its derivation naturally solves the problem of endogeneity, which makes it superior to existing fixed and variable coefficient models used in the global empirical literature on finance and growth (see Swamy et al., 2019a, pp. 296–301).

The broad objective of this chapter is to provide an estimate of the total effects of PSC or CBC on RGDP in each year of the sample period 1970–2019 and hence measure the precise

[37] The main problem with fixed coefficient models is that the error term is correlated with the included regressors if the error term is made up of omitted but relevant regressors. This means that the indirect effects of the included regressors on the dependent variable are incorrectly eliminated from every coefficient of the fixed coefficient model, and therefore the coefficients express only the direct effects of the regressors on the dependent variable. Models which estimate total effects, i.e. the sum of direct and indirect effects, provide total effects of the regressor on the dependent variable.

functional form of the relationship between PSC or CBC and RGDP in Mauritius. The specific issues addressed in this chapter are: (i) to measure the total effects of PSC or CBC on RGDP and assess the efficiency of aggregate credit on growth, (ii) to determine whether PSC or CBC has linear or non-linear effects on RGDP and detect if there is any threshold effects between them, (iii) To determine the indirect channels through which PSC or CBC affect RGDP and get additional insights into the relationship between credit, investment and growth in the country, and (iv) to highlight the policy implications of the findings and propose relevant policies.

The remainder of the chapter is divided into seven sections. Section 3.2 presents the major financial policies which have influenced the evolution of the relationship between PSC or CBC and RGDP in Mauritius. Section 3.3 reviews the empirical literature which has overwhelmingly used fixed coefficient models rather than TVC models. Section 3.4 presents the derivation of the empirical framework and discusses the empirical results. Section 3.5 concludes.

3.2 The evolution of financial policies in Mauritius

Since the early 1960s, the Government has been taking several measures with a view to creating a favourable investment climate and to stimulating the establishment of industries. The real impetus to the growth of this sector came with the Export Processing Zone (EPZ) which was set up in November 1970, with a view to encouraging the establishment of "export" enterprises in Mauritius (Bank of Mauritius annual report, 1974, p. 15). For this reason, from the date of its inception in 1967, the Bank of Mauritius emphasized to commercial banks the need to promote lenders that would support the development objectives of the real economy. This approach was quite similar to the "window guidance" practiced in Japan during the 1960s by which lending limits were given to commercial banks as guidelines rather than as legally binding restrictions (Werner, 2005, p. 268).

At the same time, the government provided a series of incentives at the time to promote the production of new goods in the country. For instance, the export enterprises enjoyed infrastructural facilities and were totally exempted from payment of import duty on capital goods and raw materials, and enjoyed a tax holiday for a period of 10 to 20 years. These industries include the electronic industry, toy manufacture, a diamond cutting and polishing plant and some garment producing units (Bank of Mauritius annual report, 1974, p. 15). Therefore, with a combination of the right kinds of credit policies by the monetary authority

coupled with the right kind of economic incentives by the state, national income expanded by 30% in 1973 (Bank of Mauritius annual report, 1974, p. 6). The unprecedented increase in world sugar prices which occurred in the latter half of 1974 led to an escalation of liquidity in the economy contributing to inflationary pressures (Bank of Mauritius annual report, 1975, p. 8). The monetary authority introduced a ceiling on the amount of private credit issued to the trade sector in 1973 (Bank of Mauritius annual report, 1974, p. 8).

During the mid 1970s the price of sugar on the world market started its descent and falling export revenues coupled with rising imports increased the balance of payments deficit. At the same time, high levels of public expenditure to finance excessive growth in wages and salaries led to a dire economic situation. Despite the increasingly tight monetary policy that the BOM was pursuing and the Government's control on imports of goods, the economic situation in Mauritius led to a deep economic crisis in 1979 and required the intervention of the IMF. The rupee was devalued twice against the SDR and, as part of the structural adjustment program led by the IMF in 1979 under the stand-by agreement, money supply was controlled through the control of credit from 1979 to 1986 (Fry and Roi, 1995, p. 2).

The period from 1983 to 1988 marked unprecedented rates of economic growth, leading to full employment in 1989. The credit policies put in place by the BOM allowed credit to flow to priority sectors and supported the industrial expansion of the economy. For instance, credit to priority sectors, which included sugar and other agricultural interests, exports sectors, industries and manufacturers, absorbed more than 50% of the increase in total credit to the private sector in 1984 (Bank of Mauritius annual report, 1984, p. 21). However, credit allocation alone was not sufficient for sustained economic growth. The high rates of growth have been a combination of factors which, in the words of Svirydzenka and Petri (2014, p. 82) have been a well-managed Export Processing Zone, conducting diplomacy regarding trade preferences, spending on education, avoiding currency overvaluation, and facilitating business.

The performance of the Mauritian economy in 1989 reflected a watershed in its process of development as the period of exceptionally high rates of economic growth, engineered by the rapid expansion of the manufacturing sector: in particular the EPZ, itself based on the absorption of unemployed labour, came to an end (Bank of Mauritius annual report, 1990, p. 6). During the early 1990s, many proponents of financial liberalization in Mauritius, such as Fry and Roi (1995), argued that low interest rates failed to mobilize savings which were needed to spur the economic growth of developing countries. The shift to a more market-

based system became inevitable and the years 1991–92 were a landmark in terms of the introduction of new financial and monetary policy reforms in Mauritius. The monetary policy reforms initiated in the 1990s marked a major departure from the system of direct monetary control *to an indirect method of monetary control, mainly through open market operations which replaced domestic credit as the main policy instrument* (Fry and Roi, 1995, p. 7).

Fry and Roi (1995) explained that the first sign to the market transition came in November 1991 with the introduction of Treasury Bills auctions. The second step was the abolition of credit ceilings for priority and non-priority sectors in 1992 and 1993 respectively. In 1994, a secondary market cell was set up at the BOM, and open market operations (OMO) targeted the bank rate which was then linked to the average T-Bill rate. Thus, OMO replaced domestic credit as the most active policy instrument. However, as in many emerging market countries, Mauritius' secondary government bond market was relatively illiquid and underdeveloped. Therefore, the BOM could not easily target short-term interest rates directly through open market operations. In the wake of the Asian crisis of 1998, a thin bond market was a weak channel to influence the bank rate and it took the Central Bank various interventions in the market to signal its monetary policy stance.

After the East Asian crisis in 1999, the Bank of Mauritius introduced the Lombard Rate (interest rate which commercial banks paid for using the Lombard Facility) as the key interest rate for monetary policy. In December 2006, the Repo Rate replaced the Lombard Rate as the policy rate to signal changes in the monetary policy of the BOM. In response to changing economic circumstances of subdued inflation and slow growth, the BOM aggressively cut the Repo rate from 2008 to 2019 in an attempt to stimulate private investment and growth. Table 3.1 summarizes a selection of financial policies which have been implemented in Mauritius from 1967 to 2019.

Table 3.1: A selection of financial policies

1967	Creation of the Bank of Mauritius
1970	Expansionary monetary policy with the use of bank rate and export concessionary finance
1972	End of expansionary monetary policy pursued since 1969
1973	Introduction of a credit ceiling on the expansion of credit to the trade sector (categorized as a non-priority sector)
1976	Continued restraint on the expansion of credit due to inflationary pressures
1979	Removal of overall credit ceiling but credit ceiling to traders maintained
1979	IMF stand by agreement to address the balance of payments crisis
1979	Devaluation of the rupee by 22.9% against the SDR to foster export growth
1979	Under the standby agreement 15% limit set to the expansion of credit to the government and private sector

1981	Devaluation of the rupee by 16.7% against the SDR to limit imports
1983	The rupee is delinked to the SDR and is linked to a trade-weighted basket of currencies
1984	Credit to the priority sectors (sugar and other agricultural interests, export sectors, industries and manufacturers) absorbed more than 50% of the increase in total credit to the private sector
1986	Liberalization of exchange rate controls on current and capital account transactions
1987	Credit to the private sector grew by 18.9% and credit policies made less restrictive to support the current industrial expansion in a non-inflationary environment
1988	Liberalization of interest rates
1989	Credit to the priority sectors accounted for 64.9% of the overall increase in credit to the private sector
1989	Creation of the Stock Exchange of Mauritius
1989	The Banking Act 1971 replaced by the Banking Act 1988, providing a more modern legal framework to promote a sound domestic banking system and the development of a reputable offshore sector
1991	Rate of interest on 3-month Treasury Bills raised from 11.5% to 11.625% to control inflationary pressures
1991	Auctioning of Treasury Bills
1992	Abolition of credit ceilings to priority sectors
1993	Abolition of credit to non-priority sectors
1994	Setting up of a secondary market cell at the Bank of Mauritius
1994	Liberalization of capital controls and adoption of the managed exchange rate system
1995	Bank rate linked to overall yield on Treasury Bills at the most recent auction
1996	Abolition of credit to deposit ratio
1996	Setting up of an informal inflation target of 8% per annum (p.a.) for 1996–1997
1997	Inflation target for the year 1996–1997 achieved at 7.9% p.a.
1998	Inflation target for 1998 set at 6% and achieved with an actual rate of 5.4% for the year
1998	Issue of 728-day Treasury Bills
1999	Introduction of reverse REPO operations
1999	Introduction of Lombard facility and the Lombard rate
2000	Lombard rate raised from 11.5% to 12.5% p.a. to stem off inflationary pressures
2001	Inflation target set in the range of 5% to 5.5% p.a. and achieved with actual rate of inflation at 4.4% p.a.
2002	Primary dealer system introduced to boost activity in the secondary market
2003	Lombard rate reduced by 125 basis points against the backdrop of global economic slowdown
2004	Bank of Mauritus Act (2004) voted in parliament in which the primary objectives of the BOM become price stability and the promotion of orderly and balanced economic development
2004	The Bank of Mauritius Act (2004) provides for the integration of domestic and offshore banking business
2005	Lombard rate raised from 9.5% to 10% p.a. to stem off inflationary pressures due to rising oil prices
2006	Introduction of the Repo rate to replace the Lombard rate as the main policy instrument
2007	Repo rate raised to 9.25% in July 2007
2008	Repo rate decreased from 9.25% to 8% in May 2008 in the wake of projected economic slowdown due to the Global Financial Crisis (GFC)
2009	Complementarity of fiscal policies and monetary policies with the introduction of a fiscal stimulus package by the government and a series of cuts in the Repo rate from 8% to 5.75% in March 2009
2010	Repo rate reduced to 4.75% in September 2010 due to downside risks to economic growth
2013	Repo rate reduced to 4.65% in June 2013 against the backdrop of weak global economic conditions
2016	Repo rate reduced to 4% in July 2016 due to downside risks to the growth outlook
2017	Repo rate reduced to 3.5% in September 2017 due to projected slow growth
2019	Repo rate reduced to 3.35% in August 2019 due to global economic slowdown

Source: Author's own compilation from various issues of the Bank of Mauritius Annual Report from 1st July to 30th June the following year

Despite the aggressive cuts in interest rates, the growth in private investment and economic growth has remained sluggish in Mauritius during the past three decades. Figure 3.1 shows the reduction in interest rates and vagaries of private investment and real GDP growth in Mauritius from the 1990s. In fact, from 2007 there has been a major decline in the growth of credit, investment and economic growth, which suggests that the GFC could have contributed to the decline in the growth rate of these variables.

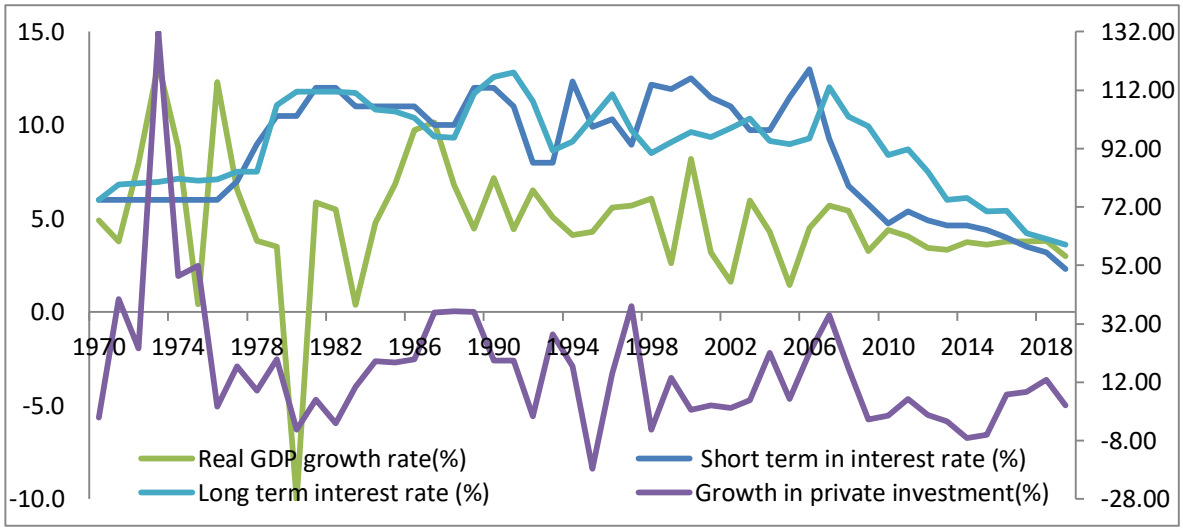

Figure 3.1: Real GDP growth, short-term interest rate and long-term interest rate (left-axis) and growth in private investment (right-axis) from 1970 to 2019

Source: Author's compilation using data from Bank of Mauritius and Statistics Mauritius

It can also be seen from Table 3.1 that from its inception the BOM has on numerous occasions resorted to promoting credit expansion to priority areas, for instance in 1974, 1984, 1987 and 1989. These credit policies coupled with other sound macroeconomic policies such as the promotion of an EPZ, conducting diplomacy regarding trade preferences, and business facilitation led to a positive feedback effect between credit, investment and growth. However, as is evident from Table 3.1, the monitoring of the quantity and quality of bank credit by the BOM took a back seat from 1993. After the abolition of credit ceilings in 1993, the next three decades witnessed major changes in the behaviour of the growth in private sector credit, commercial bank credit, private investment and economic growth. Figure 3.2 shows that from

the mid to late 1990s, there was a notable decline in the the growth in credit, investment and economic growth in the country.

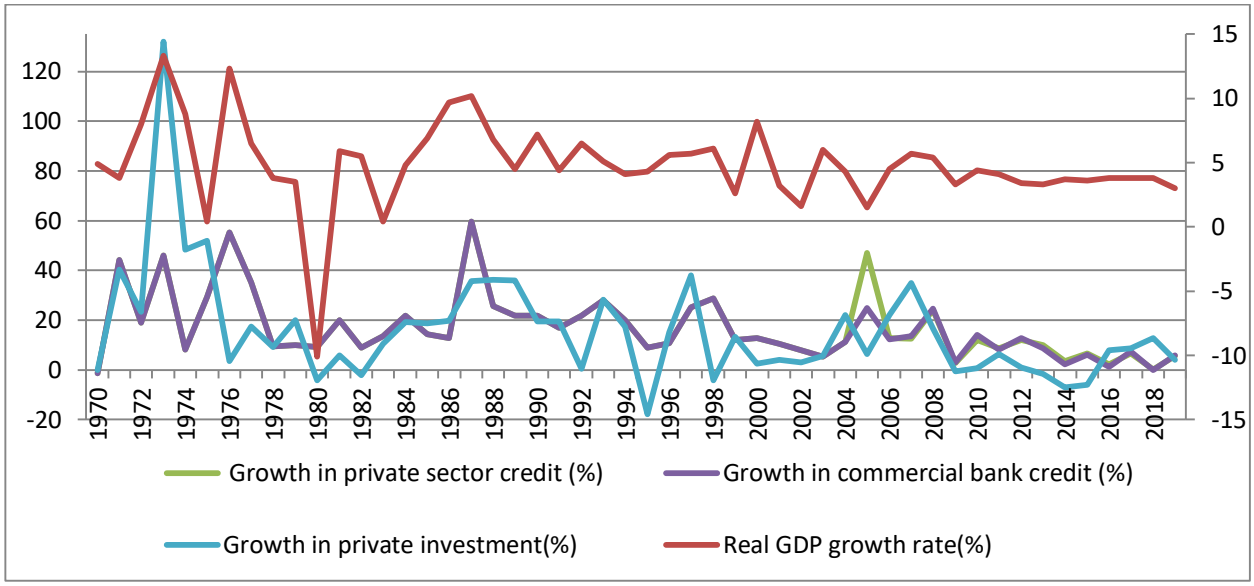

Figure 3.2: Growth in private investment to GDP (left-axis) and Growth in real GDP, Growth in private sector credit to GDP and Growth in commercial bank credit to GDP (right-axis) from 1970 to 2019

Source: Author's compilation using data from Bank of Mauritius and Statistics Mauritius

3.3 Empirical literature review

In this section, we provide a discussion of more recent literature where fixed coefficient models and TVC models have been used and found time-varying and/or non-linear effects of finance on growth (see Deidda and Fattouh, 2002; Huang and Lin, 2009; Arcand et al., 2012; Cecchetti and Kharroubi, 2012; Law and Singh, 2014; Awe et al., 2015).

The more recent empirical literature has used fixed coefficient models and found that very high levels of credit to the private sector leads to non-linear effects on economic growth (see Arcand et al., 2012, 2015; Cecchetti and Kharroubi, 2012, 2013; Law and Singh, 2014). Arcand et al. (2012) described the vanishing effects of finance on growth and suggested that financial deepening starts having negative effects on economic growth when credit to the private sector reaches a threshold of around 100% of GDP. The authors concluded that it is plausible that the relationship between finance and growth depends on whether lending is used to finance productive investment or speculative transactions. Cecchetti and Kharroubi (2012) showed that the level of financial development as measured by credit to the private sector is good up only to about 90%, after which it becomes a drag on economic growth.

Their study, which focused on 50 developed and emerging economies from 1980 to 2009, showed that the rise in credit to the private sector is detrimental to aggregate productivity growth[38].

Arcand et al. (2012) and Cecchetti and Kharroubi (2012) captured the dynamic relationship between credit to the private sector and RGDP by imposing a curvature onto the estimated relationship between the two variables. Both the authors added a polynomial term for credit to the private sector in their regression. The authors argued that the relationship is quadratic and that many econometric models are misspecified because they generally assume a linear relationship which fails to capture the vanishing effects. Arcand et al. (2012) suggested that there is a threshold (80% to 100%) above which finance starts to have negative effects on output growth. However, Arcand et al. (2012) did not estimate the total effects of credit to the private sector on RGDP but assumed that the square of the regressor included in their regression was the only regressor omitted from it. They found that the bias due to omitting this regressor was negative and increased in absolute value over time, as credit to the private sector increased. Arcand et al.'s (2012) reasoning was based on the linear relationship $y_t = x_t\alpha + u_t$ where x_t represents financial depth, y_t represents economic growth, and the least squares estimate of α is biased because of the omitted regressor, x_t^2. However, u_t is made up of all relevant omitted regressors and is correlated with x_t, and fixed coefficient models ignore this correlation.

In terms of TVC models which estimate the effects of finance on growth, Deidda and Fattouh (2002) estimated a threshold regression[39] using cross-country data for 119 developed and developing countries from 1960 to 1989 and found a non-linear relationship between finance and growth. The authors showed that in low-income countries, the relationship between

[38] In a more recent paper, Cecchetti and Kharroubi (2019) attempted to examine the relationship between credit growth and real economic growth for 17 advanced countries from 2000 to 2008. They found that, unlike Cecchetti and Kharroubi (2012) where the level relationship where finance is good before turning bad, in this study their results unambiguously showed that the faster the growth in credit, the worse it is for real output per worker growth. They argued that this is mainly because the faster the growth in credit, the safer and less productive the projects that are undertaken, and the slower the real economy grow. However, the authors still did not consider the fact that the change in the composition of credit could explain the weaker effect of credit growth on economic growth. Indeed, a large amount of bank credit today in advanced economies finances the acquisition of existing real estate and not the funding of new capital investment. Turner (2016) argued that it is clear that credit to finance investment in non-real estate assets accounts for no more than 14% of the UK total, and the same broad pattern is found across the advanced economies and increasingly in emerging ones (Turner 2016, p. 62). In the next chapter, we investigate the change in the composition of credit as a potential explanation for the weaker effect of bank credit on economic growth.

[39] It is appropriate to mention that threshold regression models are not time-varying coefficient models per se but given that the regression parameters switch between thresholds we treat them broadly as such.

financial depth and economic growth is not significant. This is reflected in the coefficient on financial depth which is highly significant for the high-income group but insignificant for the low-income group. The authors concluded that this evidence was consistent with the non-monotonic relationship implied by the model.

Huang and Lin (2009) attempted to improve the estimation method of Deidda and Fattouh (2002) by using an instrumental variable threshold regression to estimate the effects of finance on growth for a sample of 71 developed and developing countries from 1960 to 1995. In fact, Huang and Lin (2009) argue that the conclusions reached by Deidda and Fattouh (2002) might be spurious since the variable finance is likely to be endogenous rather than exogenous, and thus not all explanatory variables are uncorrelated with the error term. To deal with the endogeneity problem and account for the non-linearity, Huang and Lin (2009) implemented a threshold regression with instrumental variables e.g. legal origins (Huang and Lin, 2009, p. 6). Using initial (1960) real GDP per capita as a threshold variable, the results show a significant income threshold effects in the growth regressions. Countries with initial (1960) real per capita GDP above or equal to the estimated thresholds are classified as high-income countries and others are classified as low-income countries.

However, the threshold model used by Huang and Lin (2009) provided only threshold estimates based on the initial per capita GDP and ignored the time path of the effects of the coefficient of the regressor on the dependent variable in each year of the sample period. It is appropriate to mention that the threshold regression instrumental variables approach of Huang and Lin (2009) does not solve the endogeneity problem of Deidda and Fattouh (2002). In fact, there are serious problems with the use of instrumental-variable based techniques because the error term is correlated with the explanatory variables. A valid instrument must be uncorrelated with the errors in an equation, that is, it must be exogeneous and correlated with the explanatory variable.

Law and Singh (2014) used a threshold regime switching model for 87 countries from 1980 to 2010 and found that the threshold effects occur when credit to the private sector reaches about 88% of GDP. When FD is below the threshold finance level it has positive effects on growth. However, after the threshold level, higher FD will lead to negative effects on growth. The finding indicates that the private sector credit threshold level is 88% of GDP and close to the finding of Cecchetti and Kharroubi (2012). Law and Singh (2014) concluded that more finance is not necessarily good for economic growth and highlighted that an ‘optimal’ level of financial development is more crucial in facilitating economic growth.

A new category of TVC models known as state space models has emerged in the past two decades (see West and Harrison, 1997; Durbin and Koopman, 2001; Chan, 2002). One of the few studies that applied a state space model in the finance and growth nexus in Africa is Awe et al. (2015) who used a time-varying parameter dynamic linear regression model to estimate the time-varying effects of money supply on economic growth for each year of the sample period from 1960 to 2009 in Nigeria. The time-varying parameters were sampled via the Markov chain Monte Carlo method which showed stability and fast convergence. In the model estimation and analysis, the authors found that the economic indicator that best predicts GDP along with money supply is capital expenditure for the period under consideration (Awe et al., 2015, p. 90). Table 3.2 below summarizes the time-varying and non-linear studies on the effects of financial development on economic growth as discussed in this section.

Table 3.2 shows that several attempts have been made in the empirical literature to estimate the time-varying and/or non-linear relationship between finance and growth using a polynomial in the form of a square of private sector credit, or threshold regressions, or state space models. The upshot is that, similar to the fixed coefficient models of Arcand et al. (2012) and Cecchetti and Kharroubi (2012), the variable coefficient models of Deidda and Fattouh (2002), Huang and Lin (2009), Law and Singh (2014) and Awe et al. (2015) also ignored the correlation of the error term with the included regressors, which highlights the fact that both fixed and variable coefficient models are plagued with the same econometric problems.

Table 3.2: Time-varying and non-linear studies of the effects of financial development on economic growth

Study	Sample	Estimation Methods	Main Measures of FD	Main Findings
Deidda and Fattouh (2002)	119 developed and developing countries, 1960–1989	Cross-section analysis using threshold regression. Initial income per capita is used as the threshold variable.	Liquid liabilities to GDP	The model without threshold effects shows a positive relationship between financial depth and economic growth for high-income countries. In low-income countries, there is no significant relationship between financial depth and economic growth. This can be seen from the coefficient on financial depth which is insignificant in the first regime (low-income group).
Huang and Lin (2009)	71 developed and developing countries, 1960–1995	Instrumental variable threshold regression. Initial income per capita is used as the threshold variable. Legal origins are used as instrumental variables.	Liquid liabilities to GDP and Private sector credit to GDP	There are positive non-linear effects of finance on growth and the positive effects are larger for low-income countries than for high-income countries. Given that law enforcement is correlated with legal origins and is more heterogenous among low-income countries, the stronger positive effects of finance on growth for low-income countries may be driven by the differential effects of law enforcement.
Cecchetti and Kharroubi (2012)	50 developed and emerging economies, 1980–2009	Cross-section and Panel regression analysis using five year averages. The square of the FD measure is used to estimate the parabolic relationship between finance and growth.	Private sector credit to GDP	There is a non-linear relationship between finance and growth. The peak of the parabola suggests that for private credit extended by banks the turning point is close to 90% of GDP. After this point, private sector credit reduces economic growth. Therefore, the results show that financial sector growth eventually becomes a drag on productivity growth and economic performance.
Arcand et al. (2012)	100 developed and developing countries, 1960–2010	Cross-section and Panel regressions. The square of private sector credit is used to test the "too much finance" hypothesis.	Private sector credit to GDP	There is non-linear relationship between finance and growth. When private sector credit to GDP reaches 100%, it starts to have negative effects on growth. The results are consistent with the "vanishing effects" of financial development on economic growth. The "vanishing effects" are not driven by output volatility, banking crises, low institutional quality, or by differences in bank regulation and supervision.
Law and Singh (2014)	87 developed and developing countries, 1980–2010	Dynamic panel threshold technique with regime switching. The level of FD is the threshold variable that is used to split the sample into regimes.	Liquid liabilities to GDP and Private sector credit to GDP	When FD is below the threshold finance level it has positive effects on growth. However, after the threshold level, higher FD will lead to negative effects on growth. The finding indicates that the private sector credit threshold level is close to 88% of GDP. The authors argue that there is an "optimal" level of financial development and that the efficient allocation of credit for productive purposes is important in ensuring the effectiveness of finance for growth.
Awe et al. (2015)	Nigeria, 1960–2009	State space model with time-varying parameters to analyse the economic relationship between key economic indicators such as money supply and GDP.	Annual money supply	The economic indicator that best predicts GDP along with money supply is capital expenditure for the period 1960 to 2009. In comparison the lending rate, exchange rate, T-bill rate and external debt level performed relatively poorly in predicting GDP. The findings show that policy makers in Nigeria should embrace policies that will encourage private sector investment in sectors such as agriculture and manufacturing.

Source: Author's own compilation

In that respect, the TVC estimation technique of Swamy and Von Zur Muehlen (2020) that we use in this chapter is superior to all existing models because it does not ignore the correlation between the error term and the explanatory variables (and hence the indirect effects) but instead estimates the total effects of the regressor on the dependent variable. The fixed and TVC models used in the empirical literature of finance and growth suffer from a deeply ingrained assumption in econometrics, as made by Greene (2012, p. 12) who stated that the error term of a regression is made up of the net effect of omitted variables and is uncorrelated with the included regressors. Pratt and Schlaifer (1984, pp. 9–12) showed that the error term of each equation is typically made up of omitted relevant regressors that cannot be proved to be uncorrelated with the included variables. The correlations between the included regressors and each omitted relevant regressor lead to indirect effects when the error term is made up of omitted relevant regressors.

Pratt and Schlaifer (1984, pp. 9–12) developed a different approach to econometric model building by defining a class of relations called "laws" and discussing the conditions under which these can be observed in data. In particular, for building meaningful econometric equations, they distinguished between deterministic and stochastic law, emphasizing that a deterministic law contains the full set of relevant regressors, some of which are included and others excluded, and a stochastic law that relates the vector of all omitted relevant regressors to the vector of all included regressors plus a vector of errors. In the next section, we show how Swamy used a deterministic law to write an equation with the full set of regressors[40] and a stochastic law to tackle endogeneity issues which plague conventional econometrics[41].

The TVC estimation technique of Swamy and Von Zur Muehlen (2020) is also ideal for Mauritius because the effects of changing financial policies on the relationship between finance and economic growth may not be constant. Hence, the estimation of time-varying parameters which measure the total effects of finance on growth for each year of the sample period provides a more accurate depiction of the evolution of the relationship between the two variables. Existing empirical studies in Mauritius have used fixed coefficient models (see Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010; Muyambiri and

[40] Swamy has personally guided the author to present this approach in this chapter.

[41] For an extensive discussion on the state of econometrics, see Swamy et al. (2019b). In a nutshell, Swamy solves the endogeneity problem by introducing a stochastic equation that helps to make the included regressors independent of the error term. As for the issue of non-stationarity, the TVC equation depends on the time-varying parameter, and therefore differencing it a number of times will not make the variables stationary. Therefore, we do not difference the data. The coefficient drivers (which we shall explain later) have been introduced by Swamy and provide the extra information needed to solve the problem of non-stationarity.

Odhiambo, 2018) and hence ignored the fact that the relationship between finance and growth might have changed over time because of different financial policies adopted in the country. These studies have also ignored the fact that the error term in their model is correlated with the regressors and hence their fixed coefficient estimates provide only estimates of the direct effects of measures of financial development on economic growth.

3.4 Empirical framework[42]

This chapter uses the TVC estimation approach of Swamy and Von Zur Muehlen (2020) to investigate the relationship between finance and growth in Mauritius as it takes into account four important realities in building up a good econometric model. Chang et al. (2000, p.105) summarized these four realities as (i) the true economic relationships are unknown; (ii) at least one unidentified explanatory variable is excluded from every model; (iii) it is either meaningless or false to assume that the unidentified excluded explanatory variables are uncorrelated with the included explanatory variables in any model; and (iv) most economic data contain errors of measurement. The authors argue that because of these difficulties, a valid joint solution to the fundamental problems of unknown functional forms, omitted variables, correlations between error terms and explanatory variables and measurement errors is needed.

According to Hall et al. (2010, p. 1339), Swamy has made a singular contribution to econometrics by originating and developing an estimation procedure that deals with all these fundamental problems simultaneously. This procedure had its beginnings in Swamy's 1971 book *Statistical Inference in Random Coefficient Regression Models*, his 1970 paper "Efficient Inference in a Random Coefficient Regression Model", and Chapter 5, "Linear Models with Random Coefficients" published in *Frontiers in Econometrics*. Under the random coefficient method of Swamy, the coefficients of a regression model are allowed to fluctuate freely, with respect to both time and cross-section, so that the empirical specification passes through each data point. Subsequently, Swamy extended and generalized this technique so that it deals simultaneously with the four major problems of econometrics mentioned above. First, the TVC method proposed by Swamy handles the fact that the true economic relationships are unknown. In this case, any particular functional form we specify may actually be incorrect. The functional form of the TVC equation represents a rich class in

[42] The empirical framework in this section has its origins in a series of papers from Swamy and his co-authors (see Swamy, 1970; Swamy and Tinsley, 1980; Swamy et al., 2003; Swamy et al., 2014; Swamy et al., 2019a; Swamy et al., 2019c; Swamy and Von Zur Muelhen, 2020). Note that this list is not exhaustive. In our discussion, we refer mainly to Swamy et al. (2019a) and Swamy and Von Zur Muelhen (2020).

that variations in its coefficients can embed an infinite class of nonlinear functional forms, defined by a linear-in-variables model, that cover the true functional form as a special case (Hall et al. 2010 p. 1339). The solution to the unknown functional form problem is to work with the deterministic law with TVCs.

Second, at least one unidentified explanatory variable is excluded from every model. Therefore, the TVC model specifies a stochastic law and a deterministic law containing the full set of regressors including the excluded variables (see Swamy et al., 2019a, pp. 302–303).

Third, Pratt and Schlaifer (1984, p. 14) proved that it is either meaningless or false to assume that the unidentified excluded explanatory variables are uncorrelated with the included explanatory variables in any model. Because of this, the TVC model assumes that the included regressors in a deterministic law are correlated with its omitted regressors (see Pratt and Schlaifer (1984, p. 13).

Fourth, most economic data contain errors of measurement. In all the models, Swamy methodology includes measurement errors (see Swamy et al., 2019a, p. 303).

Swamy and Von Zur Muehlen (2020, p. 4) began by noting Zellner's enthusiastic advocacy of Feigl's definition of causality as "predictability according to a law or set of laws" which the authors considered to be a fundamental principle that should guide all of econometrics. In conformance with this definition, we define the class of relations between y_t and x_{1t} as the following law:

A Law

Consider a sequence of observations on the X_1 's and Y's. Pratt and Schlaifer (1988, p. 35) argue that Y is related to X_1 by a law if (i) for every value x_1 of X_{1t} there exists an identically and independently distributed (i.i.d.) sequence $\{U_{x_1t}\}$, and (ii) there exists a function f which on the tth observation associates to every possible value x_1 of X_{1t} a random variable. Therefore, we can write:

$$Y_{x_1t} = f(x_1, U_{x_1t}) \qquad \ldots(3.1)$$

The values u_{x_1t} of the U_{x_1t} and the corresponding values $y_{x_1t} = f(x_1, u_{x_1t})$ of the Y_{x_1t} that are defined for every x_1 on every observation t are called "potential values". In reference to

Rubin (1978), Swamy and Von Zur Muehlen (2020, p. 4) argued that it is wrong not to use appropriate potential values to state laws. Therefore, the potential values are used to state laws and the conditions for observability of laws. The only ones that will be realized on any one observation *t* are the pair (y_t, x_{1t}) corresponding to the one realized value x_{1t} of X_{1t}. In reference to Pratt and Schlaifer (1984), Swamy and Von Zur Muehlen (2020, p. 4) argued that (i) it is the existence of these potential values that distinguishes a law from statistical correlation, and (ii) it is only in terms of these potential values that it is possible to state the condition under which the law in Equation (3.1) can be observed in data.

Since the function *f* in (1) is unknown, Swamy and Von Zur Muehlen (2020, p. 4) used a deterministic law to write an equation with a full set of regressors:

A Deterministic Law:

$$y_t = \alpha_{0t} + x_{1t}\alpha_{1t} + \sum_{\ell=1}^{L} w_{\ell t}\omega_{\ell t} \qquad \ldots(3.2)$$

where the dependent variable y_t and the included regressor x_{1t} are the only observed variables in the sense that we have data on them, the first L_1 of L $w_{\ell t}$'s represents all omitted relevant regressors, the remaining L - L_1 = L_2 of L $w_{\ell t}$'s represent all omitted relevant pre-existing conditions and an assumption is made that L_1 and L_2 are unknown. Unknown L allows the authors to avoid leaving any omitted relevant regressor or any omitted relevant pre-existing condition unaccounted for. Swamy et al. (2019c) argued that controlling for all relevant pre-existing conditions also eliminates the spurious effects of an included regressor on the dependent variable if the included regressor is irrelevant. Furthermore, in Equation (3.2), α_{0t} is the intercept, α_{1t} is the coefficient of x_{1t}, and $\omega_{\ell t}$ is the coefficient of $w_{\ell t}$. Equation (3.2) is written with the full set of regressors and its coefficients are time-varying so that they can define a flexible functional form *f* in terms of potential value notation in $Y_{x_1 t}$ = $f(x_1, U_{x_1 t})$ shown in Equation (3.1). The authors noted that this is the only way to avoid misspecifications of the true functional form of Equation (3.2) when it is unknown.[43] Swamy et al. (2019a) called this functional form "linear in variables and nonlinear in coefficients" (see Swamy et al., 2019a, p. 298). The coefficients of Equation (3.2) represent direct effects.

[43] When its true functional form is unknown, any particular functional form for the non-linear relationship in (2) can be misspecified.

In the next stage, Swamy and Von Zur Muehlen (2020, p. 4) used a stochastic law to obtain a model with the total effects of a regressor on the dependent variable.

A Stochastic Law:

$$w_{\ell t} = \lambda_{0\ell t} + x_{1t}\lambda_{1\ell t} \text{ For } \ell = 1, \ldots, L \qquad \ldots(3.3)$$

where $\lambda_{0\ell t}$ is treated as the error term. To remove any spurious correlations that Equation (3.2) may imply, following Skyrms (1988, pp. 53–68), Swamy and Von Zur Muehlen (2020) controlled all relevant pre-existing conditions using Equation (3.3). Equation 3.3 is also used to eliminate the simultaneity problem with Equation (3.2). Pratt and Schlaifer (1984) proved that the included regressor x_{1t} cannot be independent of every omitted regressor in Equation (3.2), therefore there is a simultaneity problem with Equation (3.2). To solve this problem, the right-hand side of Equation (3.3) is inserted in Equation (3.2), which gives the time-varying coefficient (TVC) model below:

$$y_t = \gamma_{0t} + x_{1t}\gamma_{1t} = \boldsymbol{x}_t'\boldsymbol{\gamma}_t \qquad \ldots(3.4)$$

where $\boldsymbol{x}_t' = (x_{0t} \equiv 1 \ \forall \text{ t}, \ x_{1t})$ is the vector of included regressors. Note that $\boldsymbol{\gamma}_t = (\gamma_{0t}, \gamma_{1t})'$, $\boldsymbol{\gamma}_t$ is a 2×1 column vector whose elements are the coefficients of Equation (3.4). The derivation of Equation (3.4) from Equations (3.2) and (3.3) shows that (i) $\gamma_{0t} = \alpha_{0t} + \sum_{\ell=1}^{L} \lambda_{0\ell t}\omega_{\ell t}$, (ii) the term α_{0t} is the intercept of the deterministic law in Equation (3.2), (iii) $\sum_{\ell=1}^{L} \lambda_{0\ell t}\omega_{\ell t}$ is the error term which is the joint effects of the *remainders* ($\lambda_{0\ell t}$'s) of the $w_{\ell t}$'s after the effects $x_{1t}\lambda_{1\ell t}$ of the included regressor x_{1t} on each $w_{\ell t}$ have been subtracted out.

(iv) $\gamma_{1t} = \alpha_{1t} + \sum_{\ell=1}^{L} \lambda_{1\ell t}\omega_{\ell t}$ is the total effects of the included regressor x_{1t} on y_t, (v) the term α_{1t} represents the direct effects, and (vi) the term $\sum_{\ell=1}^{L} \lambda_{1\ell t}\omega_{\ell t}$ represents the indirect effects due to the effect of x_{1t} on every omitted relevant regressor which appears in Equation (3.3), and every omitted relevant regressor in turn affects y_t which appears in Equation (3.2). Note that even though the included regressor taking the value x_{1t} cannot be uncorrelated with every omitted variable taking the value $w_{\ell t}$ in Equation (3.2), it can be uncorrelated with the

remainder $\lambda_{0\ell t}$ of every such variable (Pratt and Schlaifer, 1988, p. 34). Thus, the included regressors of Equation (3.3) are independent of its error term and there is no endogeneity problem associated with it. Consequently, in Equation (3.4) the included regressor taking the value x_{1t} is independent with the variable taking the value $\sum_{\ell=1}^{L} \lambda_{0\ell t}\omega_{\ell t}$. This gives an advantage to Equation (3.4) over Equation (3.2).

Another advantage of Equation (3.4) is that the series having the realizations y_t and x_{1t} can be non stationary.[44] (see Appendix 5 for a description of how the TVC model solves the problem of non-stationarity).

Swamy and Von Zur Muehlen (2020, p. 5) highlighted the fact that Equation (3.2) with linear functional form is a typical econometric model usually written as:

$$y_t = \alpha_0 + x_{1t}\alpha_1 + \varepsilon_t \qquad \ldots(3.2a)$$

where the error term $\varepsilon_t = \sum_{\ell=1}^{L} w_{\ell t}\omega_{\ell}$ is made up of omitted relevant regressors and is correlated with x_{1t}. The coefficient α_1 does not measure the total effects of x_{1t} on y_t but only measures the direct effects of x_{1t} on y_t. It is important to note the difference in interpretations of the coefficients of Equations (3.4) and (3.2a). Swamy et al. (2019a, pp. 294–295) proved that model (3.2a) gives incorrect inferences.

Pratt and Schlaifer (1984, p. 13) clarified the point that when omitted regressors are not identified, as they usually are, there exists no meaningful distinction between direct and indirect effects. In this case, one can estimate the total effects γ_{1t} and does not depend on the omitted regressors used to define direct and indirect effects. Note the difference between the error term of Equation (3.2) and that of Equation (3.4). The error term $\sum_{\ell=1}^{L} w_{\ell t}\omega_{\ell t}$ of Equation (3.2) is made up of all omitted relevant regressors and all omitted relevant pre-existing conditions, and the included regressor of Equation (3.2) cannot be uncorrelated with every

[44] The process $\Delta y_t = x_t' \Delta\gamma_t + \Delta x_t' \gamma_{t-1}$, is non-stationary. This is because the mean and variance of any variables of the process $\Delta y_t = x_t' \Delta\gamma_t + \Delta x_t' \gamma_{t-1}$, if they exist, are not constants and the covariance between any two variables of the same process, if it exists, depends on the time parameter. From the equation, $\Delta y_t = x_t' \Delta\gamma_t + \Delta x_t' \gamma_{t-1}$ it follows that differencing y_t any number of times does not make it stationary. Therefore, we do not difference the data. The appropriate coefficient drivers which we use below provide extra information that is needed to solve the problem of non-stationarity.

omitted relevant regressor that affects y_t. In contrast, the error term $\sum_{\ell=1}^{L}\lambda_{0\ell t}\omega_{\ell t}$ of Equation (3.4) is made up of certain "sufficient sets" of omitted relevant regressors[45] and the included regressor of Equation (3.2) can be independent of that error term (see Swamy et al., 2019a, p. 299).

3.4.1 Introducing coefficient drivers

From Equation (3.4), the random variable X_{1t} is the cause and the random variable $\tilde{\gamma}_t$ is the effect. The cause and effect relationship implies that $\tilde{\gamma}_t$ is correlated with the included regressors ($X_{0t} \equiv 1 \ \forall$ t, X_{1t}). This means that because of this correlation Equation (3.4) cannot coincide with Equation (3.1), and therefore, consistent estimation of the coefficients of Equation (3.4) is only possible if this correlation is removed. In this respect, Swamy and Von Zur Muehlen (2020, p. 5) introduced Equations (3.5) and (3.6) and made assumption (3.7).

Assume that the coefficient vector $\boldsymbol{\gamma}_t = (\gamma_{0t}, \gamma_{1t})'$ of (4) satisfies the following equation:

$$\boldsymbol{\gamma}_t = \Pi \boldsymbol{z}_t + \boldsymbol{u}_t \qquad \ldots(3.5)$$

where Π is a $2 \times$ p (non-null) matrix of coefficients, $\boldsymbol{z}_t$ is the p-vector of observable variables which are called "coefficient drivers" and $\boldsymbol{u}_t = (u_{0t}, u_{1t})'$. It is not possible to know whether the $\boldsymbol{u}_t$'s are i.i.d. like the variables $U_{x_1 t}$ in Equation (3.1). Therefore, Swamy and Von Zur Muehlen (2020, p. 5) made the following assumption to arrive at Equation (3.6)[46]:

$$\boldsymbol{u}_t = \Phi \boldsymbol{u}_{t-1} + \boldsymbol{a}_t \qquad \ldots(3.6)$$

where Φ is diagonal and its diagonal elements are denoted by ϕ_{00} and ϕ_{11}, $-1 < \phi_{00} < 1$, $-1 < \phi_{11} < 1$, and $\boldsymbol{a}_t = (a_{0t}, a_{1t})'$ is a bivariate vector of values taken by white noise errors denoted by $\tilde{\boldsymbol{a}}_t$, with $\mathrm{E}\tilde{\boldsymbol{a}}_t = 0$ and $\mathrm{E}\tilde{\boldsymbol{a}}_t\tilde{\boldsymbol{a}}_{t'}' = \begin{cases} \sigma_a^2\Lambda_a & \text{if } t = t' \\ 0 & \text{if } t \neq t' \end{cases}$. The $\tilde{\boldsymbol{a}}_t$'s are like the i.i.d. variables $U_{x_1 t}$ in Equation (3.1).

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[45] The concept of "sufficient sets" of omitted regressors is due to Pratt and Schlaifer (1988, p. 34).

[46] Equation (3.6) for u_t is an autoregressive equation with two components: an autoregressive component and a random error term. Equation (3.6) is an autoregressive process on an error term.

X_{1t} in Equation (3.4) is conditionally independent of $\tilde{\gamma}_t$ given $\boldsymbol{z}_t$ …(3.7).

This assumption implies that the distributions of the elements of $\tilde{\gamma}_t$ are in fact completely determined by the value of $\boldsymbol{z}_t$, x_{1t} being redundant, once $\boldsymbol{z}_t$ is known (see Dawid 1979, p. 4). Swamy and Von Zur Muehlen (2020, p. 5), used an example of $p = 3$ and $z_t = (1, z_{it}, z_{jt})'$ which will restrict Equation (3.5) to the form:

$$\gamma_{0t} = \pi_{00} + z_{it}\,\pi_{0i} + u_{0t} \quad \ldots(3.8a)$$

$$\gamma_{1t} = \pi_{10} + z_{jt}\,\pi_{1j} + u_{1t} \quad \ldots(3.8b)$$

Swamy and Von Zur Muehlen (2020) argued that the two coefficient drivers z_{it} and z_{jt} from a longer list of coefficient drivers are appropriate if they produce significant estimates of all the four coefficients π_{00}, π_{0i}, π_{10} and π_{1j}. z_{it} and z_{jt} are the coefficient drivers to be chosen differently in different cases considered below; in any one case $z_{it} \neq z_{jt}$ but z_{it} in one case can be the same as z_{jt} in another case; in any one case, the coefficients of Equations (3.8a) and (3.8b) are considered as the nonzero elements of Π. One cannot estimate the coefficients of Equations (3.4), (3.8a) and (3.8b) unless one specifies what the coefficient drivers (z_{it}, z_{jt}) are. $\boldsymbol{u}_t = (u_{0t}, u_{1t})'$ represents the errors in the coefficients of Equation (3.4). The errors u_{0t} and u_{1t} are contemporaneously correlated and each can also be serially correlated if Φ in Equation (3.6) is not equal to zero.

In terms of the interpretations of the coefficients of Equations (3.8a) and (3.8b), γ_{0t} in Equation (3.8a) is the intercept of Equation (3.4) and z_{it} acts as its explanatory variable. γ_{1t} in Equation (3.8b) is the coefficient of regressor in Equation (3.4) and z_{jt} in Equation (3.8b) acts as its explanatory variable. When Equations (3.8a) and (3.8b) are inserted into Equation (3.4), all the terms on the right-hand side of Equation (3.8b) get multiplied by x_{1t}. Therefore, (i) π_{10} as the coefficient on x_{1t} can absorb at least part of the direct-effects component of γ_{1t} and (ii) π_{1j} becomes the coefficient on the interaction between z_{jt} and x_{1t}. Such a coefficient cannot absorb the direct-effects component of γ_{1t} but its estimate can indicate whether $z_{jt}\,\pi_{1j}$ absorbs a part of the indirect-effects component of γ_{1t}. Therefore, the estimate of the coefficient π_{1j} reveals the strength or weakness of the relationship between

the indirect-effects component of γ_{1t} and z_{jt}. If the intercept π_{10} of Equation (3.8b) does not completely absorb the direct-effects component and $z_{jt}\ \pi_{1j}$ does not completely absorb the indirect-effects component of γ_{1t}, then the term u_{1t} corrects the inaccuracies in both.

Swamy and Von Zur Muehlen (2020, p. 5) concluded the presentation of the derivation of their empirical framework by connecting the law in Equation (3.1) with the present model, which is the combination of Equations (3.4), (3.5) and (3.6). Using the condition for observability of law in Equation (3.1) given by Pratt and Schlaifer (1988, p. 31), Swamy and Von Zur Muehlen (2020, p. 5) showed that if there exists a vector ι_i of coefficient drivers such that the matrix Π in Equation (3.5) is nonzero and Equation (3.7) is satisfied, then Pratt and Schlaifer's (1988, p. 37) conditions for observability of the law in Equation (3.1) in data are satisfied, and the model in Equations (3.4) to (3.6) coincides with Equation (3.1) and Φ may not be equal to zero. When such coincidence takes place, it is correct to use the model in Equation (3.4)-(3.6) to measure the total effects of x_{1t} on y_t for the following reasons: (i) none of the generally accepted meanings of causality fail to involve the notion that causation is a real-world relation between events, as shown by Basmann (1988, p. 99), (ii) real-world relations are misspecifications-free models, and (iii) under assumption (3.7), the model in Equations (3.4)-(3.6) is free of all misspecifications because it coincides with Equation (3.1).

3.4.2 The selection of coefficient drivers

The TVC model of Swamy et al. (2019a, pp. 291–301) involves two types of relations. The first type consists of a relationship between a dependent variable and a set of regressors with time-varying coefficients, and the second type consists of a relation of each time-varying coefficient with coefficient drivers. In order to make the coefficients of a model function of variables, Swamy and Von Zur Muehlen (2020, p. 5) used the usual fixed coefficient equation and allowed γ_0 and γ_1 to vary over time. Equations (3.8a) and (3.8b) show that γ_{0t} and γ_{1t} are functions of the coefficient drivers z_{it} and z_{jt} respectively. Therefore, the coefficient driver z_{it} drives the coefficient γ_{0t} i.e. the intercept of Equation (3.4) while the coefficient driver z_{jt} drives the slope coefficient γ_{1t} of Equation (3.4).

Generally, we need to find the economic theories underlying the first type of relationships as well as those underlying the second type of relationships. The two types of relationships offer difficult but different problems. With the first type of relations, the true functional form is

unknown and this is why Swamy et al. (2019a) considered TVCs to generate a rich class of non-linear functional forms that can cover the true functional form as a special case (Swamy et al., 2019, p. 298). It is important to mention that with fixed-coefficient models, we do not know whether the specified functional forms are true. In this chapter, the first type of relationship between financial development and economic growth suggests that increases in claims on the private sector as measured by PSC_t or CBC_t improve the rate of economic growth (see Levine, 1997, 2005).

The theory in the second type of relationship between finance and growth suggests that claims on the private sector as measured by PSC_t or CBC_t, in particular to private investment (PI), has stronger effects on the rate of economic growth (see King and Levine 1993a; Pagano, 1993; Levine, 2005). However, PI is not the only indirect channel through which PSC_t or CBC_t affect economic growth. Gross Fixed Capital Formation (GFCF), Private Consumption (PC) and Exports (EXPORTS) are other indirect channels through which credit can positively affect economic growth. One can expect the indirect effects of credit on growth through imports (IMPORTS) to be negative. Therefore, for the second type of relationship, the coefficient drivers z_{jt} that will drive the slope coefficient γ_{1t} of Equation (3.4) are PI_t, GFCF_t, PC_t, $\mathrm{EXPORTS}_t$ and $\mathrm{IMPORTS}_t$. For the coefficient driver z_{it} that drives the intercept on Equation (3.4)[47], we use three other coefficient drivers as measures of openness: commodities export price index (CEXPI_t), openness of Mauritius trade (OMT_t), and real effective exchange rate (REEXR_t).

We try different permutations of the six coefficient drivers taking two at a time. We experiment with several pairs of coefficient drivers, one for each coefficient of Equation (3.4), imposing various exclusion restrictions on the elements of Π. It is important to mention that the pair of coefficient drivers (z_{it} , z_{jt}) used in Equations (3.8a) and (3.8b) is *adequate* if the following conditions are satisfied: (i) the pair (z_{it} , z_{jt}) in Equations (3.8a) and (3.8b) satisfies assumption (3.7), and (ii) the sums $\pi_{00} + z_{it}\,\pi_{0i} + u_{0t}$ and $\pi_{10} + z_{jt}\,\pi_{1j} + u_{1t}$ are exactly equal to $\alpha_{0t} + \sum_{\ell=1}^{L}\lambda_{0\ell t}\omega_{\ell t}$ and $\alpha_{1t} + \sum_{\ell=1}^{L}\lambda_{1\ell t}\omega_{\ell t}$, respectively. The

[47] Here we are less constrained by economic theory since γ_0 is the sum of the intercept of the deterministic law plus the error term.

elements of the vector $\boldsymbol{z}_t$ we consider in this study therefore are: GFCF_t, PI_t PC_t $\mathrm{EXPORTS}_t$, $\mathrm{IMPORTS}_t$, CEXPI_t, OMT_t, and REEXR_t.

3.4.3 The fixed coefficient model used in Chapter 2 and the alternative TVC model

In Chapter 2, we used a fixed coefficient model to investigate the effects of financial development (FD) on economic growth by regressing a measure of economic growth on FD which takes the form of: $y_t = \alpha_0 + x_{1t}\alpha_1 + \varepsilon_t$. This model suffers from a severe limitation in that it assumes ε_t and x_{1t} are uncorrelated. Recall that in Chapter 2 we employed the following ARDL model to estimate the effect of FD on RGDP:

$$\ln RGDP_t = \beta_0 + \beta_1 \ ln\, FD_t^* + \beta_2\, INF_t + \beta_3\, lnINV_t^* + \beta_4 \ln PRC + \beta_5 lnO_t^* + \varepsilon_t \quad \ldots(3.9)$$

The main problem with this equation is that the error term ε_t is correlated with the included regressors if ε_t is made up of omitted but relevant regressors. This means that the indirect effects of the included regressors on the dependent variable are incorrectly omitted from every coefficient of Equation (3.9) and therefore the coefficients of Equation (9) express only the direct effects of the regressors on the dependent variable. As an alternative, below we derive a TVC model which measures the total effects of the measures of FD on RGDP. According to Swamy et al. (2019a, p. 294), the total effects of the TVC model do not ignore the correlation between the error term and the included regressors. Although the estimates of GFCF and PI when included in the ARDL regression are significant and positive, there are indirect effects of PSC or CBC on GFCF and PI and the dependent variable which are ignored by the ARDL regression.

We now use the methodology of Swamy and Von Zur Muehlen (2020) to derive a new model to measure the total effects of finance on growth in Mauritius. After presenting the econometric model of the effects of finance on growth, we describe the selection criteria and estimation procedure. From Equation (3.2), the relationship between RGDP_t and PSC_t or CBC_t in Mauritius can be stated in terms of a deterministic law where y_t =RGDP_t and x_{1t} = PSC_t or CBC_t:

$$\mathrm{RGDP}_t = \alpha_{0t} + \alpha_{1t}\, \mathrm{PSC}_t\, (\mathrm{or}\, \mathrm{CBC}_t) + \sum_{\ell=1}^{L_t} \omega_{\ell t} w_{\ell t} \quad \ldots(3.10)$$

where w_{1t}, …, $w_{L_t t}$ are all the omitted but relevant regressors in the relationship between y_t and x_{1t} of interest.

Pratt and Schlaifer proved that the included regressor x_{1t} cannot be uncorrelated with every omitted regressor. This means that there is a simultaneity problem with Equation (3.10). To solve this problem, we consider the stochastic equation below:

$$w_{\ell t} = \lambda_{0\ell t} + \lambda_{1\ell t}\,\text{PSC}_t\,(\text{or}\,\text{CBC}_t),\ \ell = 1, \ldots, L_t \qquad \ldots(3.11)$$

where all the variables in Equation (3.11) including $\lambda_{0\ell t}$ and $\lambda_{1\ell t}$ are treated as random variables and Swamy et al. (2019a, p. 298) would call Equation (3.11) "a stochastic equation."

Inserting the right-hand side of Equation (3.11) for $w_{\ell t}$ in Equation (3.10) gives Equation (3.12) below:

$$\text{RGDP}_t = \alpha_{0t} + \sum_{\ell=1}^{L_t}\omega_{\ell t}\lambda_{0\ell t} + (\alpha_{1t} + \sum_{\ell=1}^{L_t}\omega_{\ell t}\lambda_{1\ell t})\,\text{PSC}_t\,(\text{or}\,\text{CBC}_t)$$

$$= \gamma_{0t} + \gamma_{1t}\,\text{PSC}_t\,(\text{or}\,\text{CBC}_t) \qquad \ldots(3.12)$$

where $\gamma_{0t} = \alpha_{0t} + \sum_{\ell=1}^{L_t}\omega_{\ell t}\lambda_{0\ell t}$ and $\gamma_{1t} = (\alpha_{1t} + \sum_{\ell=1}^{L_t}\omega_{\ell t}\lambda_{1\ell t})$.

α_{0t} is the intercept of Equation (3.10), the $\omega_{\ell t}$ are the coefficients of omitted regressors included in Equation (3.10), $\lambda_{0\ell t}$ is the *remainder* of each omitted regressor $w_{\ell t}$ obtained after the effects of $\lambda_{1\ell t}\,\text{PSC}_t\,(\text{or}\,\text{CBC}_t)$ of $\text{PSC}_t\,(\text{or}\,\text{CBC}_t)$ on $w_{\ell t}$ have been subtracted out.

α_{1t} represents the direct effects of $\text{PSC}_t\,(\text{or}\,\text{CBC}_t)$ on RGDP_t as shown by Equation (3.10), $\sum_{\ell=1}^{L_t}\omega_{\ell t}\lambda_{1\ell t}$ represents the indirect effects of $\text{PSC}_t\,(\text{or}\,\text{CBC}_t)$ on RGDP_t due to the fact that $\text{PSC}_t\,(\text{or}\,\text{CBC}_t)$ affects each omitted regressor $w_{\ell t}$ which in turn affects RGDP_t. The total effects of $\text{PSC}_t\,(\text{or}\,\text{CBC}_t)$ on RGDP_t is the sum of direct and indirect effects, it can be seen from Equations (3.10) and (3.11) that both direct and indirect effects depend on omitted regressors, while the total effects do not depend on omitted regressors. Therefore, in Equation (3.12) we estimate the total effects of PSC_t or CBC_t on RGDP_t.

The coefficients and the regressor in Equation (3.12) are correlated and hence we need to find appropriate coefficient drivers to satisfy the conditional independence assumption. The relationship in Equation (3.12) is an unusual relationship in the sense that the coefficients are varying over time, which means that γ_{0t} and γ_{1t} are the two coefficients that vary over time and they are correlated with PSC_t (or CBC_t). Therefore, with correlation it is not possible to get consistent estimates of γ_{0t} and γ_{1t}. Swamy and Von Zur Muehlen (2020, p. 5) made the assumption that γ_{0t} and γ_{1t} are conditionally independent of x_{1t} given the values of the coefficient drivers. Swamy and Von Zur Muehlen (2020, p. 5) used z_{it} as the coefficient driver for γ_{0t} and z_{jt} as the coefficient driver for γ_{1t} which is the total effects of PSC_t or CBC_t on RGDP_t over time. Therefore, γ_{0t} and γ_{1t} is made a function of z_{it} and z_{jt} respectively and are both independent of x_{1t} given the values of the coefficient drivers. To find which pair of coefficient drivers satisfy the conditional independence assumption, we use Equations (3.8a) and (3.8b) for z_{it} and z_{jt} respectively and consider different permutations of coefficient drivers, taking two at a time.

When we use coefficient drivers the selection criteria[48] to find the best models of the study are set below:

(i) For each coefficient driver z_{jt} we accept the significance of the total effects of PSC or CBC on RGDP i.e γ_{1t}. Explicitly, we accept cases that show 5% significance level of the two coefficients of γ_{1t} $\pi_{10} and \pi_{1j}$. The significance of the coefficient of z_{jt}, π_{1j}, also allows us to estimate and interpret the partial indirect effects of PSC or CBC on RGDP. If the coefficient driver z_{jt} partially drives the coefficient γ_{1t} of x_{1t} and the estimate of π_{1j} is significant, then z_{jt} gives a channel through which PSC or CBC indirectly affects RGDP.

(ii) If more than one model for each coefficient driver z_{jt} passes (i), we select the model that has the lowest U statistic[49].

[48] The selection criteria have been set after discussion with Swamy. Prof. Aziakpono discussed with Swamy to confirm the selection criteria. On 6th July 2021, Prof. Aziakpono emailed Swamy to ask that if in addition to the exclusive interpretation of the coefficients of the total effects of credit on growth measured by γ_{1t} (ignoring the significance of the coefficients of γ_{0t}) one can also separately interpret the coefficient of the partial indirect effects to identify the channels through which credit affects growth. On 7th July 2021, Swamy responded affirmatively.

In a nutshell, the steps that we follow in (i) and (ii) ensure that we fully harness the power of the TVC models and select the most appropriate models for the study.

3.4.4 The estimation procedure[50]

The estimation is carried out following the routine in SCEP. SCEP uses an iterative method to estimate the parameters, Φ, Δ_a, σ_a^2 and Π, where Φ is the diagonal and autoregressive matrix of the error Equation (3.6), $\sigma_a^2 \hat{\Delta}_a$, is the variance-covariance matrix of the errors in the gamma coefficients in the relationship between y_t and x_{1t}, and all the diagonal elements are variances and the off-diagonal elements are covariances. σ_a^2 is the scalar factor of σ_a^2 $\hat{\Delta}_a$ and Π is the matrix of the π's in Equations (3.8a) and (3.8b).

The critical point of the model estimation is the estimation of the Π matrix. The objective of SCEP is to get consistent estimates of the Π matrix. The iterative method used in SCEP requires the use of some initial values of Φ and Δ_a. When Φ and Δ_a are unknown, then SCEP allows the use of values $\Phi = 0$ and $\Delta_a = I_m$ (an identity matrix of order m) as the initial values. When $\Phi = 0$ and $\Delta_a = I_m$ it implies that we are far from what the model should be, but those initial values are used to make an initial estimate of the Π matrix. The next estimation of $\hat{\Phi}$ and $\hat{\Delta}_a$ is influenced by the π's that have been estimated and the estimated error terms are used to compute $\hat{\Phi}$ and $\hat{\Delta}_a$ for the next iteration. SCEP makes an estimate of each of these two matrices related to Equation (3.6) and hence improves the estimates of $\hat{\Phi}$ and $\hat{\Delta}_a$ in subsequent iterations in order to get better estimates of the Π matrix.

An iteratively rescaled generalized least squares (IRSGLS) method based on Paige (1979) is used to estimate all the unknown parameters and errors of the TVC model. A generalized linear least squares model is a generalization of OLS regression, which relaxes the assumption that the errors are homoscedastic and uncorrelated. Hence, given the way the error term is specified in Equation (3.6), the generalized linear least squares (GLS) technique

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[49] A model which has a U statistic that is closer to zero has better forecasting ability. See Appendix 3 for derivation and explanation of the forecasting model.

[50] For an extensive discussion of the estimation procedure, see Chang et al. (1992) who explained the efficient computation of stochastic coefficient models and the iterative algorithm that SCEP uses to estimate the parameters of the models.

is convenient. The GLS method of Paige (1979) is used in SCEP well because the matrices appearing in them are very often singular, which means that they do not have a regular inverse. The algorithm of Paige (1979) also handles the problem of rank deficiency in the matrices which often arise because the matrices do not have a full rank and consist of nonzero columns and rows. SCEP used to estimate the TVC model uses a GLS approach which was designed by Paige (1979) to produce a numerically stable algorithm for computing stochastic coefficient models[51].

3.4.5 Data and source

The study covers the period from 1970 to 2019. Similar to Chapter 2, data on REEXR comes from the European think tank the Bruegel Institute, which is available from 1963 to 2019. Data on CEXPI was obtained from the International Financial Statistics of the IMF. Data on OMT i.e. total exports plus imports (as a percentage of GDP) was retrieved from various issues of the Bank of Mauritius annual reports. Data on private consumption, gross fixed capital formation and private investment, nominal and real GDP was obtained from Statistics Mauritius. Data on liquid liabilities, and credit to the private sector by banks and non-banks was gathered from various issues of the Bank of Mauritius annual reports. Data on population was obtained from the United Nations World population prospects database.

3.4.6 Empirical results

3.4.6.1 Measuring the significance of the total effects of PSC or CBC on RGDP without coefficient drivers

First, we start with an estimation of the TVC model without coefficient drivers to measure the time-varying process of the total effects of PSC or CBC on RGDP. This exercise will allow us to know whether the relationship between PSC or CBC is linear or non-linear and will also detect if there is any threshold effects between finance and growth in Mauritius.

In Equation (3.5), we set p = 1, $\iota_t = 1 \ \forall$ t, $\Pi = \bar{\gamma}$ with $\bar{\gamma} = (\bar{\gamma}_0, \bar{\gamma}_1)'$. For these values, Equation (3.5) becomes:

[51] Chang et al. (1992) extensively describes the estimation procedure of the stochastic coefficient models and the iterative algorithm which SCEP uses to estimate the parameters of the model. I-Lok Chang who coded SCEP worked with the founder of Matlab, Cleve Moler in the 1970s in creating a number of Fortran routines. SCEP uses the same Fortran routines as in Matlab. However, the crucial advantage of SCEP over Matlab is that it uses the unique statistical theory of Swamy i.e. a TVC model with coefficient drivers which solve many conventional problems in econometrics.

$$\gamma_t = \bar{\gamma} + \boldsymbol{u}_t \qquad \ldots(3.9)$$

where γ_t is as explained in Equation (3.4), $E\,\tilde{\gamma}_{0t} = \bar{\gamma}_0$ and $E\,\tilde{\gamma}_{1t} = \bar{\gamma}_1$ are the means of the coefficients of Equation (3.4), and $\boldsymbol{u}_t$ follows the autoregressive process in Equation (3.6). The following IRSGLS estimates of the unknown parameters ($\bar{\gamma}$, Φ, σ_a^2 , Δ_a) of the TVC model consisting of Equations (3.4), (3.6) and (3.9) are shown in Table 3.3 below:

The models in Table 3.3 are estimated with γ's being time-varying parameters. When $\varphi = 0$ the first and second diagonal elements of the complete covariance matrix for the error term (last column of Table 3.3) shown by the variance of the white-noise component of the error u_{0t} and $\tilde{u}_{1t}$ respectively are not very close to zero, which confirms that both γ's are time-varying parameters. The estimate of the mean of the second element $\tilde{\gamma}_{1t}$ of $\tilde{\gamma}_t$ is positive and significant[52]. These results show that the total effects ($\tilde{\gamma}_{1t}$) of PSC_t or CBC_t on RGDP_t are not constant but varies over time, and that the positive effects of credit on growth were mainly declining for the period 1974 to 2019. Figure 3.3 shows the time path of the total effects of PSC or CBC on RGDP.

Figure 3.3 also shows how fast RGDP_t is changing when PSC_t or CBC_t is changing (note that the rate of change of the total effects of PSC on RGDP are slightly higher than the total effects of CBC on RGDP as can be seen by a comparison of the second diagonal element of the complete covariance matrix for the error term of the two models). It can be seen from this figure that the total effects γ_{1t} of PSC_t or CBC_t on RGDP_t are positive, increases nonmonotonically during the years 1970-1974, reaches a maximum in 1974 and decreases to a value close to zero towards the years 2019 but this decrease is not monotonic and no threshold effects is reached between PSC or CBC and RGDP from 1970 to 2019.

Figure 3.3 shows that u_{1t} is not white noise and show the time-variation in γ_{1t}. Specifically, it shows that the relationship between PSC or CBC and RGDP is nonlinear and γ_{1t}, the coefficient on PSC or CBC measuring the total effects of PSC or CBC on RGDP, can be made a function of time-varying coefficient drivers that absorb the indirect effects of PSC or

[52] It is important to note that the total effects of the case without coefficient drivers suffer from the correlation of the coefficients with the regressor. Therefore, we do not discuss the significance of the coefficients and pursue further empirical investigation by estimating the forecasting power of the model at this stage.

CBC on RGDP. This is especially important as Equation (4) suffer from the correlation of the coefficients with the regressor[53]. In the next section, the coefficients γ_{0t} and γ_{1t} are both made a function of coefficient drivers, z_{it} and z_{jt} respectively and we attempt to make both coefficients independent of x_{1t} given the values of the coefficient drivers. We shall then find out how well each coefficient driver of z_{jt} measures the indirect effects of credit on growth and hence attempt to partly explain the time path of the total effects of PSC or CBC on RGDP.

[53]Though the coefficients of Equation 4 are correlated with the regressor, we use it to confirm if the relationship between credit and growth is not constant. The reason is that the total effects of credit on growth are unique and hence give consistent estimators as shown by Swamy and Von Zur Muehlen (2020). The time-varying relationship between credit and growth is also confirmed for the case with coefficient drivers.

Table 3.3: Total effects of PSC or CBC on RGDP (case without coefficient drivers)

MODELS*	Unrestricted case (φ≠0) or restricted case (φ=0)*	Mean coefficient estimates of $\bar{\gamma}_t$		Scalar of covariance matrix	Covariance matrix of equation		Scalar of covariance matrix times Covariance matrix of equation**	
		$\hat{\bar{\gamma}}_0$	$\hat{\bar{\gamma}}_1$	$\hat{\sigma}_a^2$	$\hat{\Delta}_a$		$\hat{\sigma}_a^2 \, x \, \hat{\Delta}_a$	
PSC on RGDP	φ=0	60366.55	5.996	0.27001E-05	16416685.7	-18903265.1	443.35	-510.51
		(46.96)[a]	(4.97)[a]		-18903265.1	21766478.2	-510.51	87.84
CBC on RGDP	φ=0	60334.53	6.063	0.2770E-05	16033714.0	-18362785.9	444.12	-508.64
		(47.145)[a]	(5.05)[a]		-18362785.9	21030181.0	-508.64	82.52

Notes: * We estimated the models for both restricted and unrestricted cases of φ. We present only the models whose gamma coefficients have the highest t-ratios. The 1%, 5% and 10% significance levels are denoted by a, b and c respectively.

**When we multiply the covariance matrix, delta, by its scalar we get its complete covariance matrix for the error term. The first and second diagonal elements of this matrix show that the variances of γ_0 and γ_1 vary over time.

Source: Estimation results by author

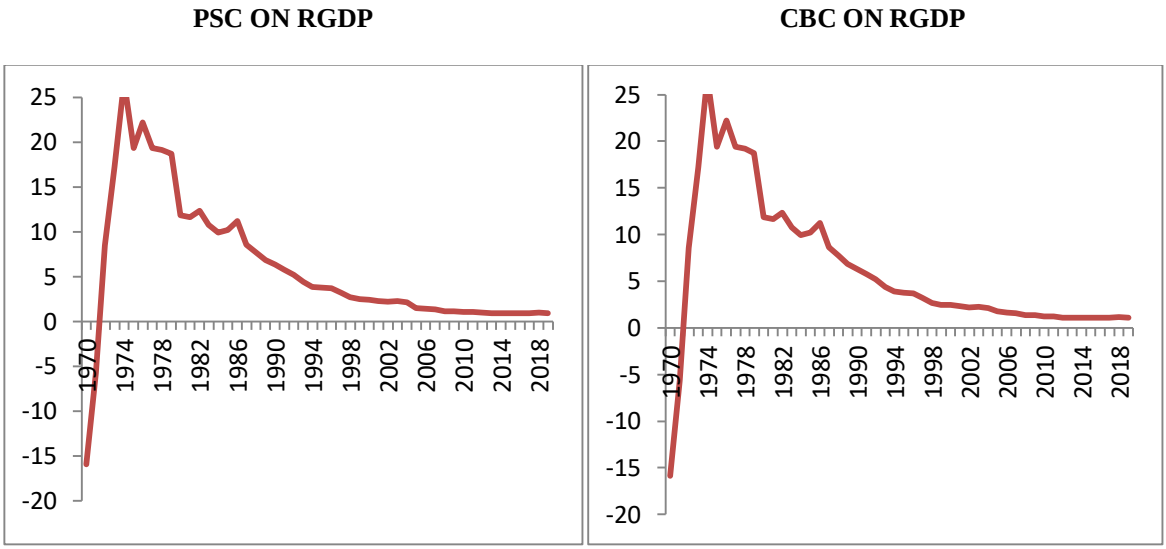

Figure 3.3: Time path of the total effects of PSC or CBC on RGDP

Source: Based on estimation by author

3.4.6.2 Measuring the significance of the total effects of PSC or CBC on RGDP with coefficient drivers

We have seen that the problem with the case without coefficient drivers is that when the coefficients are variables they are correlated with PSC_t or CBC_t .To remove this correlation, we investigate the permutations of coefficient drivers that make the coefficients conditionally independent of PSC_t or CBC_t .Since our primary interest lies in explaining the total effects of PSC_t or CBC_t on $RGDP_t$ as measured by γ_{1t} , for each coefficient driver z_{jt} we accept only the best model which shows the significance of the total effects i.e when both the partial direct effects and partial indirect effects[54] of PSC_t or CBC_t on $RGDP_t$ measured by π_{10} *and* π_{1j} respectively in Equation 8(b) are significant. Note that the error term in Equation 8 (b) captures all the remaining effects of PSC_t or CBC_t on $RGDP_t$.

The results in Table 3.4 and 3.5 provide estimates of the total effects, γ_{1t} of PSC and CBC on RGDP respectively. Tables 3.4 and 3.5 show the results for the coefficient estimates of γ_{1t} .

[54] In this thesis, we use the direct and indirect separately in our interpretation of the results of this thesis though they are non-unique. This is because we believe they are still more accurate than any other existing method used in the empirical literature to measure the indirect effects of the regressor on the dependent variable (See Sarwar et al., 2020).

π_{10} shows consistently positive and significant partial direct effects of PSC or CBC on RGDP for Models X to XXVI (except for Case XXIII for PSC[55]). The positive partial direct effects imply that the effect of credit on the economy is positive which is consistent with the theoretical literature on the effects of finance and growth. The partial indirect effects measured by π_{1j} show that all the indirect channels through which credit affects economic growth in Mauritius for Models X to XX in Table 3.4 and X to XXI in Table 3.5 are significant and negative, which indicates that bank financing of investment and consumption, and hence the *uses* of bank credit, has not been efficient in Mauritius. Furthermore, Model XXIV in Table 3.4 and Model XXV in Table 3.5 show that the indirect effects of credit on growth via imports are negative.

[55] When (PC, EXPORTS) is used as the pair of coefficient drivers to measure the total effects of PSC on RGDP, we obtain negative total effects and negative partial direct effects. These results are not in line with the estimates of other models. Furthermore, economic theory predicts that the partial direct effects of credit on growth should be positive. Therefore, based on these reasons, we put less weight on the results of Model XXIII.

Table 3.4: Total effects of PSC on RGDP (case with coefficient drivers)

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER OF Equation (3.8a)	COEFFICIENT ESTIMATES OF γ_{0t} in Equations (3.12) and (3.8a)		COEFFICIENT DRIVER OF Equation (3.8b)	COEFFICIENT ESTIMATES OF γ_{1t} in Equations (3.12) and (3.8b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
II	φ≠0	GFCF	51314.50	0.09	CEXPI	-4.61	0.13	3.10	REJECT
			(35.60)[a]	(0.030)		(-0.650)	(3.639)[a]		
III	φ≠0	PI	51295.70	-0.13	CEXPI	-4.60	0.13	0.51	REJECT
			(35.63)[a]	(-0.028)		(-0.644)	(3.676)[a]		
IV	φ=0	PC	86685.50	3.16	CEXPI	0.41	-0.03	0.27	REJECT
			(17.22)[a]	(8.777)[a]		-0.38	(-2.245)[b]		
V	φ=0	GFCF	57202.60	24.91	OMT	10.57	-0.17	2.16	REJECT
			(75.47)[a]	(11.26)[a]		-1.97	(-3.391)[a]		
VI	φ=0	PI	56762.00	38.74	OMT	12.05	-0.191	1.72	REJECT
			(83.49)[a]	(13.22)[a]		(2.538)[a]	(-4.307)[a]		
VII	φ=0	PC	68347.49	4.27	OMT	-4.87	0.013	0.27	ACCEPT **
			(36.78)[a]	(12.67)[a]		(-8.245)[a]	(2.178)[b]		
VIII	φ=0	GFCF	57883.00	22.02	REEXR	-24.80	0.152	2.64	REJECT
			(75.77)[a]	(10.36)[a]		(-2.886)[a]	(2.097)[b]		
IX	φ=0	PI	57566.98	33.84	REEXR	-27.93	0.172	1.43	ACCEPT***
			(81.69)[a]	(11.71)[a]		(-3.544)[a]	(2.603)[a]		
X	φ=0	CEXPI	33523.55	159.94	PI	12.65	-0.00023	14.38	REJECT
			(4.400)[a]	(3.222)[a]		(8.939)[a]	(-3.222)[a]		
XI	φ=0	OMT	9332.44	472.83	PI	9.51	-0.00017	10.45	ACCEPT
			(1.199)	(6.271)[a]		(8.117)[a]	(-5.186)[a]		
XII	φ=0	REEXR	128716.61	-595.44	PI	11.23	-0.00020	12.83	REJECT
			(4.661)[a]	(-2.569)[a]		(7.814)[a]	(-5.019)[a]		
XIII	φ=0	CEXPI	33072.03	161.76	GFCF	13.07	-0.00018	14.01	REJECT

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER OF Equation (3.8a)	COEFFICIENT ESTIMATES OF γ_{0t} in Equations (3.12) and (3.8a)		COEFFICIENT DRIVER OF Equation (3.8b)	COEFFICIENT ESTIMATES OF γ_{1t} in Equations (3.12) and (3.8b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
			(4.421)[a]	(3.321)[a]		(9.199)[a]	(-6.100)[a]		
XIV	φ=0	OMT	9705.12	467.95	GFCF	9.83	-0.00013	10.21	ACCEPT
			(1.265)	(6.292)[a]		(8.31)[a]	(-5.398)[a]		
XV	φ=0	REEXR	127992.29	-590.67	GFCF	11.60	-0.00016	12.52	REJECT
			(4.701)[a]	(-2.585)[a]		(7.999)[a]	(-5.223)[a]		
XVI	φ=0	CEXPI	35297.58	151.71	PC	11.42	-0.000041	22.26	REJECT
			(4.377)[a]	(2.883)[a]		(8.125)[a]	(-4.992)[a]		
XVII	φ≠0	CEXPI	108107.45	-238.11	PC	3.371	-0.00001	4.48	ACCEPT
			(12.01)[a]	(-3.766)[a]		(2.859)[a]	(-2.079)[b]		
XVIII	φ=0	OMT	8278.16	486.83	PC	8.59	-0.00003	16.19	REJECT
			(1.014)	(6.167)[a]		(7.472)[a]	(-4.475)[a]		
XIX	φ≠0	OMT	48798.57	279.95	PC	3.268	-0.00001	4.69	REJECT
			(3.026)[a]	(1.943)[c]		(3.091)[a]	(-2.864)[a]		
XX	φ=0	REEXR	130272.59	-604.58	PC	10.17	-0.000036	19.88	REJECT
			(4.509)[a]	(-2.493)[b]		(7.218)[a]	(-4.359)[a]		
XXI	φ=0	PI	57377.09	37.79	EXPORTS	4.644	-0.264	1.37	REJECT
			(85.08)[a]	(12.38)[a]		(1.274)	(-3.621)[a]		
XXII	φ=0	GFCF	57750.00	24.32	EXPORTS	3.877	-0.231	1.93	REJECT
			(78.26)[a]	(10.80)[a]		(0.962)	(-2.886)[a]		
XXIII	φ=0	PC	71.848.08	3.718	EXPORTS	-3.818	0.019	0.91	ACCEPT
			(30.99)[a]	(13.68)[a]		(-13.39)[a]	(4.085)[a]		
XXIV	φ=0	PI	56427.05	37.89	IMPORTS	15.69	-0.412	2.61	ACCEPT
			(74.85)[a]	(13.07)[a]		(2.692)[a]	(-4.107)[a]		
XXV	φ=0	GFCF	56714.66	24.49	IMPORTS	14.24	-0.373	3.29	REJECT
			(69.02)[a]	(11.40)[a]		(2.205)[b]	(-3.368)[a]		

Notes: The 1%, 5% and 10% significance levels are denoted by a, b and c respectively. For convenience we do not show the scalar of the covariance matrix times the covariance matrix of the equations in the table. The second diagonal element of the resulting matrix show that the variances of γ_1 vary over time.

*For each coefficient driver of Z_{jt} we accept the case which shows the significance of both π_{10} and π_{1J} and also has the minimum forecasting error i.e. the lowest U statistic.

**This model is further investigated because of its contradictory results with models V and VI.

***This model is further investigated because of its very high negative value for the partial direct effects.

Source: Estimation results by author

Table 3.5: Total effects of CBC on RGDP (case with coefficient drivers)

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER OF Equation (3.8a)	COEFFICIENT ESTIMATES OF γ_{0t} in Equations (3.12) and (3.8a)		COEFFICIENT DRIVER OF Equation (3.8b)	COEFFICIENT ESTIMATES OF γ_{1t} in Equations (3.12) and (3.8b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
II	φ≠0	GFCF	51350.35	-0.1409	CEXPI	-4.672	0.1343	2.7	REJECT
			(35.847)[a]	(-0.040)		(-0.6620)	(3.673)[a]		
III	φ=0	PI	55837.75	28.594	CEXPI	-19.113	0.1275	1.02	ACCEPT**
			(55.56)[a]	(7.895)[a]		(-4.958)[a]	(2.865)[a]		
IV	φ≠0	PI	51332.48	-0.5032	CEXPI	-4.665	0.1357	2.72	REJECT
			(35.26)[a]	(-0.1084)		(-0.6496)	(3.687)[a]		
V	φ=0	PC	51618.48	6.834	CEXPI	-35.32	0.295	1.89	REJECT
			(49.15)[a]	(7.326)[a]		(-8.776)[a]	(7.724)[a]		
VI	φ=0	GFCF	57282.91	26.14	OMT	9.128	-0.1667	1.62	REJECT
			(77.33)[a]	(11.46)[a]		(1.742)[c]	(-3.417)[a]		
VII	φ=0	PI	56892.15	40.42	OMT	10.159	-0.1852	1.53	ACCEPT
			(84.74)[a]	(13.24)[a]		(2.169)[b]	(-4.221)[a]		
VIII	φ=0	GFCF	57933.44	23.23	REEXR	-26.39	0.1561	1.77	REJECT
			(78.35)[a]	(10.71)[a]		(-3.159)[a]	(2.225)[b]		
IX	φ=0	PI	57628.93	36.64	REEXR	-29.629	0.1766	0.78	ACCEPT***
			(83.42)[a]	(11.89)[a]		(-3.800)[a]	(2.712)[a]		
X	φ=0	CEXPI	159842.90	-512.65	PI	1.985	-0.000018	12.27	REJECT
			(10.95)[a]	(-4.317)[a]		(16.36)[a]	(-7.119)[a]		
XI	φ≠0	OMT	55627.70	244.12	PI	2.479	-0.000013	0.65	ACCEPT
			(3.307)[a]	(1.660)[c]		(2.247)[b]	(-2.266)[b]		
XII	φ=0	OMT	9320.21	473.03	PI	9.492	-0.00016	8.91	REJECT
			(1.196)	(6.265)[a]		(8.089)[a]	(-5.081)[a]		
XIII	φ=0	REEXR	128708.07	-595.29	PI	11.212	-0.0002	10.96	REJECT

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER OF Equation (3.8a)	COEFFICIENT ESTIMATES OF γ_{0t} in Equations (3.12) and (3.8a)		COEFFICIENT DRIVER OF Equation (3.8b)	COEFFICIENT ESTIMATES OF γ_{1t} in Equations (3.12) and (3.8b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
			(4.656)[a]	(-2.566)[a]		(7.792)[a]	(-4.936)[a]		
XIV	φ=0	CEXPI	33091.90	161.69	GFCF	13.047	-0.00018	11.96	REJECT
			(4.417)[a]	(3.314)[a]		(9.169)[a]	(-6.007)[a]		
XV	φ=0	OMT	9689.82	468.19	GFCF	9.806	-0.00013	8.71	ACCEPT
			(1.261)	(6.285)[a]		(8.277)[a]	(-5.291)[a]		
XVI	φ=0	REEXR	127989.55	-590.57	GFCF	11.577	-0.00016	10.7	REJECT
			(4.695)[a]	(-2.581)[a]		(7.973)[a]	(-5.137)[a]		
XVII	φ≠0	CEXPI	109318.23	-244.65	PC	3.384	-0.0000052	5.91	ACCEPT
			(12.84)[a]	(-4.048)[a]		(3.534)[a]	(-2.430)[b]		
XVIII	φ=0	CEXPI	35287.53	151.79	PC	11.413	-0.00004	18.91	REJECT
			(4.379)[a]	(2.885)[a]		(8.122)[a]	(-4.919)[a]		
XIX	φ≠0	OMT	76300.71	30.931	PC	3.551	-0.0000054	6.84	REJECT
			(4.867)[a]	(0.223)		(4.208)[a]	(-2.530)[a]		
XX	φ≠0	OMT	8383.01	486.80	PC	8.581	-0.000029	13.72	REJECT
			(1.015)	(6.168)[a]		(7.466)[a]	(-4.387)[a]		
XXI	φ=0	REEXR	130223.24	-604.15	PC	10.165	-0.000036	16.89	REJECT
			(4.507)[a]	(-2.491)[b]		(7.213)[a]	(-4.287)[a]		
XXII	φ=0	PI	57521.20	39.11	EXPORTS	2.505	-0.2446	1.29	REJECT
			(86.26)[a]	(12.38)[a]		(0.696)	(-3.407)[a]		
XXIII	φ=0	GFCF	57842.30	25.35	EXPORTS	2.133	-0.219	1.42	REJECT
			(79.56)[a]	(10.89)[a]		(0.537)	(-2.775)[a]		
XXIV	φ=0	PC	57204.42	7.656	EXPORTS	-13.558	0.119	0.37	REJECT
			(49.22)[a]	(5.546)[a]		(-2.194)[b]	(1.133)		
XXV	φ=0	PI	56267.40	40.12	IMPORTS	15.17	-0.427	1.95	ACCEPT
			(69.02)[a]	(11.40)[a]		(2.205)[b]	(-3.368)[a]		

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER OF Equation (3.8a)	COEFFICIENT ESTIMATES OF γ_{0t} in Equations (3.12) and (3.8a)		COEFFICIENT DRIVER OF Equation (3.8b)	COEFFICIENT ESTIMATES OF γ_{1t} in Equations (3.12) and (3.8b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
XXVI	φ=0	GFCF	56704.03	26.00	IMPORTS	13.94	-0.390	2.54	REJECT
			(71.31)[a]	(11.81)[a]		(2.231)[b]	(-3.617)[a]		

Notes: The 1%, 5% and 10% significance levels are denoted by a, b and c respectively. For convenience we do not show the scalar of the covariance matrix times the covariance matrix of the equations in the table. The second diagonal element of the resulting matrix show that the variances of γ_1 vary over time.

*For each coefficient driver of Z_{jt} we accept the case which shows significance of both π_{10} and π_{1J} and also has the minimum forecasting error i.e. the lowest U statistic.
** This model is further investigated because of its high negative partial direct effects.
*** This model is further investigated because of its high negative partial direct effects.

Source: Estimation results by author

In terms of the best models of the study for each coefficient driver of z_{jt}, Table 3.4 shows that Model VII with the pair of coefficient drivers (PC, OMT) has significant total effects of PSC on RGDP and it has also the lowest U statistic. We accept this model as the best model when OMT is used as a coefficient driver for z_{jt}. However, Model VII shows that the partial direct effects of PSC on RGDP are negative and the partial indirect effects of PSC on RGDP via OMT are positive, which contradicts the results of Models V and VI. Model V with (GFCF, OMT) and Model VI with (PI, OMT) show opposing results with positive partial direct effects of PSC on RGDP and negative partial indirect effects of PSC on RGDP via OMT. Furthermore, Model IX with (PI, REEXR) shows abnormally high negative values of the partial direct effects of PSC on RGDP, which calls for a further investigation of the effects of credit on growth via openness. In this respect, instead of using OMT and REEXR for z_{jt} we use EXPORTS and IMPORTS to investigate the specific link between private sector credit, openness and economic growth in Mauritius.

The results of the different permutations are shown in Table 3.4 for Models XXI to XXV. The results for Model XXIII show that when the pair of coefficient drivers (PC, EXPORTS) is used, the partial direct effects of credit on growth are negative but the partial indirect effects of credit on growth via exports are positive and significant. The negative partial direct effects of credit on growth for (PC, EXPORTS) suggest that this pair of coefficient drivers does not provide a good tracking of the time path of the total effects of PSC on RGDP which remains positive throught the period 1970 to 2019 (see Figure 3.3 for the total effects of PSC on GDP for the case without coefficient drivers)[56]. The left-hand side of Figure 3.4 confirms that the time path of the total effects of PSC on RGDP estimated by the pair (PC, EXPORTS) remains negative and flat throughout the period 1970 to 2019. When the pair (PI, IMPORTS) is used, the results for Model XXIV show the partial direct effects of private sector credit on economic growth are positive and the partial indirect effects via imports are negative and significant. These results show that private sector credit has a negative effect on growth via openness through the IMPORTS channel.

The negative effects of credit on growth via the IMPORTS channel are also confirmed in Table 3.5 when we estimate the total effects of CBC on RGDP. Model III and IX in Table 3.5 show abnormally high negative values of the partial direct effects of CBC on RGDP.

[56]Model XXIII exhibits negative total effects and partial direct effects which are not consistent with the results we obtain for the other model estimations. Our TVC results for other models show overwhelmingly positive total effects and positive partial direct effects and negative partial indirect effects.

Therefore, we reestimate the total effects of CBC on RGDP with IMPORTS and EXPORTS as coefficient drivers for z_{jt}. The results for Model XXV when (PI, IMPORTS) are used to show the partial direct effects of bank credit on economic growth are positive but the partial indirect effects via imports are negative and significant. These results confirm that credit has a negative effect on growth via openness through the IMPORTS channel. As a consumption driven economy relying on imports, the financing of imported goods has had negative effects on economic growth. Consumer spending could be a good thing if money is spent on goods produced locally. However, during the past two decades, Mauritius has become increasingly import-dependent. There has been a rising trend in the imports to exports ratio, from 93% in 2000 to 143% in 2019, while private consumption has increased from 59% of GDP to 75% of GDP during the same period. Given that most of the consumer goods in the country are imported from abroad and not produced locally, it is not surprising that credit via imports slows down the growth of the economy.

On the other hand, the results for Model XXII to XXVI in Table 3.5 show that the total effects of CBC on RGDP are not significant, which do not confirm the results of the total effects of PSC on RGDP estimated by the pair (PC, EXPORTS). Therefore, it is possible that bank credit has been less effective in promoting exports[57] to sustain economic growth compared to non-bank credit. However, bank credit has largely been channelled to export industries, especially during the country's early years after independence. A system of credit ceilings was introduced in 1973 which controlled the expansion and direction of credit by ensuring the channelling of financial resources to priority sectors of the economy (Bank of Mauritius annual report, 1973, p. 8).

The system of credit continued to support export-oriented industries and helped to increase manufacturing exports in the mid 1970s (see Bank of Mauritius annual report 1976, p. 24) and mid 1980s (see Bank of Mauritius annual report 1984, p. 21). The period 1984–1990 marked unprecedented high growth rates and has been dubbed the economic miracle years of the country. However, credit ceilings on the non-priority sectors were lifted in July 1992 and virtually abolished from July 1993. After this period, the relationship between credit and exports waned with the phasing out of preferential trade agreements and eventual dismantling

[57]In the next chapter, we further investigate the effects of disaggregated bank credit on GDP using exports as a coefficient driver to measure the partial indirect effects of "bank credit for GDP transactions" on GDP.

of the Multi Fibre Agreement[58] (MFA) in 2005. In fact, from the mid 1990s, while bank credit to GDP rose from 44% in 1996 to reach more than 75% of GDP in 2019, exports to GDP fell sharply from 63% of GDP in 1996 to 36% of GDP in 2019, which suggests that after the 1990s, the positive effects of bank credit on economic growth via exports might have weakened.

The credit policy change from 1993 also led to a shift in the composition of bank credit towards less productive investment and consumption which did not have a strong positive incidence on RGDP. The results for the total effects of PSC or CBC on RGDP as shown in Tables 3.4 and 3.5 respectively show that, for all permutations when PI, GFCF and PC are used as the main coefficient driver for z_{jt}, the partial direct effects of credit on growth are significantly positive. However, the partial indirect effects of credit on growth are all negative and suggest that credit has negatively influenced economic growth through investment and consumption over time. The negative estimates of the coefficient on PI and GFCF suggest that less productive forms of investment have mitigated the positive total effects of PSC or CBC on RGDP in Mauritius. The significance of the negative estimate on the coefficient of the coefficient driver PC also shows as a heavily consumption-driven economy relying on imports, as bank credit for consumption has had negative effects on economic growth in Mauritius. In comparison to the magnitude of the partial indirect effects of PI and GFCF measured by π_{ij}, credit through PC and IMPORTS have had larger negative effects on economic growth.

The time path of the total effects of PSC or CBC on RGDP for the best case for each coefficient driver is shown in Figure 3.4. For the pair of coefficient drivers (OMT, PI)[59], (OMT, GFCF) and (CEXPI, PC), the time path of the total effects of PSC or CBC on RGDP are positive from around the early 1970s to about the mid 1980s, although there some sporadic downswings during this period, especially in the late 1970s when the country faced a severe external crisis. The total effects of credit on growth when the pair of coefficient drivers (OMT, PI) and (OMT, GFCF) are used occur during the period 1980 to 1982, which marked the beginning of structural adjustment period, and during the period 1984 to 1986, which marked the beginning and middle of the economic miracle years of the country.

[58] The Multi-Fibre Agreement has allowed Mauritius to build up its garment industry by restricting the clothing exports from mostly Asian countries. Thus, rich countries in the west constituted the market for exports from Mauritius, Nath and Madhoo (2003, p. 16).

[59] In Table 3.5 we find that this model has significance of π_{10} and π_{1j} and also a U statistic of less than 1 which strongly suggests that bank credit has negatively affected economic growth through private investment.

However, from 1987, there was a steady decline in the total effects of credit on growth in the country. The negative partial indirect effects of PI, GFCF and PC suggest that credit has negatively influenced growth through investment and consumption and provides a partial explanation of the declining effects of credit on economic growth from 1987 to 2019.

Figure 3.4 shows that the time path of the total effects of PSC or CBC on RGDP when (PI, IMPORTS) are used as coefficient drivers. It can be observed that the time path of the total effects of (PI, IMPORTS) remain largely negative throughout the period 1970 to 2019 and does not mirror the declining effects of credit on economic growth during the most recent decades that we found when we used other pair of coefficient drivers.

The time path for the total effects of PSC on RGDP when (PC, EXPORTS) is used as a pair of coefficient drivers remains flat and negative throughout the period. Although the partial indirect effects of PSC on RGDP suggest that the effect of credit on growth via exports is positive, the time path of the total effects of PSC on RGDP estimated by the pair (PC, EXPORTS) does not mirror the declining total effects of credit on growth during the most recent decades.

Overall, we found that when PI, GFCF and PC are used as the main coefficient driver for z_{jt} we get the most consistent explanations of the time path of the total effects of PSC or CBC on RGDP from 1970 to 2019.

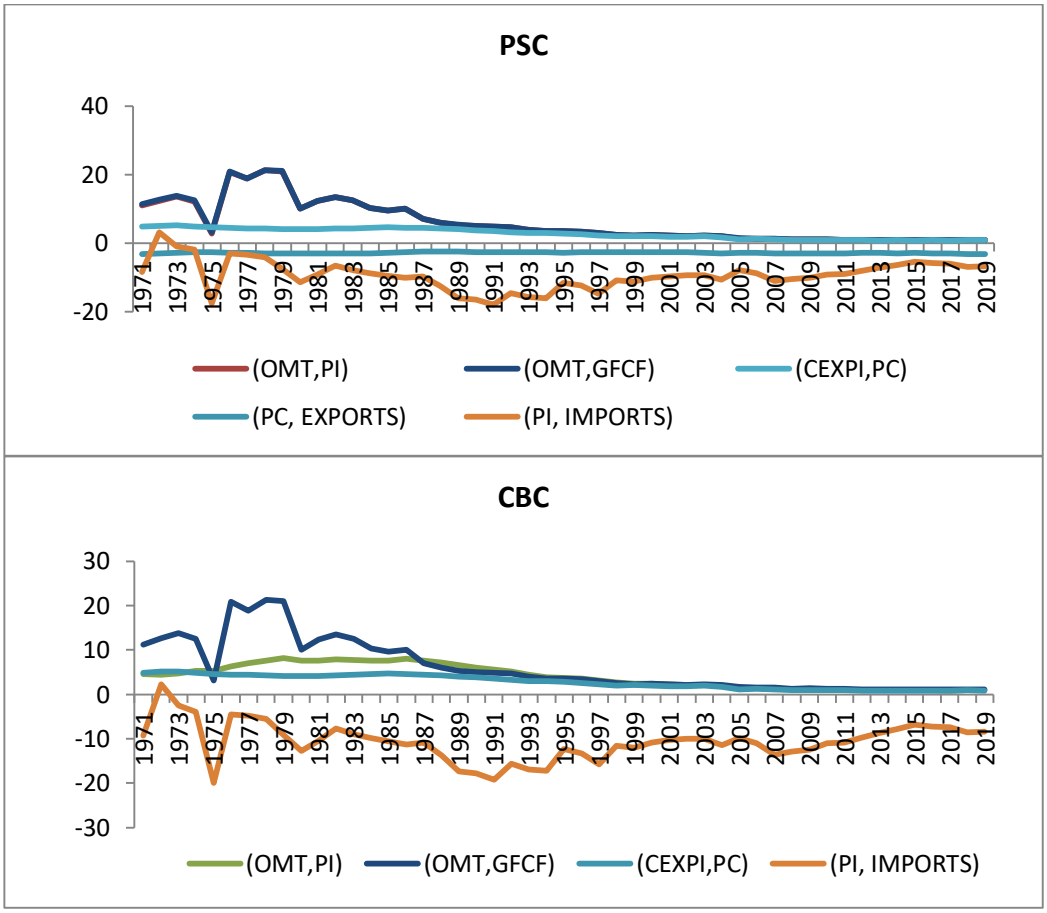

Figure 3.4: Time path of the total effects of PSC or CBC on RGDP

Note: $\hat{\gamma}_{1t}$ for the best case of each coefficient driver of z_{jt}

Source: Based on estimation by author

3.5 Conclusion

We have found that the relationship between PSC or CBC and RGDP is nonlinear for Mauritius from 1970 to 2019. Since the true functional form of this relationship was not known, we employed a TVC model to estimate this relationship. Using this approach turned out to be appropriate because the total effects of PSC or CBC on RGDP are not constant and varies over time during the sample period 1970–2019. The total effects are positive in the beginning years and are low and decreasing in the latter years of the sample period. These decreases are due to downward swings towards less productive types of bank credit. This is confirmed by the negative indirect effects component of the total effects of PSC or CBC on RGDP absorbed by PI, GFCF, PC and IMPORTS, which partially explains why the effects of credit on economic growth have been falling in the later years of the sample period.

Overall, the findings suggest that credit should encourage productive investment. Thus, we strongly propose that policymakers in Mauritius review credit policies and promote credit that is more likely to sustain RGDP growth in the country. Credit policies should be cleverly designed to encourage productive investment that would drive economic growth.

In the next chapter, we explore if the declining effects of credit on growth observed in Mauritius can be explained by the shift in the composition of bank credit. Panizza (2014, p. 13) has argued that one possible reason for the vanishing effects of credit on growth has to do with the fact that not all credit is the same. In that respect, we will use a novel theory, the quantity theory of disaggregated credit (QTDC), to disaggregate bank credit into bank credit for GDP transactions and bank credit for non-GDP transactions before testing the time-varying total effects of the former on GDP. This empirical exercise will give us additional insights into the types of bank credit that have had the strongest effects on GDP in Mauritius over time.

CHAPTER 4

THE QUANTITY THEORY OF DISAGGREGATED CREDIT (QTDC): A TIME-VARYING COEFFICIENT ESTIMATION OF THE TOTAL EFFECTS OF BANK CREDIT FOR GDP TRANSACTIONS ON GDP

Abstract

Using the QTDC approach, this chapter disaggregates commercial bank credit into two types namely, bank credit for GDP transactions (C_r) and bank credit for non-GDP transactions. We then select the two best performing proxies of C_r and test their statistical significance and predictive value on nominal GDP in Mauritius from 1970 to 2019 using the time-varying coefficient (TVC) estimation approach of Swamy and Von Zur Muehlen (2020). Our conclusions are the following: The results show that both proxies of bank credit for GDP transactions, proxies 10[60] and 11[61], had initially stronger total effects on NGDP but when banks shifted their allocation of credit to non-GDP sectors the effects of bank credit for GDP transactions on NGDP waned. Proxy 10 has stronger total effects on NGDP than proxy 11, which confirms that bank credit to the construction sector has major non-GDP effects. These results confirm the predictions of QTDC. The same results hold when we replace NGDP with RGDP. The best model of the total effects of proxy 10 on RGDP shows that the credit controls systems put in place by the Bank of Mauritius from 1973 till 1993 have encouraged the allocation of funds to bank credit for GDP transactions, in particular to investment in machines, and supported high economic growth in the 1970s and during the Mauritian miracle years in the 1980s. Overall, the results suggest that policies that guide bank lending towards GDP transactions can potentially be very effective in stimulating economic growth, much more so than conventional interest rate policies, to which credit guidance can act as a complement and not necessarily as a substitute. Therefore, policies should ensure that bank credit is channelled mainly to productive investment[62] that will put the country back on a path of sustainable economic growth. The results of this chapter have profound implications for how to reignite economic growth in a country during times of slow growth.

[60] Proxy 10 is calculated using total commercial bank credit minus bank credit to the construction sector minus bank credit to the financial sector.
[61] Proxy 11 is calculated using total commercial bank credit minus bank credit to the financial sector.
[62] For example, investment in machines today has a broader meaning and includes precision agriculture, high-tech manufacturing, renewable energy technology, pharmaceuticals, artificial intelligence and robotics amongst others.

"Economists are now labouring to include banking in their models. However already sixteen years ago a paper was published in this journal which presented probably the simplest possible framework that incorporates the economic consequences of banking into a macroeconomic framework: The 'Quantity Theory of Credit' (QTC, Werner (1997))" (Werner, 2013, p. 357).

4.1 Introduction

The global financial crisis (GFC) has sparked renewed interest in the use of monetary policy to address the needs of the real economy (see Mehrling, 2013, p. 117; Stiglitz, 2013, p. 13; Turner, 2016, p. 245). Traditional monetary theory focuses mainly on the liability side of the commercial banks' balance sheets and hence on the use of monetary aggregates such as M1 and M2 to influence the path of economic growth. In the 1970s, monetary policy was much driven by Friedman's monetarist theory which focused on money and deposits as key macro-economic variables influencing nominal demand and inflation. However, due to the unreliable relationship observed between monetary aggregates and macro-economic variables, in the 1980s New-Keynesian approaches advised that monetary policy should move away from quantities and onto the price of money i.e. the rate of interest. The interest rate theory is backed by the theory of market equilibrium which implies that, ceteris paribus, higher interest rates will reduce investment and aggregate demand to control inflation. With the onset of the global financial crisis, Keynesian theories went through major tests. The interest rate having reached the 'zero-lower bound' without stimulating the economy after the financial crisis, the Federal Reserve Bank resorted to "quantitative easing"[63] which involved large-scale purchases of assets in an attempt to inject money into the financial system.

Quantitative easing in its original form was first proposed by Werner (1995), who used the term when proposing a new form of monetary policy for the Bank of Japan during the 1990s recession (Achameesing, 2020). Werner (1995) proposed policies executed at the level of the Bank of Japan that would directly stimulate *commercial* bank lending to the *real* sectors, also known as GDP transactions (Achameesing, 2020). In its original form, quantitative easing means an increase in a variable which Werner (1995) called "bank credit for GDP transactions" that would stimulate nominal GDP growth. The link between these two variables follows directly from the Quantity Theory of Disaggregated Credit (QTDC) introduced by Werner in 1992. This chapter introduces the QTDC which, in contrast to

[63] Quantitative easing is written in inverted commas to point out that it does not mean what it is commonly believed to be. We explain the original definition provided by Werner (1995).

monetary aggregates, focuses on the asset side of the banks' balance sheets. Werner (1992) introduced the QTDC to show that it is credit aggregates that mainly affect the growth path of the economy. Werner (1992) explained that if credit is rationed as shown by Stiglitz and Weiss (1981), there is always excess demand for credit and thus markets cannot be expected to be in equilibrium. Stiglitz and Greenwald (2003, p. 23) argued that with credit rationing, interest rates may not be determined by the intersection of the demand and supply of loanable funds, but a decrease in the supply of loans translates directly into a reduction in economic activity. Markets that do not clear are rationed. Rationed markets are determined by quantities, not prices, according to the short side principle (Werner, 2005, p. 27). Thus if banks ration credit, this certainly will result in macroeconomic credit rationing, since the total amount of credit creation constitutes the overarching budget constraint on the entire economy which is quantity-rationed by it (Werner, 2005, p. 198).

In his book, *Between debt and the devil*, Turner (2016, p. 139) argued that the stellar economic performance in the 1960s of Japan and the East Asian tigers was achieved by clever institutional design, and direct intervention in resource allocation, especially in the credit markets. Similarly, Werner (2005) provided empirical evidence for Japan in the 1980s by dividing bank credit into flows to non-GDP and GDP transactions. He showed that bank credit that finances the purchase of existing assets does not stimulate nominal GDP, as opposed to bank credit extended to finance new real investment or consumption, and that while rapid growth of real estate credit did not produce an acceleration of nominal GDP, it was the fundamental reason that Japan suffered a sustained period of recession in the 1990s. In Mauritius, after the wave of financial liberalization policies in the country in the late 1980s and early 1990s which led to the relaxation of all credit guidelines in 1993, there was a major shift in the composition of credit by commercial banks to real estate and financial sectors.

According to data from the Bank of Mauritius, commercial banks have largely turned to real estate lending as there has been an incredible surge in the amount of lending to that sector, from Rs 1 billion in 1996 to Rs 98.6 billion in 2018 (Bank of Mauritius annual report, 2018, p. 52). These figures from the Bank of Mauritius for the Construction category include lending for the construction of new real estate which is new capital investment but also includes the purchase of existing real estate (the exact figures for each sub-category are not available). Furthermore, bank credit to offshore companies (companies which do most of their business activities abroad) in Mauritius has also surged during the past thirty years. Bank credit to the financial sector has increased from Rs 323 million in 1993 to a whopping

Rs 114 billion in 2019 (Bank of Mauritius annual report, 2019, p. 84). The financialization of the Mauritian economy means that more bank credit has been used for financial sectors and as the QTDC predicts, NGDP would stagnate in these circumstances.

The empirical literature on QTDC overwhelmingly finds unidirectional granger causality from bank credit for GDP transactions to nominal GDP (Bezemer and Werner, 2009; Voutsinas and Werner, 2011; Lyonnet and Werner, 2012; Ryan-Collins et al., 2016). However, all empirical tests of QTDC so far have used fixed coefficient models to measure the causal relationship between increases in the proxy of bank credit for GDP transactions and nominal GDP growth. Werner's and others testing of QTDC using fixed coefficient models have ignored the indirect effects of bank credit for GDP transactions on NGDP.

In the previous chapter, we found that the non-linear effects of bank credit on economic growth in Mauritius are in line with a large number of studies (see Arcand et al., 2012, 2015; Cecchetti and Kharroubi, 2012, 2013; Law and Singh, 2014). However, to the best of our knowledge, none of these studies have investigated the potential misallocation of credit to real estate and financial sectors as a potential explanation for the vanishing effect of finance on growth. Although Arcand et al. (2012) admit that the vanishing effects of finance on growth could depend on whether lending is used to finance investment in productive assets or to feed speculative bubbles, they do not pursue a decomposition of credit to investigate the effects of different types of credit on economic growth. The broad objective of this chapter is to investigate the non-linear effects of the relationship between finance and growth in Mauritius by using a decomposition of bank credit. Existing empirical studies on the finance and growth nexus in Mauritius (see Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010) have also not pursued this line of research, which we believe can shed light on the vanishing effect of credit on GDP growth in the country.

The specific issues addressed in this chapter are: (i) to disaggregate bank credit using the methodology of QTDC, which will help to identify which types of credit likely contribute to GDP transactions in Mauritius; (ii) to use a TVC estimation technique to measure the total effects of bank credit for GDP transactions on GDP in Mauritius, which will also add to the global empirical literature on QTDC which has so far used fixed coefficient models and thus suffer from serious econometric problems; and (iii) to estimate the indirect channels through which bank credit for GDP transactions affects GDP, which will also add to the global literature on QTDC.

The rest of the chapter is structured as follows: in Section 4.2, we present the derivation of the QTDC. In Section 4.3, we discuss the empirical literature on the QTDC. In Section 4.4 we present the evolution of bank credit in Mauritius. In Section 4.5 we provide a TVC estimation of the total effects of bank credit for GDP transactions on GDP and discuss the empirical results. Finally, in Section 4.6 we highlight the policy implications of this study.

4.2 The quantity theory of disaggregated credit

The quantitative link between money and the economy goes back to the early works of John Locke and David Hume in the 18th century. But the most popular version of the equation of exchange was described by Irving Fisher (1911) and is presented below:

$$MV = PT \quad \ldots(4.1)$$

Equation (4.1) implies that the total amount that is spent during a period in the real economy is proportional to the total value of transactions (Achameesing, 2020). However, an important drawback of Fisher's equation is that although statistical data on M and P were available (V is the residual), data on T, which is the number of transactions, did not exist. In this respect, to circumvent this problem, economists such as Pigou (1917) proposed a new version of Fisher's equation of exchange in which the stock of money is proportional to "total nominal expenditures" which could then be measured by GDP. The modified equation of exchange, called its "income version", would therefore replace PT by PY:

$$Effective\ Money = nominal\ GDP$$

$$MV = PY \quad \ldots(4.2)$$

The result of this change in the formulation of the link between money and the real economy has had profound implications on modern monetary macroeconomics. Indeed, most economists, including monetarist Milton Friedman, have been using this income version in their work, although the original quantity equation is mainly about transactions. However, it is clear that GDP does not include all transactions and, in particular, it has been recognized that asset transactions are not part of it. In fact, both Fisher (1926) and Keynes (1930) distinguished between industrial and financial transactions, explaining that the latter is only a mere change in ownership and does not consist of the production of new goods and services. Therefore, it implies that MV = PY is only a special case of MV = PT. The assumption of PY = PT is misleading as it implies that all transactions are part of GDP. But asset transactions are not part of GDP, and the problem of the traditional approach is that it ignores those asset

transactions which are often larger than real economy transactions. Since a substantial proportion of money is used for transactions that are not part of GDP, we need to divide money flows to GDP and non-GDP transactions (Werner, 2012b, p. 7).

The first of Werner's (1992) contributions was to incorporate a correct operationalization of the 'money' variable (M). He argued that defining money as a deposit aggregate is problematic because conventional money supply measures like M1, M2 and M3 largely refer to money that is deposited with banks. These measures represent merely potential and not effective purchasing power. Therefore, Werner (1992) argued that a quantity relationship between money and GDP should more accurately refer to that part of the money supply that becomes effective purchasing power. He proposed to define the money variable M using the banking sector's asset side, i.e. bank lending, because it represents effective purchasing power and can be expected to affect GDP directly. Werner (1997) did so on the grounds that "banks create new purchasing power by the extension of loans", commenting that a "wealth of evidence" has been supportive of this view (Werner, 1997, p. 282). The fact that banks create money (i.e. deposits) when they lend has increasingly been acknowledged by leading central banks (see Bundesbank, 2009a, 2012, 2017, p. 13; ECB, 2011, p. 68, 2012, p. 112; McLeay et al. (from the Bank of England), 2014, p. 4; Norges Bank, 2018, p. 35; Reserve Bank of New Zealand, 2019, p. 1).

Secondly, Werner (1992, 1997) performed a breakdown of the quantity equation that would yield a constant velocity. His second contribution was to use the observation made by Mill (1848) and Keynes (1936) that money could be used to purchase goods but also to purchase financial assets. If more money is used to purchase financial assets, this will not be reflected in GDP and therefore velocity will appear to be declining. Indeed, the 'quantity equation' relationship, expressed as a stable income velocity, "came apart at the seams during the course of the 1980s" (Goodhart, 1989, p. 298). The trick is to disaggregate the equation of exchange for all transactions into two flows: those of money used for GDP and those of money used for non-GDP transactions (Werner, 2012b, p. 6). Then if money used for GDP transactions grows at the same rate as GDP, this implies that the velocity of circulation will be constant (Achameesing, 2020).

Using these two innovations, Werner (1992) performed two "surgeries" on Equation (4.1) (note below that PT=PQ as they both represent the total value of transactions). First, he substituted bank credit for M in Equation (4.3). Second, he decomposed money that flows to two different types of transactions: GDP (also known as real sector transactions) and non-

GDP transactions (also known as financial transactions) as in Equation (4.4). Werner's quantity theory of disaggregated credit is then derived as follows:

$$C^b V = PQ \quad \ldots(4.3)$$

$$C^b V = C^b_R V_R + C^b_F V_F \quad \ldots(4.4)$$

$$PQ = P_R Q_R + P_F Q_F \quad \ldots(4.5)$$

Equation (4.3) shows the substitution of M by C^b, which represents bank credit. Equation (4.4) shows the decomposition of the flow of bank credit spent on real sector transactions, i.e. C^b_R, and the flow of bank credit that is spent on financial sector transactions, i.e. C^b_F. Equation (4.5) decomposes all transactions into the economy as real and financial sector transactions. Note that $P_R Q_R$ represents all real sector transactions or GDP transactions and can be written as nominal GDP, i.e. $P_R Y$, whereas $P_F Q_F$ represents all financial or asset transactions or non-GDP transactions and can be written as $P_F A$. The next step in Werner's logic is to equate the first pair of variables from Equation (4.4) to its corresponding counterpart in Equation (4.5). Therefore, we can write the following:

$$C^b_R V_R = P_R Q_R = P_R Y \quad \ldots(4.6)$$

with $V_R = \frac{P_R Y}{C^b_R}$ constant

and:

$$C^b_F V_F = P_F Q_F = P_F A \quad \ldots(4.7)$$

with A= *Quantity of assets*, $V_F = \frac{P_F Q_F}{C^b_F}$ constant

From Equation (4.6), it can be seen that bank credit for GDP transactions directly influences NGDP. From Equation (4.7), it can be seen that bank credit for non-GDP transactions impacts mainly asset prices as the quantity of real estate is largely inelastic in the short run. Whilst in monetarist and New Keynesian perspectives an implicit assumption is often made that all credit flows to the real economy, a significant proportion of bank credit may flow into financial transactions (Ryan-Collins et al. p. 162). Therefore, if monetary policy aims at increasing nominal demand and output, the QTDC emphasizes that monetary policy should aim at increasing bank credit for GDP transactions.

4.3 Empirical literature on QTDC

Werner's (1997) proxy of bank credit for GDP transactions can be considered the 'benchmark' which subsequent research has tried to follow. In that paper, he used Bank of

Japan quarterly sectoral bank loan data to measure bank credit for GDP transactions also known as bank credit to the real sector, C_R^b, which is defined as $C_R^b = C^b - C_F^b$, C^b being total commercial bank credit and C_F^b being bank credit for non-GDP transactions also known as bank credit to the financial sector. Werner (1997) subtracted C_F^b from C^b to obtain a proxy for C_R^b. Werner (1997) identified C_F^b as being "those asset collateralising bank loans that have been used for speculative asset transactions. As has been found earlier..loans to the real estate sector, construction firms and non-bank financial institutions (which mainly served as conduit for real estate loans) represent such speculative credit creation that was used for real estate transactions" (Werner, 1997, p. 7). Werner (1997) concluded that the empirical results for the Japanese case have been unambiguously supportive of the fact that the Japanese asset bubble of the 1980s was due to excess credit creation by banks for speculative purposes, largely in the real estate market (Werner, 1997, p. 15).

In a subsequent investigation for Japan, Werner (2005) constructed two proxies of bank credit for GDP transactions. Similar to Werner (1997), he excluded bank loans to the real estate sector, the construction sector and the non-bank financial sector (Werner, 2005, p. 203). In the 2005 paper, he explored bank lending to the service sector on the grounds that a large amount of loans to this sector has also been used for financial or real estate speculation. He constructed two versions of the proxy of bank credit for GDP transactions (i.e. with and without the service sector), and concluded that although including the service sector in the proxy made velocity more stable, this was only temporary, since from the early 1990s onwards, velocity increased substantially. The findings showed that "not the entire rise in service sector loans was used for speculative purposes" (Werner 2005, p. 204). Werner (2005) found that his correct measure of the real circulation, V_R, had no significantly correlated time trend and is an almost horizontal line, and he concluded that the velocity decline did not actually occur but was based on misleading information which neglected the possibility of a rise in money used for financial transactions (Werner, 2005, pp. 205–206).

For the Czech Republic, Bezemer and Werner (2009) found clear evidence of unidirectional causality from bank credit for GDP transactions to NGDP (Bezemer and Werner, 2009, p. 14). Bezemer and Werner (2009) studied the link between credit and output by using measures of bank credit to the real sector and bank credit to the financial sector.[64] Bezemer

[64] The authors used bank loan data from the Czech National Bank denominated in Czech Crowns to resident and non-resident households and firms and to the government, from 1992Q1 to 2007Q3. The Czech National Bank

and Werner, 2009, p. 10-11) defined bank credit to the financial sector (C_F^b) as bank lending to non-bank financial institutions (such as pension funds and insurance companies) and real estate[65], and bank credit to the real sector (C_R^b) as credit flows to manufacturing, agriculture, natural resources, other services and government. The authors noted that this is an imperfect approximation to C_R^b as, for instance, real-sector firms used some of their funds in asset transactions and the government also invested in land and buildings. Importantly, their proxy of bank credit for GDP transactions included bank loans to the government on the grounds that public institutions may contribute to GDP growth.

Voutsinas and Werner (2011) found that Granger causality is unidirectional from growth in bank credit for GDP transactions to NGDP growth. Following the approach in Werner (1997), Voutsinas and Werner (2011) constructed their own proxy for Japan, which they defined as bank credit to all sectors apart from bank credit to real estate, financial institutions and construction. Lyonnet and Werner (2012) applied the QTDC to the UK and found that growth in NGDP is unidirectionally Granger-caused by the growth in bank credit for GDP transactions. Their proxy of bank credit for GDP transactions for UK included bank lending to private non-financial corporations, bank lending to the household sector (secured lending to individuals and unsecured lending to individuals)[66], and bank lending to unincorporated businesses and non-profit making institutions (Lyonnet and Werner, 2012, p. 104).

In the case of Spain, Werner (2014) used cointegration and Granger-causality analysis, and found unidirectional causation from growth in bank credit for GDP transactions to NGDP growth. Werner (2014) constructed a proxy for bank credit for GDP transactions for the Spanish economy using data covering the period 1995 to 2013. When constructing the proxy of bank credit for GDP transactions Werner (2014) excluded bank credit extended to other financial intermediaries[67], to the real estate sector and to the construction industry. The proxy included bank lending to non-profit institutions and mortgage lending to households. Kuzin and Schobert (2014) performed Granger-causality tests for Germany, and theirs was the first paper to find mixed evidence on the relationship between increases in bank credit for GDP transactions and NGDP growth. In the decade before the German reunification growth in

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reports real sector loans to households and to firms in 26 sector categories comprising manufacturing, agriculture, natural resources and services (Bezemer and Werner, 2009, p. 9).

[65] They note that "asset markets have indirect effects on growth" (Bezemer and Werner, 2009, p. 3).

[66] Although they use Bank of England *Bankstats* data, they do not make the same mistake as Ryan-Collins et al., (2016) of including non-bank lending to individuals. See the previous footnote.

[67] We have checked Bank of Spain data and there is no mention of other financial intermediaries. This leads me to the conclusion that Werner excluded what he called "other financial intermediaries" by excluding what the dataset calls the "service sector".

bank credit for GDP transactions Granger caused NGDP growth and the correlation between them is positive. In the first decade after the reunification there is no longer a significant link between increases in bank credit for GDP transactions and NGDP growth. In constructing a proxy of bank credit for GDP transactions for the German economy, Kuzin and Schobert (2014) included bank lending to non-bank firms, and excluded mortgage loans and consumption loans to households on the grounds that housing credit and mortgages of private households are often used for non-GDP transactions such as buying land or already existing real estate. The authors also state that consumption credit usually played only a minor role in Germany and so did not include it in their proxy of bank credit for GDP transactions.

Ryan-Collins et al. (2016) constructed proxies for the UK. The proxy of bank credit for GDP transactions included lending to non-financial companies and lending to households but excluded lending to other financial corporations, because they argued that such loans do not contribute to GDP transactions (Ryan-Collins et al., 2016, p. 164). In the case of households, the authors included mortgage lending in the proxy of bank credit for GDP transactions because they believe that households borrowed against the value of their homes (via home equity withdrawal) for consumption purposes (Ryan-Collins et al., 2016, p. 164). The authors employed the 'General-to-Specific' methodology and an equilibrium-correction model was estimated. The results showed a long-run cointegrating relationship between increases in bank credit for GDP transactions and NGDP growth. In particular, there were strong effects of growth in bank credit for GDP transactions on growth in NGDP.

Bermejo-Carbonell and Werner (2018) constructed a proxy of bank credit for GDP transactions for Spain, which included bank lending to industry (excluding construction), to the agricultural sector, and to commerce but excluding consumer credit. However, in contrast to Werner (2014), the authors included foreign bank lending in the proxy of bank credit for GDP transactions, arguing that money from different European countries that employ the same currency can easily flow into Spain.[68] Bermejo-Carbonell and Werner (2018, p. 441) found that past values of productive credit are important for forecasting future nominal GDP values, but not the reverse (predictive power i.e. Granger causality running unidirectionally from growth in productive credit to nominal GDP growth). Table 4.1 below presents a summary of the empirical studies on the QTDC which we have discussed. It shows which

[68] They also make an argument on the role of foreign money: "FDI cannot be expected to help economic growth … foreign-denominated money stays abroad, and when exchanged into domestic money, results in domestic credit creation, which is more sustainably created by lending to domestic counterparties" Bermejo-Carbonell and Werner (2018, p. 444).

sectors have been included in the proxy of bank credit for GDP transactions in comparison to the proxy of bank credit for non-GDP transactions.

Table 4.1: Summary of empirical studies on QTDC

Author(s)	Country	Sectors in the 'real' proxy[69]				Sectors in the 'financial' proxy		
		HH	NFC	GG	RoW	REC	OFIs	HH mortgages
Werner (1997)	Japan	X	X[70]			X	X	X
Werner (2005)	Japan	X	X			X	X	X
Bezemer and Werner (2009)	Czech Republic		X[71]	X[72]				
Voutsinas and Werner (2011)	Japan	X	X			-	-	-
Lyonnet and Werner (2012)	UK	X[73]	X					
Werner (2014)	Spain	X[74]	X[75]					
Kuzin and Schobert (2014)	Germany		X[76]		X[77]			
Ryan-Collins et al. (2016)	UK	X[78]	X			-	-	-
Bermejo-Carbonell and Werner (2018)	Spain	X[79]	X		X[80]	-	-	-

Notes: X means inclusion. HH = households. NFC = non-financial corporations. GG = general government. RoW = Rest of the world. REC = real estate and construction businesses. OFIs = other financial intermediaries.

Source: Author's own compilation using data from available QTDC empirical literature

4.4 The evolution of the composition of bank credit in Mauritius

While the Mauritian economy has evolved, the composition of bank credit has also changed significantly over time. After the abolition of all forms of credit guidance in 1993, the financialization of the Mauritian economy meant that increasing amounts of credit have flown to financial transactions. Figure 4.1 shows the shift in the composition of bank credit towards construction and the financial sector from the late 1990s. The BoM, which compiles

[69] The authors include these sectors as "bank lending to sector *i*". I ignore non-profit institutions serving households (NPISH) due to their small size.
[70] Excluding loans to real estate and construction businesses (see Werner, 1997, 2005, p. 202).
[71] They exclude the real estate sector (Bezemer and Werner, 2009).
[72] They include bank loans to the government, but not government securities held by banks (Bezemer and Werner, 2009).
[73] Lyonnet and Werner (2012, p. 104), bank lending to the household sector: "secured lending to individuals" (i.e. mortgage lending) and "unsecured lending to individuals" (i.e. consumption lending).
[74] It includes mortgage lending to households but not consumption lending (Werner, 2014).
[75] Excluding the real estate sector and to the construction industry (Werner, 2014).
[76] They exclude bank lending to business services (Kuzin and Schobert, 2014). Incidentally, they also exclude loans to financial services, although this is not counted as part of the NFC sector.
[77] German net exports vis-à-vis EU countries (Kuzin and Schobert, 2014).
[78] Mortgage lending by banks but not consumption lending (Ryan-Collins et al.,2016, p.164).
[79] It includes bank lending to "industry (excluding construction) […] to the agricultural sector, and […] to commerce", and "subtract consumer credit" (Bermejo-Carbonell and Werner, 2018).
[80] They include foreign bank lending to residents, but without discriminating to which sectors these funds are lent (Bermejo-Carbonell and Werner, 2018).

data on the sectorwise distribution of credit in Mauritius, does not distinguish between the construction of new real estate from the buying and selling of existing real estate, and both categories of credit are lumped by the BoM into the construction category. The buying and selling of existing land, housing and other property do not have any effect on GDP. These are mere financial transactions.

A closer look at the data on the sector-wise distribution of bank credit to the construction sector reveals that from Rs 1 billion in 1990, this figure stood at Rs 108 billion in 2019 (Bank of Mauritius annual report, 2019). In fact, bank credit to the construction sector together with bank credit to the financial and business services sector accounted for more than 70% of the increase in credit to the private sector in 2018 (Bank of Mauritius annual report, 2018, p. 51). Real estate projects in Mauritius have gained impetus with the introduction of the Integrated Resort Scheme (IRS) and Real Estate Scheme (RES) which encourage foreigners to acquire property around the island. Brooks et al. (2017) examined the impact of foreign real estate schemes on land prices in Mauritius, and showed that the price of land paid by locals had been pushed up by about 4–22% as a result of these developments. These developments could have contributed to the increase in the demand and supply of credit to the real estate market.

There has also been a surge in the amount of bank credit allocated to financial companies. The data shows that bank credit to the financial sector stood at Rs 323 million in 1993 but this figure surged to more than Rs 110 billion in 2019 (Bank of Mauritius annual report, 2019, p. 84). It is important to note that bank credit to offshore companies does not have a large impact on GDP as these companies carry out most of their business activities outside the country. Importantly, bank credit to offshore companies consists of the majority of bank credit to the financial sector, standing at around 60% of total bank credit to the financial sector (Bank of Mauritius annual report, 2019, p. 84). Therefore, similar to bank credit to the construction sector, it remains doubtful if the soaring level of bank credit to the financial sector has had significant effects on GDP.

Figure 4.1 shows that after 1990 bank credit to the tertiary sector (mainly to hotel activities, acquisition and construction) increased, while bank credit to the primary and manufacturing industries fell sharply. We find that the amount of bank credit that has flown to manufacturing was especially significant during the economic miracle years of the country from the early 1980s to the late 1980s. After that time, it seems that bank credit did not spearhead a new wave of industrial development as the amount of bank credit to the

manufacturing industry fell sharply from 1990 onwards. Bank credit to the government and individuals and professionals remained low and stable from 1970 to 2019, while bank credit to the other categories remained insignificant during that time. Referring to Greenaway and Milner (1989), Zafar (2011, p. 100) suggests that preferential agreements such as the MFA was important in giving the country access to developed markets relative to established Asian producers. Mauritius significantly increased its total exports from the 1970s to 1990s, and indeed the period from 1984 to 1989 has been dubbed the "economic miracle" in the history of the country.

There was also a significant rise in bank credit to tertiary sectors, including bank credit to hotels and information and communication technology (ICT) amongst others. Bank credit to hotels, which promotes increases in services, makes up more than 66% of the credit to this sector (Bank of Mauritius annual report, 2019, p. 84). The ICT sector comprises mostly low value-added activities such as mobile phone subscriptions, internet bandwidth, and fixed telephone providers, and the percentage of total bank credit allocated to the ICT sector is a meagre 0.6% of total bank credit (Bank of Mauritius annual report, 2018, p. 52). Bank credit to traders, individuals and professionals and government which have GDP effects have also changed over time but the change has been quite stable. Bank credit to traders includes credit to wholesalers, retailers and dealers who generally engage in GDP transactions. Bank credit to individuals and professionals also promote GDP transactions: for instance, individual consumption covers a broad range of goods and services that includes furniture, cars and education amongst others. Bank credit to public non-financial corporations, which could be treated as part of government expenditure, also encourages GDP transactions.

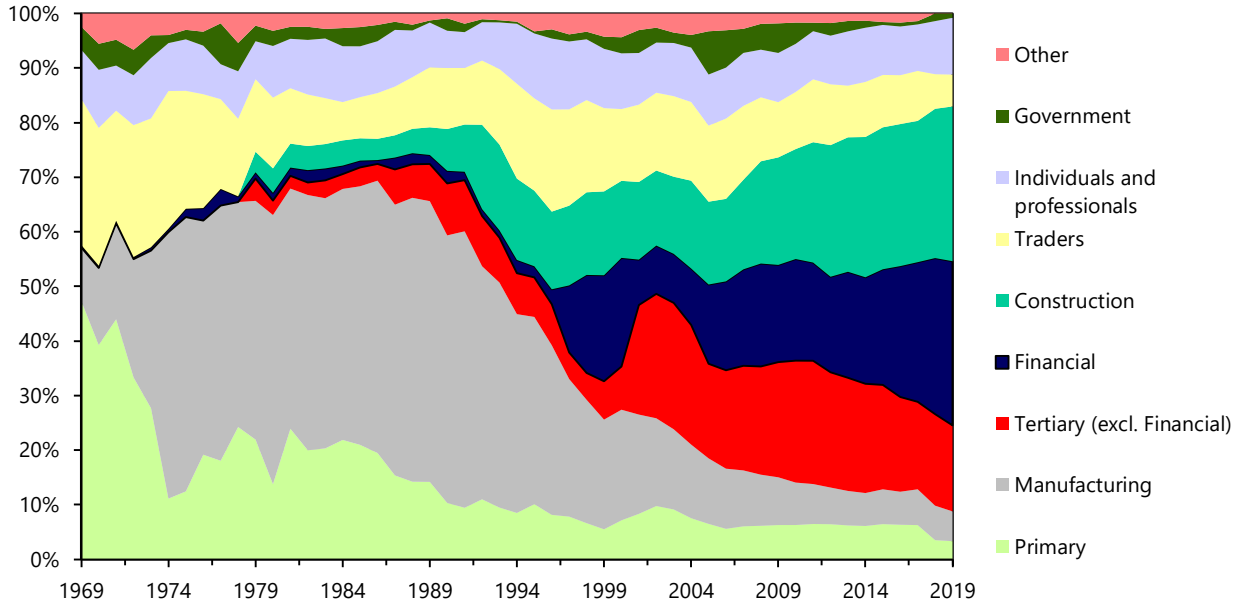

Figure 4.1: Sectoral composition of bank credit 1970–2019

Source: Author's own compilation using data from various issues of Bank of Mauritius annual reports

During much of the period from 1970 to 2019, the growth in commercial banks' credit in Mauritius has often exceeded nominal GDP growth. Figure 4.2 shows different periods when bank credit growth has significantly exceeded nominal GDP growth, notably in 1976, 1987, 1998, 2005 and 2008. In general, it shows that after 1987 and in the 1990s the trend of bank credit growth and nominal GDP growth were on a declining path which accelerated after the GFC of 2008. Figure 4.1 shows a gradual shift at about the same time in the composition of credit to the construction, financial and tertiary sectors, which also accelerated after the GFC. The shift in the composition of credit could affect the relationship between the growth in credit and NGDP and therefore a decomposition of bank credit is warranted. By using QTDC to disaggregate bank credit into bank credit for GDP transactions and bank credit for non-GDP transactions and testing the effects of the former on NGDP, we will be able to get additional insights into the evolution of the relationship between credit and growth in Mauritius.

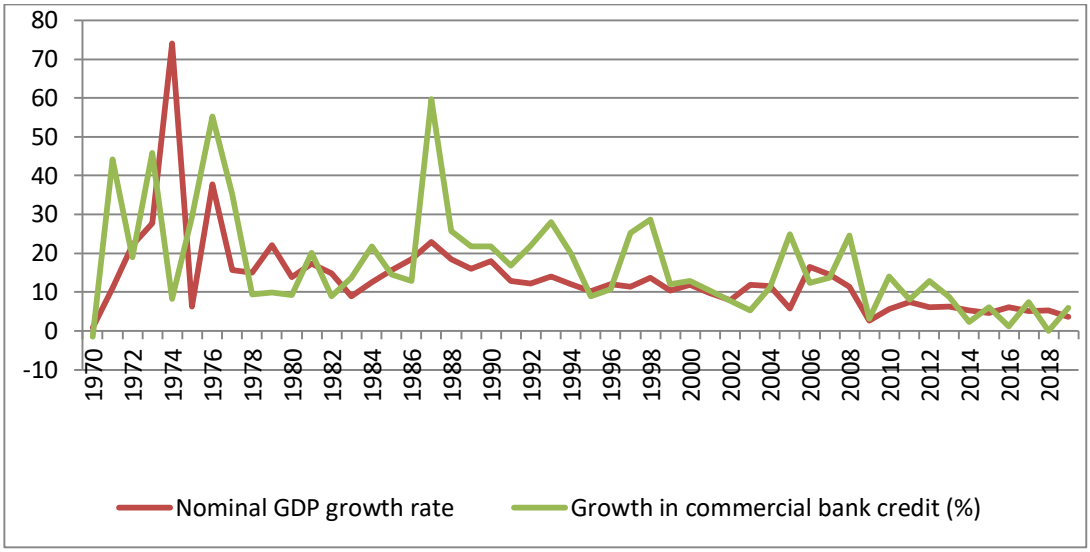

Figure 4.2: Nominal GDP growth and Bank credit growth

Source: Author's own compilation using data from Statistics Mauritius

4.5 Measuring bank credit for GDP transactions in Mauritius

It is important to recall that the equation of exchange and quantity theory of money assume a constant velocity of money. As Werner (2005) explained, the velocity of money shows the strength of the link between money and the real economy. If there is a strong link between the two, it means that "money" is being used for real sector transactions (Achameesing, 2020). This implies that the velocity of money should be stable. However, there is a dilemma which has been observed in many countries around the world which is the fall in the velocity of money (Achameesing, 2020). See Figure 4.3 for Mauritius.

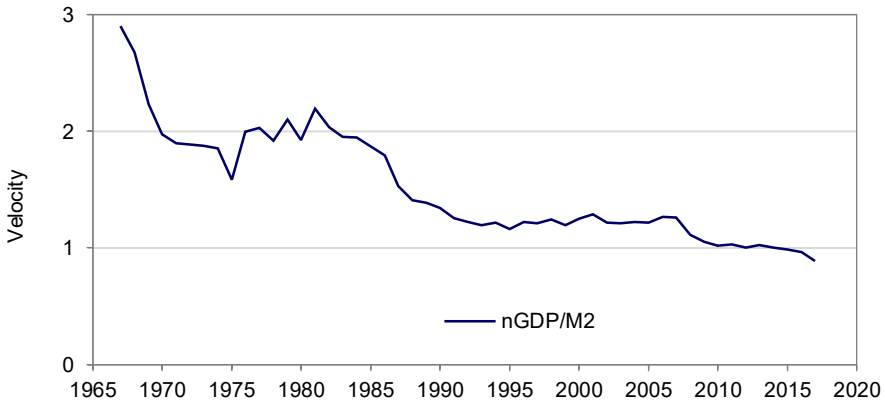

Figure 4.3: Velocity of broad money (GDP/M2) in Mauritius

Source: Author's own compilation using data from Bank of Mauritius

The QTDC shows that the velocity decline is due to the neglect of non-GDP transactions (financial transactions). Put simply, the velocity of money expresses the relationship between the numerator, GDP, and the denominator, money. If the latter rises faster than the former, there will be a velocity decline (Achameesing, 2020). Therefore, if money created for financial transactions is excluded from the denominator, the QTDC predicts that the velocity of money should become stable (Werner, 2005, p. 202). The stable velocity prediction is a cornerstone of the QTDC and helps to categorize bank credit for GDP or non-GDP transactions. This is especially significant as some kinds of credit might overlap and have both GDP and non-GDP effects. For example, bank credit to construction of new houses has GDP effects, but the demand for existing housing whose buying and selling are financial transactions have non-GDP effects.

The key challenge when testing the QTDC is crafting reliable and theoretically consistent proxies. There are various ways of doing this. The first and most obvious one is to follow a sectoral disaggregation and ask how likely each sector is to allocate the bank-borrowed funds to GDP expenditures (such as investment in fixed capital, inventories, R&D, etc.), as opposed to non-GDP expenditures (e.g. purchase of existing commercial real estate, "balance sheet restructuring", M&A, investment abroad, and so on). This, of course, is not easy to answer. We follow the same methodology as Werner (1997, 2005) to craft candidate proxies for Mauritius (see all details in Appendix 6). Each proxy has a distinct composition of borrowing.

Although there are infinite possible combinations, we tune each proxy to reflect different subsamples of what we suspect are GDP-intensive sectors. For example, we use the financial sector as a stand-alone (Proxy 2), because we know the financial sector contributes little to GDP. This is confirmed by the very high value of average velocity and standard deviation of Proxy 2 as shown in in Table 4.2. Table 4.2 displays the average *value* and *stability* of each proxy's velocity; stability being measured by the standard deviation formula. A priori speaking, a good proxy ought to yield a low-standard deviation (i.e. high stability) velocity. As we would expect, the more comprehensive proxies have the lowest standard deviations, i.e. the proxy and nominal GDP are in a more stable relationship. In terms of the average value of velocity, which is also shown in Table 4.2, previous empirical work on QTDC has estimated its value to be around 2 (see Clavero, 2017, p. 22).

Table 4.2: Average velocity and standard deviation for each proxy

ID	Proxy or monetary aggregate	Average velocity	Standard deviation
1	Total bank credit	2.84	1.44
2	To financial sector	227.73	334.97
3	To financial and construction	161.45	338.40
4	To financial, construction, tertiary and traders	10.75	9.40
5	To financial, construction, tertiary and traders and individuals and professionals	7.70	6.16
6	To financial, construction, tertiary and traders and individuals, professionals and government	7.01	5.50
7	To primary, manufacturing and tertiary	5.36	1.66
8	To primary, manufacturing and tertiary and trading	4.17	1.23
9	To primary, manufacturing and tertiary and trading and individuals and professionals	3.63	1.18
10	To primary, manufacturing and tertiary and trading and individuals and professionals and government	3.50	1.15
11	To primary, manufacturing and tertiary and trading and individuals and professionals, government and construction	2.33	1.05

Source: Author's own compilation of data of bank credit to different sub-components using data from various issues of Bank of Mauritius annual reports

Table 4.2 shows Proxy 2 and 3 include the financial sector and financial and construction sectors respectively and these two proxies remain very unstable over time. As the empirical literature on QTDC shows, those two sectors are the "usual suspects" when it comes to the issue of bank credit for non-GDP transactions and, as we discussed previously, Mauritius has witnessed a surge in bank credit to the financial and construction sectors during the past three decades. However, as a note of caution, it is still important to take into account the fact that besides the buying and selling of existing land and property, the construction sector also includes the building of new property and real estate development which largely contributes to GDP.

Proxies 4, 5 and 6 show a significant improvement in the stability of velocity as shown by the standard deviation of the proxies in Table 4.2. The inclusion of bank credit to tertiary and traders in Proxy 3, and bank credit to tertiary and traders and individuals and professionals in Proxy 3, leads to an improvement in the standard deviation of Proxies 4 and 5 respectively. The inclusion of bank credit to the government in Proxy 5 also leads to a lower standard deviation of Proxy 6. We try different combinations for subsectors of the 'real' economy. For

instance, we combine primary, manufacturing and tertiary in various ways (e.g. Proxies 7–10). As a matter of fact, from the 1970s and 1980s, Mauritius has relied largely on investments in primary and manufacturing to spearhead economic growth and those sectors are therefore natural candidates for sectors that encouraged GDP transactions. From the late 1980s and early 1990s, investments in hotels, transportation and other services took the lead, thus also promoting a large number of GDP transactions.

In that respect, when we include the primary, manufacturing and tertiary sectors in Proxies 7 to 10, we observe a further improvement in the stability of velocity. The inclusion of traders in Proxy 8 improves the stability of velocity. A disaggregated view of bank credit to the traders' sector shows that bank credit to wholesalers, retailers, automobile dealers and garages generally promote GDP transactions. Similarly, Proxy 9, which includes bank credit to individuals and professionals, promotes GDP transactions through either consumption or investment. For instance, household consumption covers a broad range of goods and services that includes furniture, medical goods and services, recreation, transport equipment and services and education amongst others. Proxy 10 incorporates bank credit to government and, as discussed earlier, includes mainly bank credit to public non-financial corporations which encourages GDP transactions. The stability in Proxies 7 to 10, which include mostly GDP transactions relative to Proxies 2 to 3, can be seen in Table 4.2 by looking at their standard deviation.

Based upon the QTDC literature, we believe that the sectors that are more likely to contribute to GDP transactions are comprehensively measured by Proxy 10. We are further comforted with this choice by the stable relationship of Proxy 10 with nominal GDP as measured by its standard deviation. However, as the QTDC literature has emphasized, bank credit to the construction sector has both GDP and non-GDP effects and therefore cannot be excluded outright from the proxy of bank credit for GDP transactions. Therefore, we add the construction sector to Proxy 10 which has been the best performer so far. As Table 4.2 shows, the resulting Proxy 11 reduces both the average velocity and standard deviation of Proxy 10 which signals that Proxy 11 could also provide a very good explanation of NGDP.

In the next section, we provide a TVC estimation of the total effects of Proxies 10 and 11 on NGDP in Mauritius from 1970 to 2019.

4.6 The fixed coefficient model used to test for QTDC and the alternative TVC model[81]

In testing QTDC, Werner and others have used fixed coefficient models. In Ryan-Collins, et al. (2016, p. 6), the authors investigated the effects of competing monetary policy instruments on nominal GDP and their first equation used an autoregressive distributed lag model which we simplify below:

$$\text{YOY}\, NGDP_t = \alpha_1 \text{YOY}\, NGDP_{t-1} + \beta_1\, YOY\, Broad\, money_t + \beta_2\, YOY\, long\, term\, rate_t + \beta_3\, YOY\, short\, term\, rate_t + \beta_4\, YOY\, CreditRE_t + \varepsilon_t \quad \ldots(4.8)$$

Equation (4.8) shows that the two variables of interest are YOY $NGDP_t$, which represents the year on year (annual) growth rate in Nominal GDP, and YOY $CreditRE_t$, which represents the year-on-year growth rate of bank credit to the real sector, also known as bank credit for GDP transactions. This model suffers from a severe limitation in that it assumes ε_t and its regressors are uncorrelated. The main problem with Equation (4.8) is that the error term ε_t is correlated with the included regressors if ε_t is made up of omitted but relevant regressors. For instance, YOY Private Investment (PI) is an omitted relevant regressor in ε_t but it is assumed to be uncorrelated with YOY CreditRE. But YOY CreditRE has effects on YOY Private Investment (PI) to affect YOY NGDP. This means that the indirect effects of YOY CreditRE on YOY NGDP are incorrectly eliminated from β_4 and therefore β_4 expresses only the direct effects of YOY CreditRE on YOY NGDP. Therefore, the fixed coefficient models ignore the indirect effects which arise because of the correlation between the included regressors and the error term, and hence the cointegration techniques used by the authors are also fatally flawed.[82]

As an alternative to Equation (4.8), we rewrite the TVC model which measures the total effects of bank credit for GDP transactions (BCGDP) on NGDP. We use the empirical framework of Swamy and Von Zur Muehlen (2020) and write a new model to measure the total effects of BCGDP on NGDP.

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[81] For a full derivation of the empirical framework, the reader can refer to Swamy and Von Zur Muehlen (2020).

[82] In this same paper of Ryan-Collins et al. (2016, p. 9) the authors used cointegration techniques. The assumptions needed to apply cointegration techniques to the regression of y_t on x_{1t} are not satisfied if the relationship with time-varying coefficients holds. TVC models contradict cointegration relationships. The coefficients of every cointegration relationship do not contain indirect effects and its error term is made up of omitted relevant regressors.

Using the relationship between NGDP_t and $BCGDP_t$ in Mauritius can be stated in terms of a deterministic law where y_t =NGDP_t and $x_{1t} = BCGDP_t$:

$$\text{NGDP}_t = \alpha_{0t} + \alpha_{1t}\ BCGDP_t + \sum_{\ell=1}^{L_t} \omega_{\ell t} w_{\ell t} \qquad \ldots(4.9)$$

where $w_{1t}, \ldots, w_{L_t t}$ are all the omitted but relevant regressors in the relationship between y_t an x_{1t} in which we are interested. Pratt and Schlaifer (1984) proved that the included regressor x_{1t} cannot be uncorrelated with every omitted regressor. This means that there is a simultaneity problem with Equation (4.9). To solve this problem, we rewrite a stochastic equation as follows:

$$w_{\ell t} = \lambda_{0\ell t} + \lambda_{1\ell t} BCGDP_t, \ell = 1, \ldots, L_t \qquad \ldots(4.10)$$

where all the variables in Equation (4.10) including $\lambda_{0\ell t}$ and $\lambda_{1\ell t}$ are treated as random variables. This is why we call Equation (4.10) "a stochastic equation".

Inserting the right-hand side of Equation (4.10) for $w_{\ell t}$ in Equation (4.9) gives Equation (4.11) which we write below:

$$\begin{aligned} \text{NGDP}_t &= \alpha_{0t} + \sum_{\ell=1}^{L_t} \omega_{\ell t}\lambda_{0\ell t} + (\alpha_{1t} + \sum_{\ell=1}^{L_t} \omega_{\ell t}\lambda_{1\ell t})\ BCGDP_t \\ &= \gamma_{0t} + \gamma_{1t}\ BCGDP_t \end{aligned} \qquad \ldots(4.11)$$

where $\gamma_{0t} = \alpha_{0t} + \sum_{\ell=1}^{L_t} \omega_{\ell t}\lambda_{0\ell t}$, $\gamma_{1t} = (\alpha_{1t} + \sum_{\ell=1}^{L_t} \omega_{\ell t}\lambda_{1\ell t})$.

α_{0t} is the intercept of Equation (4.9), the $\omega_{\ell t}$ are the coefficients of omitted regressors included in Equation (4.9), $\lambda_{0\ell t}$ is the *remainder* of each omitted regressor $w_{\ell t}$ obtained after the effects $\lambda_{1\ell t}$ of $BCGDP_t$ on $w_{\ell t}$ have been subtracted out. The term α_{1t} represents the direct effects of $BCGDP_t$ on NGDP_t as shown by Equation (4.9), $\sum_{\ell=1}^{L_t} \omega_{\ell t}\lambda_{1\ell t}$ represents the indirect effects of $BCGDP_t$ on NGDP_t due to the fact that $BCGDP_t$ affects each omitted regressor $w_{\ell t}$ which in turn affects NGDP_t.

The total effects of $BCGDP_t$ on NGDP_t are the sum of direct and indirect effects, and it can be seen from Equations (4.9) and (4.10) that both direct and indirect effects depend on omitted regressors, and *the total effects do not depend on omitted regressors.* Therefore, we estimate the total effects of $BCGDP_t$ on NGDP_t in Equation (4.11).

The coefficients and the regressor in Equation (4.11) are correlated and hence we need to find appropriate coefficient drivers to satisfy the conditional independence assumption. For this purpose, we use the following two equations:

$$\gamma_{0t} = \pi_{00} + \boldsymbol{z}_{it}\,\pi_{0i} + u_{0t} \qquad \ldots(4.12a)$$

$$\gamma_{1t} = \pi_{10} + \boldsymbol{z}_{jt}\,\pi_{1j} + u_{1t} \qquad \ldots(4.12b)$$

where z_{it} and $\boldsymbol{z}_{jt}$ are called the coefficient drivers. We need to find z_{it} and $\boldsymbol{z}_{jt}$ so that γ_{0t} and γ_{1t} are conditionally independent of $BCGDP_t$ given z_{it} and $\boldsymbol{z}_{jt}$. Finally, the autoregressive Equation (3.6) in Chapter 3 is rewritten as $\boldsymbol{u}_t = \Phi\,\boldsymbol{u}_{t-1} + \boldsymbol{a}_t$ (13), where $\boldsymbol{u}_t = (u_{0t}, u_{1t})'$ where Φ is diagonal, $\boldsymbol{E}\boldsymbol{a}_t = 0$ and $\boldsymbol{E}\boldsymbol{a}_t\boldsymbol{a}_{t'}' = \begin{cases}\sigma_a^2\Delta_a \text{ if } \boldsymbol{t}=\boldsymbol{t}'\\ 0 \text{ if } \boldsymbol{t}\neq\boldsymbol{t}'\end{cases}$.

Therefore, in this study, we consider the following: $y_t = \text{NGDP}_t$, $x_{1t} = BCGDP_t$ where (i) $proxy10C_t$ (total bank credit minus bank credit to the financial sector) and (ii) $proxy10_t$ (total bank credit minus bank credit to the financial sector minus bank credit to the construction sector). (z_{it}, $\boldsymbol{z}_{jt}$) are the coefficient drivers where $\boldsymbol{z}_{jt}$ can be one of gross fixed capital formation (GFCF_t), private investment (PI_t), or private consumption (PC_t), and z_{it} openness measures can be any of Openess of Mauritius trade (OMT_t), real effective exchange rate (REEXR_t), commodities export price index (CEXPI_t) taking two at a time. We experiment with nine different permutations of six coefficient drivers, taking two at a time, and we use the same selection criteria as in Chapter 3 to find the best models.

It is important to mention that in this study we perform a TVC estimation of the total effects of bank credit for GDP transactions on NGDP and not increases in the former on growth of the latter[83]. Empirical studies on QTDC notably Lyonnet and Werner (2012), Werner (2014)

[83]This is because we are investigating the reasons that could explain the non-linear relationship in the total effects of CBC on RGDP in Chapter 3. Hence, we want to estimate the total effects of bank credit for GDP transactions on NGDP from 1970 to 2019 to investigate if the gradual increase in bank credit for non-GDP transactions can explain the weakening relationship between CBC and RGDP during more recent times. In this

and Ryan-Collins et al. (2016) have tested the effects of increases in bank credit for GDP transactions on Nominal GDP growth.

In fact, the time difference operations of the TVC model show that increases in bank credit for GDP transactions can lead to nominal GDP growth provided that certain conditions are satisfied. We can see this below.

In addition to (4.11), (4.12a) and (4.12b), we assume that:

$$u_t = (u_{0t},\ u_{1t})' = \Phi\, u_{t-1} + a_t \qquad \ldots(4.13)$$

Taking the time difference of equations (4.11), (4.12a) and (4.12b) we can write:

$$\begin{aligned} \Delta y_t &= \Delta\gamma_{0t} + \gamma_{1t}\, x_{1t} - \gamma_{1,t-1}x_{1,t-1} + \gamma_{1,t-1}x_{1t} - \gamma_{1,t-1}x_{1t} \\ &= \Delta\gamma_{0t} + (\Delta\gamma_{1t})x_{1t} + \gamma_{1,t-1}(\Delta x_{1t}) \qquad \ldots(4.14) \end{aligned}$$

where Δ is the difference operator and for example, $\Delta y_t = y_t - y_{t-1}$, $\Delta\gamma_{0t} = \pi_{0i}(\Delta z_{it}) + \Delta u_{0t}$, $\Delta\gamma_{1t} = \pi_{1j}(\Delta z_{jt}) + \Delta u_{1t}$ and $(\Delta u_{0t}, \Delta u_{1t})$ are completely unknown. Whether Δy_t is positive whenever Δx_{1t} is positive depends on the signs and magnitudes of the terms in $\Delta\gamma_{0t} + (\Delta\gamma_{1t})x_{1t} + \gamma_{1,t-1}(\Delta x_{1t})$. Equation 4.14 shows that if x_{1t} is changed i.e $\Delta x_{1t}>0$, then y_t will change ($\Delta y_t>0$), ceteris paribus, given $(\Delta\gamma_{1t})x_{1t}$ and $\Delta\gamma_{0t}$ assuming x_{1t} is non-negative. Indeed, this assumption is realistic given that x_{1t} is a very large number and therefore is likely to swamp the intercept, and the fact that $\Delta\gamma_{1t}$ is consistently positive. Therefore, one can say that with fairly high probability, i.e very low risk that a policy that increases x_{1t} would almost always raise y_t.

4.6.1 Data and source

The study covers the period from 1970 to 2019. Similar to Chapters 2 and 3, data on REEXR comes from the European think tank the Bruegel Institute, which is available from 1963 to 2019. Data on CEXPI was obtained from the International Financial Statistics of the IMF. Data on OMT i.e. total exports plus imports as % of GDP was retrieved from from the various issues of the Bank of Mauritius annual reports. Data on private consumption, gross

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thesis, we do not investigate QTDC from a policy perspective i.e whether an increase in bank credit for GDP transactions leads to NGDP growth.

fixed capital formation and its sub-components and private investment, nominal and real GDP was obtained from Statistics Mauritius. Data on details of the sub-components of commercial bank was gathered from various issues of the Bank of Mauritius annual reports. Data on population was obtained from the United Nations World population prospects database.

4.6.2 Empirical results

4.6.2.1 Measuring the total effects of BCGDP on GDP without coefficient drivers[84]

The following IRGLS estimation will allow us to estimate the time-varying relationship between bank credit for GDP transactions on NGDP and RGDP and whether the relationship is linear or non-linear. We obtain the IRSGLS estimates of the unknown parameters ($\bar{\gamma}$, Φ , σ_a^2 , Δ_a) as shown in Table 4.3 below.

[84] We follow the same steps in Chapter 3 when we estimate the total effects of PSC or CBC on RGDP for the case without coefficient drivers. To recall for the initial coefficient driver Equation (3.5) in Chapter 3, we set p = 1, $\boldsymbol{z}_t = 1 \ \forall$ t, $\Pi = \bar{\gamma}$ with $\bar{\gamma} = (\bar{\gamma}_0, \bar{\gamma}_1)'$. For these values, Equation (3.5) becomes: $\boldsymbol{\gamma}_t = \bar{\gamma} + \boldsymbol{u}_t$ where $\boldsymbol{\gamma}_t$ is as explained in Equation (3.4), $E\,\tilde{\gamma}_{0t} = \bar{\gamma}_0$ and $E\,\tilde{\gamma}_{1t} = \bar{\gamma}_1$ are the means of the coefficients of Equation (3.4), and $\boldsymbol{u}_t$ follows the autoregressive process in Equation (3.6).

Table 4.3: Total effects of BCGDP on GDP (Case without coefficient drivers)

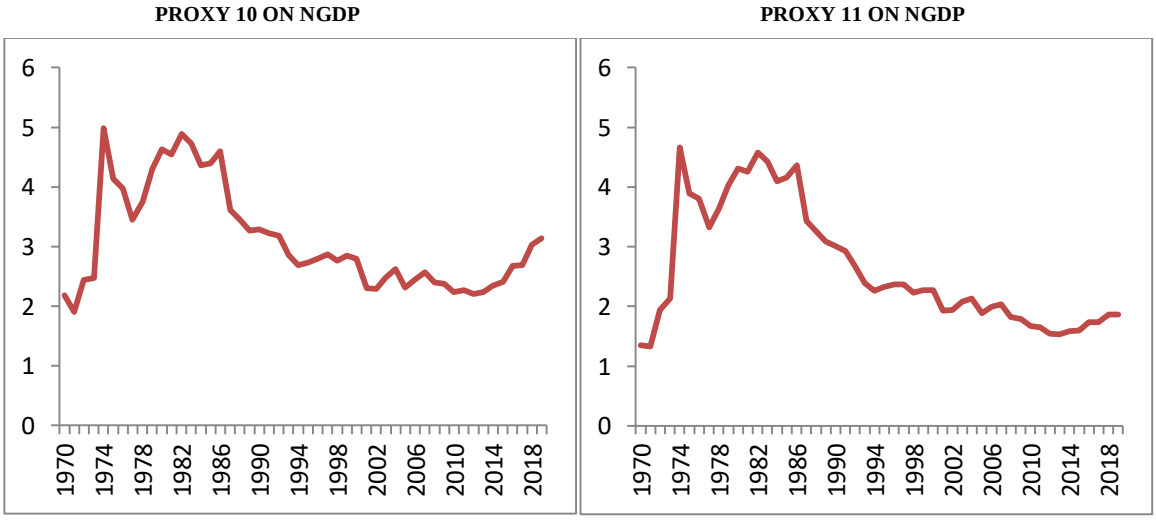
MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)*	Coefficient estimates of $\bar{\gamma}_t$		Scalar of covariance matrix	Covariance matrix of equation		Scalar of covariance matrix times Covariance matrix of equation**	
		$\widehat{\bar{\gamma}_0}$	$\widehat{\bar{\gamma}_1}$	$\hat{\sigma}_a^2$	$\hat{\Delta}_a$		$\hat{\sigma}_a^2 \, x \, \hat{\Delta}_a$	
Proxy 10 on NGDP	φ=0	806.7	3.102	9.065	0.1212E−09	0.3171E−05	0.1099E-08	0.2875E-04
		(5.862)[a]	(22.666)[a]		0.3171E−05	0.8294E−01	0.2875E-04	0.75
Proxy 11 on NGDP	φ=0	990.8	2.630	0.2553E-07	16956892.8	−26394376.4	4.33	- 6.74
		(4.561)[a]	(4.103)[a]		−26394376.4	41084361.1	-6.74	10.49
Proxy 10 on RGDP	φ=0	60004.36	7.162	0.5150E-05	9243263.2	−10492452.9	476.02	-540.35
		(48.406)[a]	(5.794)[a]		−10492452.9	11910465.6	-540.35	613.38
Proxy 11 on RGDP	φ=0	60210.93	6.549	0.5047E-05	10171444.2	−11277892.4	513.33	-569.17
		(47.960)[a]	(5.239)[a]		−11277892.4	12504699.9	-569.17	631.08

Notes: *We estimated the models for both restricted and unrestricted cases of φ. We present only the models whose gamma coefficients have the highest t-ratios. The 1%, 5% and 10% significance levels are denoted by a, b and c respectively.
**When we multiply the covariance matrix, delta, by its scalar we get its complete covariance matrix for the error term. The first and second diagonal elements of this matrix show that the variances of γ_0 and γ_1 respectively vary over time.

Source: Estimation results by author

The results in Table 4.3 for the total effects of Proxies 10 and 11 on NGDP show that the mean of the second element $\tilde{\gamma}_{1t}$ of $\tilde{\boldsymbol{\gamma}}_t$ is positive and significant, which confirms the prediction of QTDC that bank credit for GDP transactions has strong effects on NGDP. The second diagonal element of the complete covariance matrix for the error term (last column of Table 3.3) shown by the variance of the white-noise component of the error $\tilde{u}_{1t}$ is not close to zero, which shows that the total effects ($\tilde{\gamma}_{1t}$) of $BCGDP_t$ on GDP_t are not constant, varies over time, and the relationship between GDP_t and $BCGDP_t$ is not linear. The first two panels in Figure 4.4 show the total effects of Proxies 10 and 11 on NGDP. The total effects of Proxy 10 on NGDP are stronger than the total effects of Proxy 11 on NGDP throughout the period 1970 to 2019, which confirms the prediction of QTDC that bank credit to the construction sector weakens the positive effects of bank credit on GDP as it includes a large amount of bank credit for non-GDP transactions.

Specifically, the total effects of Proxy 10 on NGDP reach a peak of 4.98 in 1974 and 4.88 in 1982, while the total effects of Proxy 11 on NGDP make its highest highs at 4.66 in 1974 and 4.58 in 1982. After 1985, there is also a stronger deceleration in the total effects of Proxy 11 on NGDP with a lower low of 1.54 in 2012 in comparison to the low of 2.20 for the total effects of Proxy 10 on NGDP[85]. The variance of the white-noise component of the error $\tilde{u}_{1t}$ is significantly larger for the the total effects of Proxy 11 on NGDP as opposed to the total effects of Proxy 10 on NGDP (10.49 vs 0.75) which suggests a faster rate of change of the total effects of proxy 11 on NGDP from 1970 to 2019.



[85] After 2012, there was a significant acceleration in the total effects of Proxy 10 on NGDP which was due to a significant increase in bank credit to SMEs. We explain this extensively in the next section when we discuss the case with coefficient drivers.

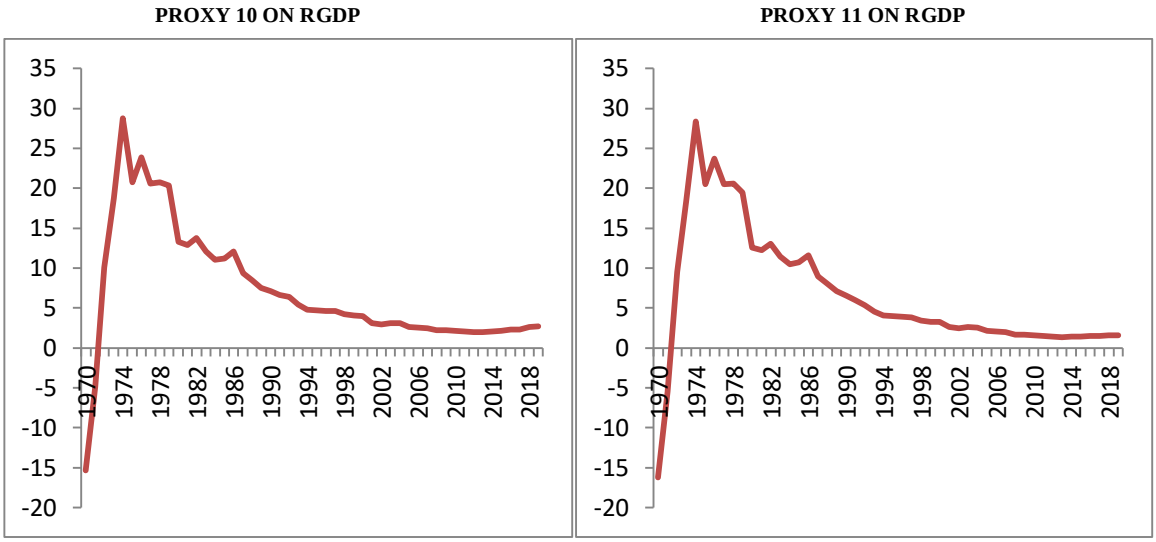


Figure 4.4: Time path of the total effects of Proxies 10 and 11 on GDP

Source: Based on estimation results by author

When we change the dependent variable from NGDP to RGDP, the total effects of Proxies 10 and 11 on RGDP exhibit a significant rise from 1970 to 1974, followed by a non-monotonic decline from 1975 to 2019. The lower panel of Figure 4.4 shows the non-linear relationship between Proxies 10 and 11 and RGDP. This gives further evidence of non-linearity in the relationship between bank credit and GDP in Mauritius.

As opposed to existing fixed and variable coefficient model estimations which estimate only the *direct effects* of the regressor on the dependent variable, we have used a TVC model to estimate the *total effects* of $BCGDP_t$ on GDP_t. However, Equation (4.11) still suffers from the correlation of the coefficients with the regressor. In the next section, we use different permutations of coefficient drivers to remove the correlation of the coefficients with the regressor. We shall then assess how well each coefficient driver explains the behaviour of the total effects of $BCGDP_t$ on GDP_t over time.

4.6.2.2 Measuring the total effects of BCGDP on NGDP with coefficient drivers

Table 4.4: Total effects of Proxy 10 on NGDP (case with coefficient drivers)

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER OF 12(a)	COEFFICIENT ESTIMATES OF γ_{0t} in Equations 11 and 12(a)		COEFFICIENT DRIVER OF 12(b)	COEFFICIENT ESTIMATES OF γ_{1t} in Equations 12 and 12(b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
II	φ=0	CEXPI	-284.03	5.277	PI	3.821	-0.000026	0.84	REJECT
			(-0.328)	(-0.934)		(22.42)[a]	(-5.518)[a]		
III	φ=0	OMT	-2306.94	27.571	PI	3.648	-0.000023	0.75	ACCEPT
			(-2.256)[b]	(2.779)[a]		(22.49)[a]	(-5.080)[a]		
IV	φ=0	REEXR	-5573.21	51.153	PI	3.821	-0.000026	0.83	REJECT
			(-1.916)[c]	(2.095)[b]		(23.76)[a]	(-5.782)[a]		
V	φ=0	CEXPI	-331.01	5.466	GFCF	3.867	-0.00002	0.81	REJECT
			(-0.387)	(0.982)		(22.52)[a]	(-5.735)[a]		
VI	φ=0	OMT	-2259.73	26.96	GFCF	3.69	-0.000018	0.73	ACCEPT
			(-2.236)[b]	(2.749)[a]		(22.49)[a]	(-5.266)[a]		
VII	φ=0	REEXR	-5653.49	51.67	GFCF	3.867	-0.00002	0.80	REJECT
			(-1.977)[c]	(2.153)[b]		(23.90)[a]	(-6.017)[a]		
VIII	φ=0	CEXPI	-51.94	4.194	PC	3.652	-0.0000044	1.23	REJECT
			(-0.056)	(0.689)		(21.23)[a]	(-4.420)[a]		
IX	φ=0	OMT	-2487.54	29.92	PC	3.493	-0.0000038	1.1	ACCEPT
			(-2.271)[b]	(2.821)[a]		(21.51)[a]	(-4.045)[a]		
X	φ=0	REEXR	-5348.02	49.82	PC	3.661	-0.0000045	1.23	REJECT
			(-1.695)[c]	(1.882)[c]		(22.40)[a]	(-4.639)[a]		
XI	φ=0	GFCF	713.78	3.34	EXPORTS	1.734	-0.0255	0.21	REJECT
			(8.267)[a]	(8.863)[a]		(3.238)[a]	(-2.544)[a]		
XII	φ≠0	PC	213.98	1.504	EXPORTS	-1.542	0.0218	0.24	REJECT
			(1.751)[c]	(10.66)[a]		(-2.725)[a]	(2.870)[a]		
XIII	φ=0	PC	474.99	1.757	EXPORTS	-3.667	0.0487	0.19	ACCEPT
			(8.024)[a]	(15.81)[a]		(-6.892)[a]	(7.258)[a]		

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER OF 12(a)	COEFFICIENT ESTIMATES OF γ_{0t} in Equations 11 and 12(a)		COEFFICIENT DRIVER OF 12(b)	COEFFICIENT ESTIMATES OF γ_{1t} in Equations 12 and 12(b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
XIV	φ≠0	GFCF	700.87	2.34	IMPORTS	3.428	-0.0375	0.06	ACCEPT
			(5.193)[a]	(5.455)[a]		(4.084)[a]	(-2.696)[a]		
XV	φ=0	GFCF	560.16	3.588	IMPORTS	3.555	-0.0552	0.13	REJECT
			(6.220)[a]	(10.11)[a]		(4.544)[a]	(-4.026)[a]		
XVI	φ≠0	PI	762.34	2.547	IMPORTS	3.565	-0.033	0.13	REJECT
			(4.767)[a]	(4.110)[a]		(3.891)[a]	(-2.223)[b]		
XVII	φ=0	PI	594.74	4.469	IMPORTS	3.376	-0.0461	0.12	REJECT
			(5.209)[a]	(6.798)[a]		(3.409)[a]	(-2.662)[a]		
XVIII	φ=0	PC	603.18	1.541	IMPORTS	-2.814	0.0373	0.31	REJECT
			(7.202)[a]	(10.96)[a]		(-3.086)[a]	(3.029)[a]		

Notes: Proxy 10 is calculated by substracting bank credit to the financial and construction sectors from total commercial bank credit.The 1%, 5% and 10% significance levels are denoted by a, b and c respectively. For convenience we do not show the scalar of the covariance matrix times the covariance matrix of the equations in the table. The second diagonal element of the resulting matrix show that the variances of γ_1 vary over time.

*For each coefficient driver of Z_{jt} we accept the case which shows significance of both π_{10} and π_{1J} and also has the minimum forecasting error i.e. the lowest U statistic.

Source: Estimation results by author

Table 4.5: Total effects of Proxy 11 on NGDP (case with coefficient drivers)

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER OF 12(a)	COEFFICIENT ESTIMATES OF γ_{0t} in Equations 11 and 12(a)		COEFFICIENT DRIVER OF 12(b)	COEFFICIENT ESTIMATES OF γ_{1t} in Equations 12 and 12(b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
II	φ=0	CEXPI	-348.97	6.159	PI	3.628	-0.000036	1.24	REJECT
			(-0.401)	(1.085)		(21.401)[a]	(-7.746)[a]		
III	φ=0	OMT	-2562.57	30.717	PI	3.442	-0.000033	1.09	ACCEPT
			(-2.547)[a]	(3.149)[a]		(21.67)[a]	(-7.492)[a]		
IV	φ=0	REEXR	-4590.85	43.48	PI	3.62	-0.000036	1.22	REJECT
			(-1.5416)	(1.740)[c]		(22.17)[a]	(-7.928)[a]		
V	φ≠0	CEXPI	-2063.45	19.68	GFCF	2.705	-0.0000061	0.18	REJECT
			(-4.888)[a]	(7.539)[a]		(3.306)[a]	(-0.630)		
VI	φ=0	CEXPI	-407.83	6.389	GFCF	3.689	-0.000028	1.2	REJECT
			(-0.481)	(1.155)		(21.84)[a]	(-8.116)[a]		
VII	φ=0	OMT	-2499.40	29.89	GFCF	3.498	-0.000025	1.06	ACCEPT
			(-2.543)[a]	(3.135)[a]		(22.02)[a]	(-7.827)[a]		
VIII	φ=0	REEXR	-4701.52	44.21	GFCF	3.667	-0.000028	1.18	REJECT
			(-1.623)	(1.819)[c]		(22.648)[a]	(-8.315)[a]		
IX	φ=0	CEXPI	-98.17	5.001	PC	3.441	-0.0000066	1.96	REJECT
			(-0.103)	(0.803)		(19.76)[a]	(-6.472)[a]		
X	φ=0	OMT	-2750.31	33.20	PC	3.269	-0.0000059	1.73	ACCEPT
			(-2.504)[b]	(3.123)[a]		(20.15)[a]	(-6.276)[a]		
XI	φ=0	REEXR	-4359.54	42.16	PC	3.44	-0.0000066	1.95	REJECT
			(-1.331)	(1.534)		(20.445)[a]	(-6.635)[a]		
XII	φ=0	GFCF	709.05	3.635	EXPORTS	1.384	-0.0238	0.33	REJECT
			(8.303)[a]	(11.80)[a]		(2.782)[a]	(-2.432)[b]		
XIII	φ≠0	PC	206.02	1.623	EXPORTS	-1.568	0.020	0.16	REJECT
			(1.994)[b]	(11.52)[a]		(-3.412)[a]	(2.860)[a]		
XIV	φ=0	PC	387.54	1.724	EXPORTS	-2.521	0.033	0.06	ACCEPT

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER OF 12(a)	COEFFICIENT ESTIMATES OF γ_{0t} in Equations 11 and 12(a)		COEFFICIENT DRIVER OF 12(b)	COEFFICIENT ESTIMATES OF γ_{1t} in Equations 12 and 12(b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
			(7.168)[a]	(22.72)[a]		(-7.524)[a]	(6.346)[a]		
XV	φ≠0	GFCF	750.1	2.489	IMPORTS	2.999	-0.0355	0.25	REJECT
			(5.394)	(5.749)[a]		(3.621)[a]	(-2.559)[a]		
XVI	φ=0	GFCF	556.07	3.804	IMPORTS	3.215	-0.0525	0.19	ACCEPT
			(6.185)[a]	(13.43)[a]		(4.273)[a]	(-4.024)[a]		
XVII	φ≠0	PI	840.02	2.625	IMPORTS	3.087	-0.0307	0.32	REJECT
			(4.946)[a]	(4.055)[a]		(3.316)	(-2.051)[b]		
XVIII	φ=0	PI	569.88	5.185	IMPORTS	3.093	-0.0482	0.35	REJECT
			(4.908)[a]	(9.168)[a]		(3.215)[a]	(-2.879)[a]		
XIX	φ=0	PC	461.78	1.691	IMPORTS	-2.347	0.0272	0.26	REJECT
			(6.027)[a]	(16.87)[a]		(-3.565)[a]	(2.739)[a]		

Notes: Proxy 11 is calculated by substracting bank credit to the financial sector from total commercial bank credit. The 1%, 5% and 10% significance levels are denoted by a, b and c respectively. For convenience we do not show the scalar of the covariance matrix times the covariance matrix of the equations in the table. The second diagonal element of the resulting matrix show that the variances of γ_1 vary over time.

*For each coefficient driver of Z_{jt} we accept the case which show significance of both π_{10} and π_{1J} and also has the minimum forecasting error i.e. the lowest U statistic.

Source: Estimation results by author

The results shown in Tables 4.4 and 4.5 provide estimates of the total effects, γ_{1t} of Proxies 10 and 11 on NGDP respectively. The two coefficients of γ_{1t}, π_{10} and π_{1j}, represent the partial direct effects and partial indirect effects respectively of BCGDP as measured by Proxies 10 and 11 on NGDP. All the remaining part of the total effects is captured by the error term in Equation (4.12b). What stands out is the consistency of the results of the total effects of Proxy 10 on NGDP for Models II to X and the total effects of Proxy 11 on NGDP for Models II to XI across different measures of openness. The results for π_{10} shows significant positive partial direct effects of Proxies 10 and 11 on NGDP. The positive partial direct effects imply that the effects of bank credit for GDP transactions on NGDP are significant and positive, which adds empirical support to QTDC. The partial indirect effects measured by π_{1j} show that all the indirect channels through which Proxies 10 and 11 affect NGDP in Mauritius for Models II to XI are significant (except Model V for proxy 11) but negative, which calls into question the *uses* of bank credit in the country. This confirms our prior insight that there are vanishing effects of finance on growth because the composition of bank credit has changed.

In Tables 4.4 and 4.5, the pair of coefficient drivers (z_{it}, z_{jt}) for (OMT, PI), (OMT, GFCF), (OMT, PC), (PC, EXPORTS) and (GFCF, IMPORTS) show the best results for each coefficient driver of z_{jt} in terms of significance at the 5% level of the two coefficients of γ_{1t}, namely π_{10} and π_{1j}, and the lowest U statistic. The negative sign on the different coefficients of π_{1j} for the four coefficient drivers of z_{jt} for the pair of coefficient drivers, (OMT, PI), (OMT, GFCF), (OMT, PC) and (GFCF, IMPORTS) shows that bank credit has not promoted GDP growth through investment, consumption and imports.

On the other hand, bank credit has promoted GDP growth through exports for the pair of coefficient drivers (PC, EXPORTS) (see Model XIII in Table 4.4 and Model XIV in Table 4.5) but the partial direct effects are negative. The negative partial direct effects of credit on growth with the pair of coefficient drivers (PC, EXPORTS) suggest that this pair of coefficient drivers helps to deplete the total effects over time of Proxies 10 and 11 on NGDP[86]. Figure 4.5 confirms that the time path of the total effects of Proxies 10 and 11 on

[86] The partial indirect effects of disaggregated bank credit on GDP using exports as a coefficient driver show that bank credit stimulates GDP via exports. This finding corroborates the findings of Chapter 3 in which we find that private sector credit stimulates economic growth via exports. However, since the partial direct effects and the total effects are negative, we remain cautious in the interpretation of these results.

NGDP estimated by the pair (PC, EXPORTS) remains negative and flat throughout the period 1970 to 2019. These results suggest that the positive coefficient on the estimate of EXPORTS has not been strong enough to drive the positive relationship between bank credit for GDP transactions and NGDP.

The time path of the total effects of Proxies 10 and 11 on NGDP in Figure 4.5 for the pair of coefficient drivers (OMT, PI), (OMT, GFCF) and (OMT, PC) shows that the strongest effects of bank credit for GDP transactions on NGDP occurred from 1973 to 1986 although there were a few sporadic declines in the relationship between the two during that time. These periods were marked by the introduction of a credit ceiling on the expansion of unproductive credit in 1973 and the promotion of bank credit to manufacturing industries. The time path of the total effects of Proxy 10 and 11 on NGDP for the pair of coefficient drivers (GFCF, IMPORTS) also shows positive effects of bank credit for GDP transactions on NGDP from the mid 1970s to 1982 but these effects are relatively weaker compared to the pair of coefficient drivers (OMT, PI), (OMT, GFCF) and (OMT, PC)[87].

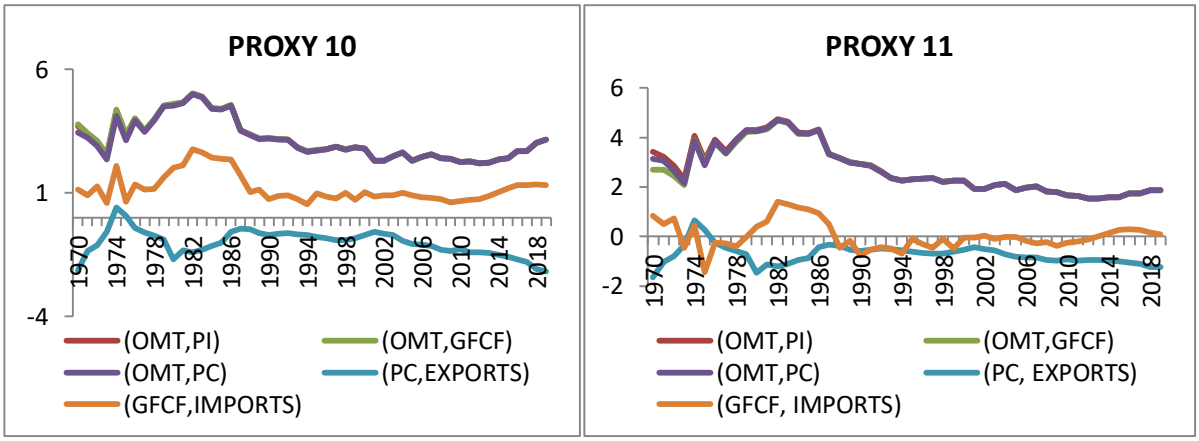


Figure 4.5: Time path of the total effects of Proxies 10 or 11 on NGDP

Note: $\hat{\gamma}_{1t}$ for the best case of each coefficient driver of z_{jt}

Source: Based on estimation results by author

The total effects of Proxies 10 and 11 on NGDP rose at the beginning of the economic miracle years from 1984 to 1986[88]. However, from about 1987, the effect of bank credit for

[87] The time path of the total effects of Proxy 11 on NGDP with the pair of coefficient drivers (GFCF, IMPORTS) remains largely in the negative region throughout the period 1970 to 2019.

[88] In the last part of this study, we show that the total effects of Proxy 10 on RGDP (when investment in machines (IM) is used as a coefficient driver for z_{jt}) perform much better in explaining the economic miracle from 1984 to the early 1990s.

GDP transactions on nominal GDP started to fall though non-monotically. After the financial liberalization policies put in place in the early 1990s, bank credit to financial sectors and construction sectors (previously categorized as non-priority sectors) started to quickly gain ground in the 1990s. The evolution of the sectoral composition of credit (see Figure 4.1) shows that the rise in bank credit to the construction and financial sectors took off from the mid-1990s. Since the construction and financial sectors are less GDP intensive in nature, the expansion of bank credit to these sectors has led to a decline in the positive total effects of bank credit for GDP transactions on NGDP from late 1980s to about 2013.

In 2012–2013, the total effects of Proxies 10 and 11 on NGDP reached a minimum point before turning around. We believe that a major event happened in the country after that time which can provide an explanation of the reversal in the total effects of Proxies 10 and 11 on NGDP from 2015 onwards. On 2nd April 2015, there was the collapse of a major commercial bank in the country, the Bramer Banking Corporation, which was subsequently taken over by a newly formed state-owned bank, the MauBank, which itself came from the defunct Mauritius Post Cooperative Bank. The newly established MauBank started its activities on 4th January 2016 with its core activity being to provide significant financial support to SMEs. Maubank introduced innovative and competing financing plans for SMEs who want to engage in agri-business, ICT, Blue Economy, innovation and research, among others (Government of Mauritius, 2016).

The assets of MauBank increased from Rs 10 billion in 2015–2016 to reach more than Rs 15 billion in 2018–2019, which represents an increase of more than 50% within less than four years. We believe that these developments have led to a significant boost in bank credit for GDP transactions through SME loans and hence provide an explanation of the acceleration in the positive effects of Proxy 10 on NGDP from 2015–2016 onwards. Notice that the increase in the total effects of Proxy 11 on NGDP is relatively muted because of a significant increase in bank credit to the construction sector from 2015. From 2015 to 2019, bank credit to the construction sector experienced an increase of more than 25% to reach Rs 108 billion in 2019 (Bank of Mauritius annual report, 2019).

A closer look at the magnitude of the total effects of Proxy 10 on NGDP shows that it is always higher than the total effects of Proxy 11 on NGDP throughout the period 1970 to 2019. The total effects of Proxy 10 on NGDP rose from a low of 2.54 in 1973 to reach a peak of 5.02 in 1982 and after 1986 gradually declined to reach its lowest level at 2.19 in 2012. In contrast, the time path of the total effects of Proxy 11 on NGDP rose from a low of 2.08 in

1973 to reach its highest level at 4.69 in 1982 before falling to a trough of 1.53 in 2013. From the late 1980s and early 1990s, there was a stronger deceleration in the time path of the total effects of Proxy 11 on NGDP in comparison to the time path of the total effects of Proxy 10 on NDP. These findings add support to the QTDC which predicts that as banks increase their allocation of credit to more non-GDP transactions, the effect on credit on the economy weakens. The forecasting results of the models which estimate the total effects of Proxy 10 on NGDP are superior to the models which estimate the total effects of Proxy 11 on NGDP, which further adds empirical support to QTDC and the fact that bank credit for GDP transactions has powerful effects on the economy.

The relative weakness in the total effects of Proxy 11 on NGDP in comparison to the total effects of Proxy 10 on NGDP is explained by the fact that bank credit to the construction sector includes bank credit for non-GDP transactions. The inclusion of existing transactions as part of bank credit to construction is a fact which has been implicitly recognized by the BOM, which defines the construction sector as the construction of buildings such as dwellings and offices, public utility buildings and civil engineering projects relating to the road network, sewage systems or the port. It also encompasses the real estate sector which *includes the acquisition and disposal of real estate properties*, property rentals and other real estate services (Bank of Mauritius annual report, 2017, p. 47). The financing of construction also includes the transaction of a major non-GDP component in the form of existing land whose value has been rising sharply across the island from the 2000s (see Brooks et al. (2017, p. 8). This surge in the price of land implies that a larger amount of bank credit to the construction sector is in effect financing the acquisition of more expensive land, which weakens the positive effects of bank credit on GDP.

4.6.2.3 Measuring the total effects of bank credit for GDP transactions on GDP using disaggregated measures of investment as coefficient drivers

In this section, we estimate the total effects of bank credit for GDP transactions on GDP using a decomposition of GFCF. We disaggregate GFCF into three specific types of investment and use the three disaggregated measures of investment as coefficient drivers to estimate the partial indirect effects of bank credit for GDP transactions on GDP. In a presentation at the Cass Business School, Turner (2014) provided an interesting perspective of looking at the evolution of investment from the 1970s to the current time. He suggested a tentative hypothesis based on the distinction between investment in “real estate”, “machines” and “infrastructure”. Turner (2016, p. 71) highlighted the current dominance of real estate

investment which shows the increasing importance of land and housing as secured collateral for banks.

The rising dominance of real estate lending also reflects its importance as an asset class for borrowers. The awareness of rising land prices gives momentum to the price effect as real estate becomes an asset class in which people invest not only to enjoy housing services but also in the anticipation of future capital gains. As the supply of land is perfectly inelastic, increases in demand tends to drive its price continuously higher. The inevitable consequence is that an increasing share of investment is accounted for by those categories of capital expenditure where prices are not falling, and the most important of those is real estate. In his bestselling book *Capital in the 21st century*, Piketty (2013) showed that in many countries, the surge in the wealth to income ratio over the past 50 years in many economies has been driven largely by the value of housing.

On the other hand, investment in what Turner (2014, p. 28) calls "machines" is subject to the opposite price trend, which explains why investment is falling. By "machines" Turner (2014, p. 28) means all the forms of capital equipment, hardware, robots, information systems and software, and applications etc. According to the IMF World Economic Outlook (2015, p. 134) the price of capital equipment relative to prices of current goods and services has fallen by 33% between 1990 and 2014. Compared with the substantial amount of investment that went into building automobiles and airline factories in the earlier part of the 20th century, Brynjolfsson and McAfee (2014, p. 58) explained that the collapsing cost of hardware capacity and the zero marginal cost of software replication enable ICT companies today to create huge wealth with very little capital investment. Finally, Turner (2014, p. 28) also explained that there is a significant need for investment in infrastructure in many economies which may be well below the socially optimum level, especially in an era of global warming and climate change.

Using the proposition of Turner (2014), we disaggregate GFCF in Mauritius into three types of investment: Real and Commercial Real Estate Investment (RCREI), Investment in Machines (IM) and Investment in Infrastructure (II). We present the evolution in the three disaggregated measures of investment in Figure 4.6. We find that there has been a significant increase in residential and commercial real estate investment in Mauritius. It shows the trend in this type of investment gaining momentum after financial liberalization in 1990s as investment in residential housing and commercial real estate activities increased in the country. Real estate projects seem to have gained further impetus with the introduction of the

Integrated Resort Scheme (IRS) in 2002 and Real Estate Scheme (RES) in 2007 which boosted real estate investment across the island.

The trend in IM, which consists largely of investment in manufacturing industries, suffered a dramatic fall in recent years from its highest levels in the early 1970s and mid-1980s which marked the peak of the economic miracle years of the country. The trend clearly shows that investment in machines mainly used at the time in primary and secondary industries has fallen consistently since the early 1990s and today forms only a minor share of total investment in the country. Figure 4.6 also shows that total infrastructure investment has remained quasi stable in the country over the past fifty years.

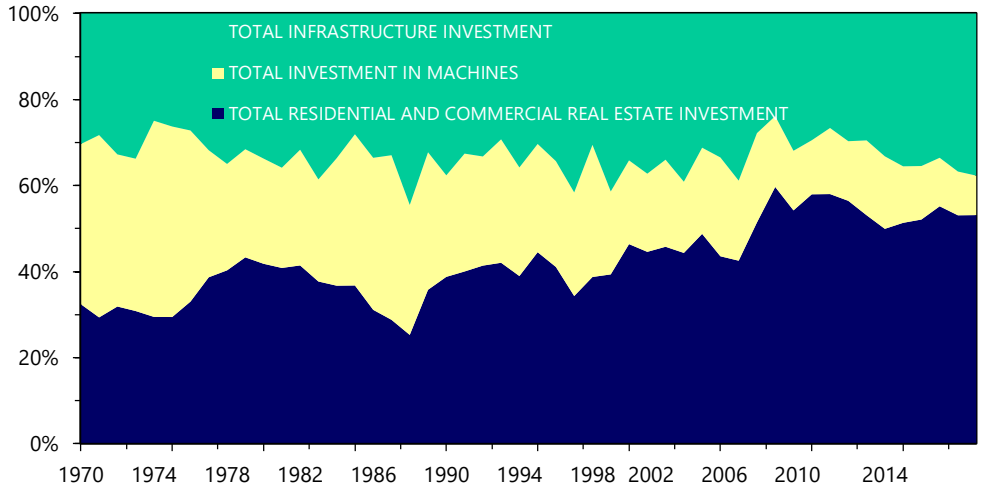


Figure 4.6: GFCF and its disaggregation into three types of investment based on Turner (2014)

Source: Author's own compilation of data from Statistics Mauritius

It is possible that given the bias of the banking system in Mauritius to lend against the security of real estate, there has been too much investment in RCREI in the country. On the other hand, IM has fallen over time as the country has experienced a fall in investment in primary and manufacturing activities. However, we argue that for a developing economy such as Mauritius there is still a significant need for investment in "machines" which today could include precision agriculture, high-tech manufacturing, pharmaceutics, renewable technology, ICT, FinTech, robotics and artificial intelligence. II as a share of total investment has remained quasi stable over the past fifty years. However, there might still be a need to revamp existing infrastructure as well as the need to create new infrastructure that will underpin the growth of a modern economy in the 21st century.

In this section, we estimate the total effects of Proxies 10 and 11 on GDP (NGDP and RGDP) using RCREI, IM and II as our main coefficient drivers for z_{jt}. Consider the following: y_t = GDP_t, x_{1t} = $BCGDP_t$, which can either be (i) $proxy10_t$ (total bank credit minus bank credit to the financial sector minus bank credit to the construction sector) or (ii) proxy11_t (total bank credit minus bank credit to the financial sector) and the coefficient drivers (z_{it}, z_{jt}) which consist of nine permutations of three measures of openness for z_{it}: Openness of Mauritius trade (OMT_t), Real effective exchange rate (REEXR_t), Commodities export price index (CEXPI_t) and three disaggregated measures of investment[89] for z_{jt} namely Residential and Commercial Real Estate Investment ($RCREI_t$), Investment in Machines (IM_t) and Investment in Infrastructure (II_t). RCREI, IM and II are used as coefficient drivers to estimate the partial indirect effects of Proxies 10 and 11 on GDP. In terms of the selection criteria to find the best model of this study, we use the same criteria as before. The TVC results are shown in Tables 4.6, 4.7, 4.8 and 4.9 below.

[89] Note that data on gross fixed capital formation and its sub-components was obtained from Statistics Mauritius.

Table 4.6: Total effects of Proxy 10 on NGDP (case with coefficient drivers for disaggregated investment)

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER of Equation (4.12a)	COEFFICIENT ESTIMATES of γ_{0t} in Equations (4.11) and (4.12a)		COEFFICIENT DRIVER of Equation (4.12b)	COEFFICIENT ESTIMATES of γ_{1t} in Equations (4.11) and (4.12b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
II	φ=0	CEXPI	-277.48	5.196	II	3.834	-0.000058	0.81	REJECT
			(-0.316)	(0.908)		(21.70)[a]	(-5.332)[a]		
III	φ=0	OMT	-2306.27	27.535	II	3.657	-0.000051	0.73	ACCEPT
			(-2.221)[b]	(2.732)[a]		(21.56)[a]	(-4.860)[a]		
IV	φ=0	REEXR	-5562.65	51.01	II	3.836	-0.000059	0.80	REJECT
			(-1.887)[c]	(2.063)[b]		(22.97)[a]	(-5.588)[a]		
V	φ=0	CEXPI	-779.71	7.337	IM	4.303	-0.00019	0.30	REJECT
			(-1.115)	(1.621)		(26.08)[a]	(-8.595)[a]		
VI	φ=0	OMT	-1943.09	22.411	IM	4.095	-0.00017	0.27	ACCEPT
			(-2.324)[b]	(2.750)[a]		(25.45)[a]	(-7.889)[a]		
VII	φ=0	REEXR	-6043.57	53.59	IM	4.284	-0.00019	0.29	REJECT
			(-2.637)[a]	(2.788)[a]		(28.00)[a]	(-9.062)[a]		
VIII	φ=0	CEXPI	-192.17	4.87	RCREI	3.743	-0.000033	0.95	REJECT
			(-0.2163)	(0.840)		(22.29)[a]	(-5.151)[a]		
IX	φ=0	OMT	-2370.66	28.45	RCREI	3.579	-0.000029	0.85	ACCEPT
			(-2.267)[b]	(2.807)[a]		(22.48)[a]	(-4.751)[a]		
X	φ=0	REEXR	-5490.48	50.71	RCREI	3.747	-0.000039	0.95	REJECT
			(-1.836)[c]	(2.020)[b]		(23.59)[a]	(-5.401)[a]		

Notes: Proxy 10 includes bank credit to primary, manufacturing, tertiary and trading and individuals and professionals and government. The 1%, 5% and 10% significance levels are denoted by a, b and c respectively. For convenience we do not show the scalar of the covariance matrix

times the covariance matrix of the equations in the table. The second diagonal element of the resulting matrix show that the variances of γ_1 vary over time.

*For each coefficient driver of Z_{jt} we accept the case which shows significance of both π_{10} and π_{1J} and also has the minimum forecasting error i.e. the lowest U statistic.

Source: Estimation results by author

Table 4.7: Total effects of Proxy 11 on NGDP (case with coefficient drivers for disaggregated investment)

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER of Equation (4.12a)	COEFFICIENT ESTIMATES of γ_{0t} in Equations 11 and 12(a)		COEFFICIENT DRIVER of Equation (4.12b)	COEFFICIENT ESTIMATES of γ_{1t} in Equations (4.11) and (4.12b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
II	φ=0	CEXPI	-365.54	6.16	II	3.67	-0.000084	1.21	REJECT
			(-0.4203)	(1.087)		(21.19)[a]	(-7.772)[a]		
III	φ=0	OMT	-2525.04	30.22	II	3.479	-0.000075	1.06	REJECT
			(-2.503)[b]	(3.087)[a]		(21.33)[a]	(-7.471)[a]		
IV	φ=0	REEXR	3766.20	-20.46	II	4.383	-0.00013	0.23	ACCEPT
			(1.643)	(-1.198)		(16.18)[a]	(-6.555)[a]		
V	φ=0	CEXPI	-835.45	8.09	IM	4.147	-0.00024	0.34	REJECT
			(-1.189)	(1.777)		(25.30)[a]	(-10.97)[a]		
VI	φ=0	OMT	-2217.57	25.66	IM	3.921	-0.00023	0.28	ACCEPT
			(-2.698)[a]	(3.205)[a]		(24.98)[a]	(-10.44)[a]		
VII	φ=0	REEXR	-5096.12	46.14	IM	4.119	-0.00024	0.33	REJECT
			(-2.141)[b]	(2.311)[b]		(26.24)[a]	(-11.21)[a]		
VIII	φ≠0	CEXPI	-2089.76	19.34	RCREI	3.143	-0.000027	0.33	ACCEPT
			(-4.635)[a]	(6.689)[a]		(9.188)[a]	(-2.388)[b]		
IX	φ=0	CEXPI	-233.37	5.650	RCREI	3.527	-0.000048	1.45	REJECT
			(-0.2575)	(0.955)		(20.77)[a]	(-7.170)[a]		
X	φ=0	OMT	-2644.34	31.85	RCREI	3.349	-0.000043	1.27	REJECT
			(-2.528)[a]	(3.144)[a]		(21.12)[a]	(-6.952)[a]		
XI	φ≠0	REEXR	-4478.43	42.86	RCREI	3.522	-0.000048	1.44	REJECT
			(-1.441)	(1.643)		(21.50)[a]	(-7.344)[a]		

Notes: Proxy 11 includes bank credit to primary, manufacturing, tertiary and trading and individuals and professionals, government and construction.The 1%, 5% and 10% significance levels are denoted by a, b and c respectively. For convenience we do not show the scalar of the covariance matrix times the covariance matrix of the equations in the table. The second diagonal element of the resulting matrix show that the variances of γ_1 vary over time.

*For each coefficient driver of Z_{jt} we accept the case which shows significance of both π_{10} and π_{1J} and also has the minimum forecasting error i.e. the lowest U statistic.

Source: Estimation results by author

Table 4.8: Total effects of Proxy 10 on RGDP[90] (case with coefficient drivers for disaggregated investment)

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER of Equation (4.8a)	COEFFICIENT ESTIMATES of γ_{0t} in Equations (4.12) and (4.8a)		COEFFICIENT DRIVER of Equation (4.8b)	COEFFICIENT ESTIMATES of γ_{1t} in Equations (4.12) and (4.8a)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
II	φ=0	CEXPI	33584.40	157.36	II	14.24	-0.00054	0.67	REJECT
			(4.540)[a]	(3.267)[a]		(9.580)[a]	(-5.803)[a]		
III	φ=0	OMT	10646.68	457.72	II	10.78	-0.00038	0.53	ACCEPT
			(1.383)	(6.128)[a]		(8.625)[a]	(-4.975)[a]		
IV	φ=0	REEXR	124224.59	-560.23	II	12.679	-0.00047	0.69	REJECT
			(4.635)[a]	(-2.491)[b]		(8.362)[a]	(-4.941)[a]		

[90] In this section, we investigate the total effects of Proxies 10 and 11 on RGDP. The reason we change the dependent variable from NGDP to RGDP is to be consistent with Chapters 2 and 3 in which we use RGDP as the dependent variable. In the last part of the appendix (see appendix 7), for comparison, we also provide the ARDL results for the direct effects of Proxies 10 and 11 on RGDP. The ARDL results show positive effects of both proxies on RGDP in the short run while their effects are negative in the long run.

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER of Equation (4.8a)	COEFFICIENT ESTIMATES of γ_{0t} in Equations (4.12) and (4.8a)		COEFFICIENT DRIVER of Equation (4.8b)	COEFFICIENT ESTIMATES of γ_{1t} in Equations (4.12) and (4.8a)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
V	φ≠0	CEXPI	99318.03	-183.48	IM	3.73	-0.00011	0.33	ACCEPT
			(12.24)[a]	(-3.266)[a]		(6.916)[a]	(-2.063)[b]		
VI	φ=0	CEXPI	132794.50	-390.82	IM	3.569	-0.00015	2.38	REJECT
			(13.11)[a]	(-4.948)[a]		(13.59)[a]	(-6.231)[a]		
VII	φ≠0	OMT	70503.24	58.56	IM	4.476	-0.00013	0.39	REJECT
			(5.594)[a]	(0.520)		(6.905)[a]	(-2.120)[b]		
VIII	φ=0	OMT	10195.42	641.03	IM	3.894	-0.00017	1.77	REJECT
			(0.6130)	(4.493)[a]		(15.30)[a]	(-6.956)[a]		
IX	φ=0	REEXR	174796.17	-773.52	IM	3.901	-0.00017	2.18	REJECT
			(5.634)[a]	(-2.921)[a]		(14.14)[a]	(-6.707)[a]		
X	φ=0	CEXPI	34662.15	152.99	RCREI	13.18	-0.0003	7.15	REJECT
			(4.512)[a]	(3.054)[a]		(9.078)[a]	(-5.244)[a]		
XI	φ=0	OMT	9875.12	468.13	RCREI	9.99	-0.00021	5.17	ACCEPT
			(1.247)	(6.010)[a]		(8.293)[a]	(-4.537)[a]		
XII	φ=0	REEXR	125398.15	-566.97	RCREI	11.75	-0.00026	6.41	REJECT
			(4.539)[a]	(-2.446)[b]		(8.010)[a]	(-4.499)[a]		

Notes: Proxy 10 includes bank credit to primary, manufacturing, tertiary and trading and individuals and professionals and government.The 1%, 5% and 10% significance levels are denoted by a, b and c respectively. For convenience we do not show the scalar of the covariance matrix times the covariance matrix of the equations in the table. The second diagonal element of the resulting matrix show that the variances of γ_1 vary over time.

*For each coefficient driver of Z_{jt} we accept the case which shows significance of both π_{10} and π_{1J} and also has the minimum forecasting error i.e. the lowest U statistic.

Source: Estimation results by author

Table 4.9: Total effects of Proxy 11 on RGDP (case with coefficient drivers for disaggregated investment)

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER of Equation (4.12a)	COEFFICIENT ESTIMATES of γ_{0t} in Equations (4.11) and (4.12a)		COEFFICIENT DRIVER of Equation (4.12b)	COEFFICIENT ESTIMATES of γ_{1t} in Equations (4.11) and (4.12b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
II	φ=0	CEXPI	33187.26	161.21	II	13.66	-0.00054	0.64	REJECT
			(4.422)[a]	(3.295)[a]		(9.140)[a]	(-5.184)[a]		
III	φ=0	OMT	9717.77	468.15	II	10.27	-0.00039	0.47	ACCEPT
			(1.258)	(6.248)[a]		(8.221)[a]	(-5.062)[a]		
IV	φ=0	REEXR	128501.33	-594.84	II	12.13	-0.00048	0.67	REJECT
			(4.735)[a]	(-2.610)[a]		(7.967)[a]	(-4.977)[a]		
V	φ=0	CEXPI	29931.39	174.59	IM	16.98	-0.00161	3.42	REJECT
			(4.561)[a]	(4.103)[a]		(11.09)[a]	(-7.770)[a]		
VI	φ=0	OMT	11647.94	440.43	IM	12.80	-0.00118	2.52	ACCEPT
			(1.688)[c]	(6.554)[a]		(9.715)[a]	(-6.672)[a]		
VII	φ=0	REEXR	125442.22	-578.37	IM	15.03	-0.00142	3.11	REJECT
			(5.121)[a]	(-2.815)[a]		(9.287)[a]	(-6.417)[a]		
VIII	φ≠0	CEXPI	113781.64	-263.44	RCREI	2.965	-0.000018	0.18	ACCEPT
			(12.81)[a]	(-3.968)[a]		(2.334)[b]	(-2.116)[b]		
IX	φ=0	CEXPI	151989.99	-509.32	RCREI	2.847	-0.000039	10.7	REJECT
			(15.48)[a]	(-6.224)[a]		(16.83)[a]	(-6.574)[a]		
X	φ≠0	OMT	37243.21	437.28	RCREI	2.909	-0.000023	0.20	REJECT
			(1.935)[c]	(2.622)[a]		(9.312)[a]	(-3.014)[a]		

MODELS	Unrestricted case (φ≠0) or restricted case (φ=0)	COEFFICIENT DRIVER of Equation (4.12a)	COEFFICIENT ESTIMATES of γ_{0t} in Equations (4.11) and (4.12a)		COEFFICIENT DRIVER of Equation (4.12b)	COEFFICIENT ESTIMATES of γ_{1t} in Equations (4.11) and (4.12b)		THEIL FORECASTING VALUES	CONCLUSION*
		Z_{it}	π_{00}	π_{0i}	Z_{jt}	π_{10}	π_{1j}	U STATISTIC	ACCEPT/ REJECT
XI	φ=0	OMT	17512.93	616.99	RCREI	3.506	-0.000054	7.7	REJECT
			(1.224)	(5.337)[a]		(18.24)[a]	(-7.370)[a]		
XII	φ≠0	REEXR	130331.79	-411.84	RCREI	3.077	-0.000023	0.21	REJECT
			(4.240)[a]	(-1.600)		(7.126)[a]	(-2.496)[b]		
XIII	φ=0	REEXR	205563.54	-993.94	RCREI	3.112	-0.000044	9.55	REJECT
			(8.847)[a]	(-4.869)[a]		(22.16)[a]	(-8.397)[a]		

Notes: Proxy 11 includes bank credit to primary, manufacturing, tertiary and trading and individuals and professionals, government and construction.The 1%, 5% and 10% significance levels are denoted by a, b and c respectively. For convenience we do not show the scalar of the covariance matrix times the covariance matrix of the equations in the table. The second diagonal element of the resulting matrix show that the variances of γ_1 vary over time.

*For each coefficient driver of Z_{jt} we accept the case which shows the significance of both π_{10} and π_{1J} and also has the minimum forecasting error i.e. the lowest U statistic.

Source: Estimation results by author

The results in Tables 4.6, 4.7, 4.8 and 4.9 provide estimates of the total effects, γ_{1t} of Proxies 10 and 11 on GDP respectively. The results for π_{10} shows strong positive and significant partial direct effects of Proxies 10 and 11 on GDP. The partial indirect effects measured by π_{1j} show that all the indirect channels through which Proxies 10 and 11 affect GDP in Mauritius are significant but negative which again shows that the *uses* of bank credit have not been efficient in the country.

Table 4.6 shows the partial indirect effects π_{1j} in Models V, VI and VII for the pair of coefficient drivers, (CEXPI, IM), (OMT, IM) and (REEXR, IM) are all weakly negative and have the highest significance than the other models. This result suggests that though bank credit for GDP transactions contributed to NGDP through investment in machines in the 1970s and 1980s, its effects faded during the most recent decades. The decline in the relationship between bank credit and investment in machines can be seen from 1987 onwards though there are sporadic periods of growth during that time (see Figure 4.7). The consistency of the results across different measures of openness and the excellent forecasting results of the pair of coefficient drivers (CEXPI, IM), (OMT, IM) and (REEXR, IM) add further robustness to the results of these models.

Table 4.7 confirms that if we abstract from Model IV with the pair of coefficient drivers (REEXR, II), the partial indirect effects π_{1j} of IM with (CEXPI, IM), (OMT, IM) and (REEXR, IM) show that they are weakly negative and their coefficients have a stronger significance than the other coefficient drivers of z_{jt}. Apart from the pair of coefficient drivers (REEXR, II) and (CEXPI, RCREI), the forecasting results for (OMT, IM) and (REEXR, IM) are superior to all other models. These results confirm that the effects of bank credit for GDP transactions worked relatively better through investment in machines. The total effects of Proxy 11 on NGDP estimated by the pair of coefficient drivers (REEXR, II) show that effects of bank credit for GDP transactions on NGDP also seem to work well through II, which can be seen from the relatively weaker magnitude of the partial indirect effects of π_{1j} coupled with excellent forecasting results. However, the results are not consistent across different measures of openness. The magnitude of the partial indirect effects of π_{1j} and the forecasting results of the pair of coefficient drivers (CEXPI, II) and (OMT, II) do not support the findings of the pair of coefficient drivers (REEXR, II).

Table 4.8 shows that the coefficients of the partial indirect effects π_{1j} of IM for Models V, VI and VII with the pair of coefficient drivers (CEXPI, IM), (OMT, IM) and (REEXR, IM) respectively are all weakly negative, which suggests that the total effects of Proxy 10 on economic growth have worked relatively better through IM. The excellent forecasting results of (CEXPI, IM) and (REEXR, IM) adds further confidence to the results. The results in Table 4.9 show that the coefficients of the partial indirect effects π_{1j} of Models VIII and X with the pair of coefficient drivers (CEXPI, RCREI) and (OMT, RCREI) respectively are weakly negative, which suggests that the total effects of Proxy 11 on economic growth have worked relatively better through RCREI. The excellent forecasting results of (CEXPI, RCREI) and (OMT, RCREI) also adds robustness to this observation.

The time paths of the best models for the total effects of Proxies 10 and 11 on GDP when each of the three disaggregated measures of investment are used as coefficient drivers of z_{jt} are shown in Figures 4.7 and 4.8. They show that if we abstract from the peak of (REEXR, II) in 1974, the total effects of Proxy 10 on GDP are stronger than the total effects of Proxy 11 on GDP throughout the period.

In fact, irrespective of whether we use aggregate or disaggregated measures of investment, the time path of the total effects of Proxy 10 on GDP outperforms the time path of the total effects of Proxy 11 on GDP, which confirms the prediction of the QTDC that bank credit to the construction sector weakens the effect of bank credit on GDP. Also, the bimodal distribution in Figure 4.7 in comparison to Figure 4.8, suggests a more stable relationship between bank credit for GDP transactions and NGDP in comparison to the relationship between bank credit for GDP transactions and RGDP. The superior forecasting results in Tables 4.6 and 4.7 compared to the forecasting results of Tables 4.8 and 4.9 also shows the empirical validity of the QTDC.

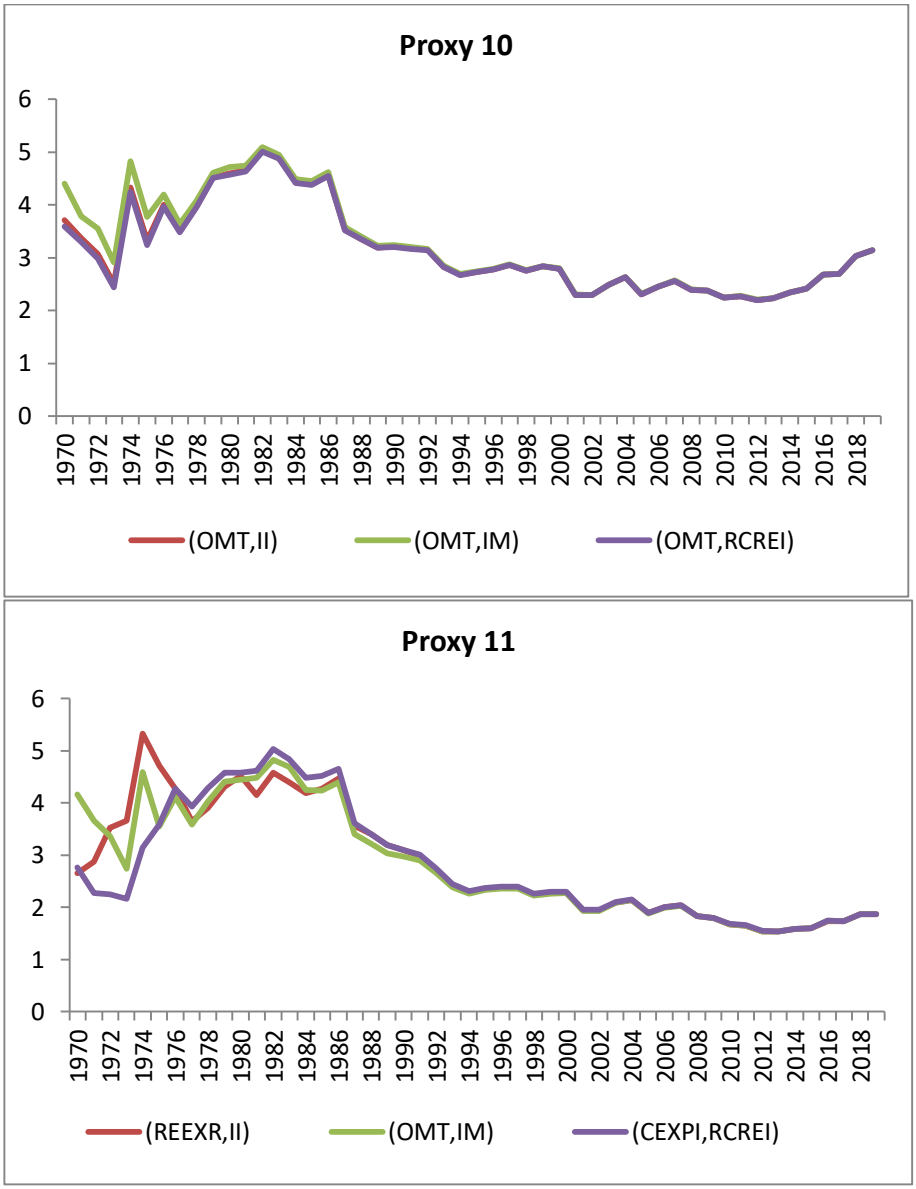


Figure 4.7: Time path of the total effects of Proxy 10 or 11 on NGDP

Note: $\hat{\gamma}_{1t}$ for the best case of each coefficient driver of z_{jt} (disaggregated measures of investment)

Source: Based on estimation results by author

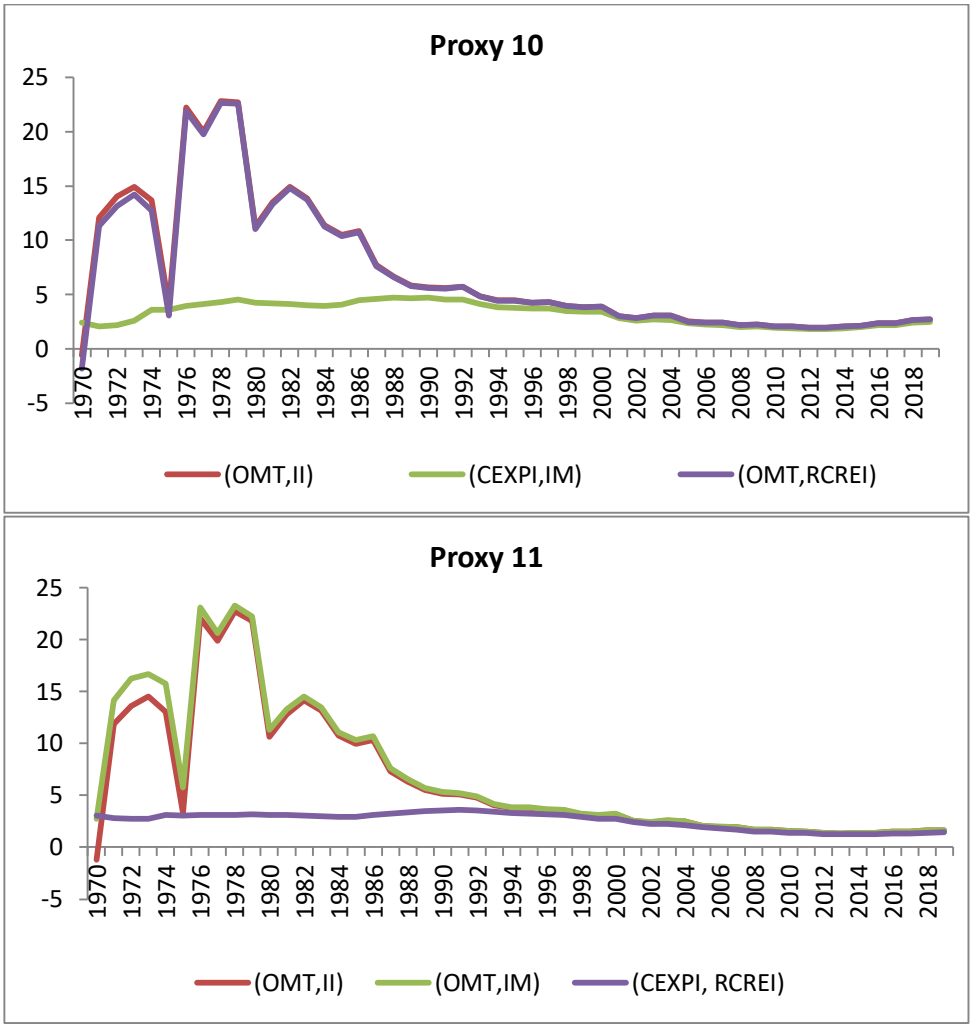


Figure 4.8: Time path of the total effects of Proxy 10 or 11 on RGDP

Note: $\hat{y}_{1t}$ for the best case of each coefficient driver of z_{jt} (disaggregated measures of investment)

Source: Based on estimation results by author

Figures 4.7 and 4.8 show stronger total effects of Proxies 10 and 11 on GDP (NGDP and RGDP) in the 1970s and 1980s but the effects fade after this period as banks shifted their allocation of credit towards non-GDP transactions. However, the time paths of the total effects of Proxy 10 on RGDP in Figure 4.8 for (OMT, II) and (OMT, RCREI) and Proxy 11 on RGDP for (OMT, II) and (OMT, IM) seem to provide an incomplete explanation of the positive effects of bank credit on economic growth during the economic miracle years of the country from 1983 to the late 1980s. The forecasting results of these pair of coefficient drivers are also inferior to the pair of coefficient drivers (CEXPI, IM) for Proxy 10 and (CEXPI, RCREI) for Proxy 11.

Figure 4.9 zooms out the total effects of Proxy 10 on RGDP estimated by the pair of coefficient drivers (CEXPI, IM) and the time path of the total effects of Proxy 11 on RGDP with the pair of coefficient drivers (CEXPI, RCREI) and both show strong effects of bank credit for GDP transactions on economic growth until about 1992 before the effects of credit on economic growth started to decline from 1993.

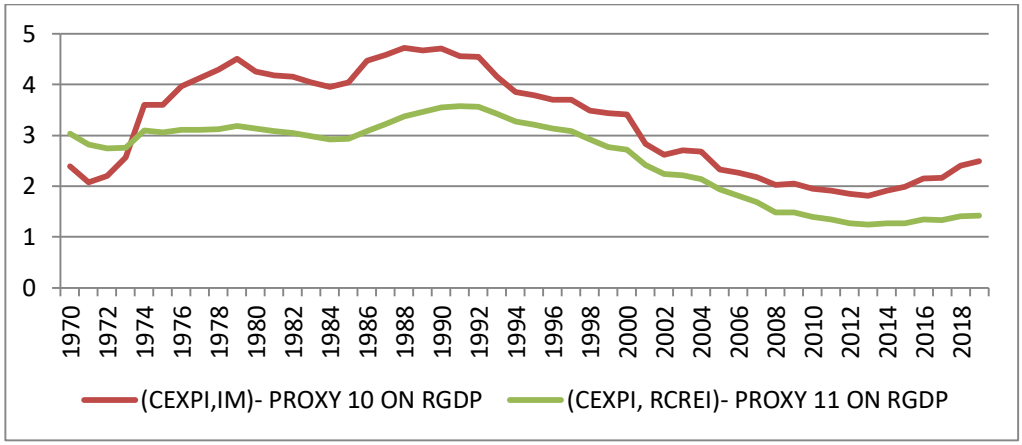


Figure 4.9: Time path of the total effects of Proxy 10 or 11 on RGDP

Note: $\hat{\gamma}_{1t}$ for the best two models

Source: Based on estimation results by author

The total effects of Proxies 10 and 11 on RGDP estimated by the pair of coefficient drivers (CEXPI, IM) and (CEXPI, RCREI) respectively provide striking evidence of the effects of credit policies by the BoM on the *strength* of the link between bank credit for GDP transaction and *real* GDP. The figure shows the total effects of Proxies 10 and 11 on RGDP. The series grows substantially in the early 1970s and mid 1980s, and starts a moderate decline in around 1992. With striking coincidence, the period 1973–1992 was one of a system of *credit controls* whose overriding objective at the time was to ensure that the expansion of bank credit was directed towards *productive* sectors of the economy. Here is a little history.

The introduction of credit controls – which mainly took the form of *ceilings* imposed by the BoM on the credit the banks were allowed to extend to specific *sectors* of the Mauritian economy – took place in June 1973 as a response to what was perceived as an excessive demand for unproductive credit. The measure took the form of a cap on the growth rate of bank lending to the *trade sector*, which the BoM mandated was to rise by less than 10 percent per year during the latter half of 1973 (Bank of Mauritius annual report, 1973, p. 23). In July

1974, an exemption was introduced for those industries operating in the Export Processing Zone (EPZ) and to those holding a Development Certificate, to which the ceilings stopped to apply (Bank of Mauritius annual report, 1974, p. 29). Concomitantly, the industrial sector continued its growth in 1976 and the credit requirements of export industries, both long-term and working capital were met on a priority basis and export finance provided at a concessional rate (Bank of Mauritius annual report, 1976, p. 11). In June 1976, bank credit to industries and manufacturers accounted for more than 45% of total private sector credit (Bank of Mauritius annual report, 1976, p. 24).

The fall in sugar prices from the mid 1970s, rising imports and continuing pressures of foreign exchange reserves called for an intensification of the existing measures in the formulation of monetary policy for 1979. From May that year, importers of lower priority items were not allowed access to credit from the domestic banking system or from abroad (Bank of Mauritius annual report, 1979, p. 7). In the late 1970s, the country faced a severe balance of payments crisis and subsequently the time path of both Proxies 10 and 11 on RGDP declined from 1979 to 1984. During that time, under the stand-by agreement an overall credit ceiling continued to be established in consultation with the IMF (Fry and Roi, 1995, p. 2).

The trend in the allocation of credit to the productive sectors of the economy strengthened again from 1984 which marked the beginning of the "economic miracle" years of the country. The priority sectors of the economy absorbed over 50 percent of the increase during the year 1983–84 (Bank of Mauritius annual report, p. 21). The manufacturing sector alone absorbed 65 percent of the overall increase in private sector credit (Bank of Mauritius annual report, 1986, p. 23). In 1986–87, about 92 percent of bank credit was extended to the "productive sectors" of the economy, and the manufacturing sector alone accounted for nearly 50 percent of the overall increase in private sector credit (Bank of Mauritius annual report 1987, p. 21).

Fluctuations of the two series *within* the 1973–1993 periods are consistent with the data on how bank credit was allocated. It is striking how story is told in a different way but quite eloquently in Figure 4.9. The whole period of credit controls on unproductive credit, which lasted 20-odd years, from June 1973 until 1992–1993, coincides with a sharp rise in the total effects of Proxy 10 on RGDP in 1973–4, and a steady decline of the total effects of Proxies 10 and 11 after 1992–93 – a striking coincidence that is not accidental and is to be expected.

In July 1992 and 1993, all forms of credit ceilings on the expansion of credit were *removed*. After the removal of all forms of credit controls in 1993, there was a surge in bank credit to financial and construction activities. In July 1993, the sub-ceiling on credit to the non-priority sectors of the economy was abolished, and one year later credit to non-priority sectors of the economy soared by 55.3 percent and accounted for 71.1 percent of the total increase in private sector credit (Bank of Mauritius annual report, 1994, p. 27). This trend in bank credit continued during much of the 1990s and credit to the construction and financial sectors accelerated (see Figure 4.1).

It is illuminating also to reflect on the difference between the two series plotted in Figure 4.9, both in terms of their absolute values and their trends. The way the statistics from the Bank of Mauritius – which this chapter has used – are constructed are such that bank credit to the 'construction sector' not only includes bank credit to construction companies – which, admittedly, contribute to GDP through GFCF, e.g. the creation of structures, flats, houses, offices, etc. – but, crucially, also bank credit to real estate companies, which contribute much less to GDP; those that not only act as intermediary agents but also as dealers who buy and sell *existing* tangible assets, and the national accounts treat those transactions as outside the perimeter of GDP.

Overall, through the whole period covered by the graph, Proxy 10 has stronger total effects than Proxy 11 on RGDP. A comparative analysis shows that the time path for the total effects of Proxy 10 on RGDP rises from a low of 2.06 in 1971 to reach a peak of 4.51 in 1979. As compared to the total effects of Proxy 10 on RGDP, the total effects of Proxy 11 on RGDP remains weaker as it rises from a low of 2.74 in 1972 to reach a peak of 3.18 in 1979. The total effects of Proxy 10 on RGDP remain stronger than the total effects of Proxy 11 on RGDP during the economic miracle years of the country, with Proxy 10 reaching its highest level at 4.71 in 1988 which is above the high of 3.57 of Proxy 11 in 1991. As banks shifted their allocation of credit to more non-GDP transactions there was a stronger deceleration in the time path of the total effects of Proxy 11 on RGDP which fell after 1993 to reach an all-time low of 1.24 which is lower than the low of 1.81 of Proxy 10 in 2013.

The sharper decline in the time path of the total effects of Proxy 11 on RGDP is due to the fact that as banks increased their allocation of credit to construction there was an increase in bank credit for non-GDP transactions, and thus the link between bank credit and economic growth weakened considerably. This makes sense, for Proxy 10 is Proxy 11 excluding the 'construction sector' (which includes construction as well as real estate). The reason is that

for every Rs 1 lent to the sectors in Proxy 10, a greater share is likely to fund GDP transactions compared to Proxy 11. In particular, the real estate sector will likely borrow heavily, and allocate a small fraction of the funds to GDP activities, and most of the borrowed money will be spent on buying existing – pre-built – tangible real estate assets including increasingly more expensive land, thereby not contributing to GDP (the contribution to GDP has *already* happened in the construction phase of those assets).

To recap: The statistical results, synthesized in Figure 4.9, are perfectly consistent with the historical record, the rises and falls in the total effects of the two proxies coinciding very well with the introduction and abolition of credit ceilings to unproductive sectors, respectively, and it is also consistent with our understanding of the different sectors of the economy and how much they contribute to GDP and non-GDP transactions.

We believe that the evolution of the time path of the total effects of Proxy 10 on RGDP with IM as the main coefficient driver[91] that measures the indirect effects of bank credit on economic growth validates the importance of bank credit for productive investment. These findings concur with the views of eminent economists such as Schumpeter (1954) who stated that bank lending may lead to the creation of "real capital" that would not have otherwise existed: Banks do not, of course, "create" legal-tender money and still less do they "create' machines. They do, however, something – it is perhaps easier to see this in the case of the issue of banknotes- which, in its economic effects, comes pretty near to creating legal-tender money and which may lead to the creation of "real capital" that could not have been created without this practice (Schumpeter, 1954, p.1114).

In addition to bank credit, we believe a number of other factors have also played a role in explaining the high growth rates of Mauritius especially in the 1980s. Romer (1992) argued that ideas, rather than capital, labour, or other factors of production, were the key ingredient for growth. In the case of Mauritius, he suggested that importing ideas from abroad through inward FDI was mainly due to Chinese businessmen bringing textile manufacturing ideas and kick-starting the country's industrialization (Svirydzenka and Petri, 2014, p. 4). Indeed, the

[91] Model V for the total effects of Proxy 10 on RGDP satisfies the two rules of Zellner (1988, p. 8) in establishing a causal law in econometrics. Model V satisfies the first rule because it does not involve any logical or mathematical contradictions. The conditional independence assumption laid down in Swamy and Von Zur Muelhen (2020, p. 5) is satisfied because the random gamma coefficients are completely determined by the pair of coefficient drivers (CEXPI, IM), Proxy 10 being redundant once the data for the pair of coefficient drivers (CEXPI, IM) are given (note all the four $\pi's$ in Model V are significant). Model V also satisfies the second rule of Zellner (1988, p. 8) as it is also capable of yielding explanations of past data and verifiable predictions of as yet unobserved data. The forecast of the out of sample values of RGDP by Model V has a U statistic less than one.

time path of the total effects of Proxy 10 on RGDP surged to its peak in 1988 which marked the climax of the golden years of the country. It should be noted that the clothing and textile industry was the major sector experiencing the transformation with employment growing from 20,000 in 1983 to over 80,000 in 1988 (Nath and Madhoo, 2003, p. 24).

In their paper Subramanian and Roy (2001) attempted to delve deeper into the question of explaining the Mauritian miracle by referring to the ideas of Meade (1961), Romer (1993), Sachs and Warner (1995, 1997) and Rodrik (1999). James Meade wrote in 1961: "It is going to be a great achievement if the country can find productive employment for its population without a serious reduction in the existing standard of living … The outlook for peaceful development is weak." Subramanian and Roy (2001, p. 5) argued that history proved Nobel Prize winner James Meade famously wrong as the level of economic growth soared in Mauritius from the 1970s.

Subramanian and Roy (2001) argued that Romer (1993), Sachs and Warner (1995, 1997) and Rodrik (1999) did not provide convincing explanations of the Mauritian growth experience in the mid-1970s and 1980s. Subramanian and Roy (2001) showed that the economic miracle could be attributed partly to strong domestic institutions in place in the country and this has not been given due attention by economists in explaining the high growth experience of Mauritius. Their econometric results, however, suggest that even after accounting for the role of institutions, there is a sizable unexplained component to Mauritian growth (Subramanian and Roy, 2001, p. 37). This research points to a new factor or variable to be taken into consideration that has not been given the attention it deserves – authors seem barely aware of it – namely, credit guidance schemes. We argue that the setting up of the credit controls system by the BoM in the form of a credit ceiling on the expansion of credit to non-priority sectors in 1973 and the unrestrained expansion of credit to priority sectors from 1973 to 1993 has been a key element in driving higher growth rates of the country in the 1970s and indeed during its economic miracle years in the 1980s.

4.7 Conclusion and policy recommendations

This study has brought to light four major findings. First, the effects of bank credit for GDP transactions on GDP are not constant but vary over time and are non-linear. This result contrasts the findings of previous empirical studies on QTDC that have used fixed coefficient models and hence assumed that the positive effects of bank credit for GDP transactions on GDP are constant. Second, bank credit has had stronger effects on growth from 1970 to about

1990 but then the effect weaken due to increasing bank credit for non-GDP transactions. Third, Proxy 10 has had stronger effects on GDP than Proxy 11 because the latter includes bank credit to construction whose non-GDP effects weaken the relationship between bank credit and GDP. Fourth, the indirect effects of Proxy 10 on economic growth as measured by Investment in Machines gives a powerful channel through which bank credit can stimulate economic growth.

The findings of this study suggest two overlapping reasons which potentially explain the vanishing effects between finance and growth observed in Mauritius. First, banks have increasingly been allocating bank credit to non-GDP transactions from 1993 to 2013. Second, the weaker impact of bank credit to the construction sector on economic growth could be explained by the fact that a larger fraction of the costs of RCREI consists of the rising costs of land which does not contribute to GDP transactions. Hence, with higher land prices, increasing bank credit to RCREI has had vanishing effects on economic growth. Thus, we propose policies that include *a limit on bank credit for non-GDP transactions, an increase in capital risk weights for real estate lending, loan to income constraints on borrowers* and more radical measures such as *the creation of new banks with a dedicated focus on non-real estate lending*.

Financial policies should ensure that bank credit is reoriented to productive investments that would steer the country back on a path of high and sustainable growth. This study suggests that "true Quantitative Easing" as a policy tool, as originally defined by Werner (1995) i.e. the direct stimulation of GDP through the increase in bank credit for GDP transactions, can be a powerful instrument in comparison to the quite blunt tool of interest rate tool currently used by the BoM (Achameesing, 2020). An understanding of the real mechanisms behind "true QE" is likely to increase its acceptance, and we believe it is here where macroeconomics must shift the weight of its focus, i.e. "a new paradigm in monetary macroeconomics", from which Mauritius could be a beneficiary, if properly understood and embraced by its policy makers (Achameesing, 2020).

CHAPTER 5

SUMMARY, IMPLICATIONS OF KEY FINDINGS AND CONCLUSION

5.1 Summary

The broad objective of this thesis has been to investigate the efficiency of bank lending in Mauritius. The results have shown overwhelming evidence that banks in Mauritius have been inefficient in the allocation of credit, especially after the relaxation of all forms of credit controls in 1993, and this has had detrimental effects on economic growth. We began the empirical test in Chapter 2 with a fixed coefficient estimation of the effects of two measures of FD namely, PSC and CBC on RGDP. In contrast to the findings of previous empirical studies (see Jouan, 2005; Jankee, 2006; Seetanah, 2008; Nowbutsing et al., 2010), our results show that both measures of FD have significantly negative effects on economic growth in the long-run.

Existing studies on finance and growth in Mauritius have also used fixed coefficient models to measure the effects of finance on growth. In view of the different economic policies adopted in the country since independence in 1968, we argue that it is possible that the relationship between PSC or CBC and RGDP has changed over time. Hence, in Chapter 3, for the first time in the global empirical literature of finance and growth, we use the TVC model proposed by Swamy and Von Zur Muehlen (2020) to measure the time-varying total effects of PSC or CBC on RGDP. The TVC model solves many problems of conventional econometrics such as non-stationarity and endogeneity. Furthermore, in contrast to the existing empirical literature on the indirect effects of finance and growth (see Sarwar et al., 2020), the TVC model uses coefficient drivers to measure more precisely the indirect effects through which finance can affect economic growth.

The TVC results in Chapter 3 demonstrate that there are diminishing effects of bank credit on growth over time which is similar to the findings of an increasing number of studies (see Rousseau and Wachtel, 2011; Panizza, 2012; Cecchetti and Kharroubi 2012, 2013; Law and Singh, 2014). However, to the best of our knowledge, none of the studies have looked at the *composition* of credit as a possible explanation for the vanishing effects of finance on growth. With that in mind, in Chapter 4, we used the quantity theory of disaggregated credit (QTDC) to disaggregate bank credit into bank credit for GDP transactions and bank credit for non-

GDP transactions. Out of many candidate proxies of bank credit for GDP transactions, we selected Proxies 10 and 11 for two reasons. First, based upon QTDC they include the types of bank credit that are more likely to promote GDP transactions. Second, both proxies have the most stable relationship with NGDP. The TVC results in Chapter 4 show stronger total effects of Proxy 10 on GDP relative to Proxy 11 on GDP which is to be expected as Proxy 11 also includes the construction sector which has major non-GDP effects.

In the next part of Chapter 4, we attempt to have a mesoscopic[92] view of the indirect effects of bank credit for GDP transactions on GDP (NGDP and RGDP). Thus, we proceed with a further exploration of bank credit for GDP transactions on GDP using a disaggregation of GFCF into three types of investment. We follow the proposition of Turner (2014, p. 28) and used three disaggregated measures of investment: residential and commercial real estate investment (RCREI), investment in infrastructure (II), and investment in machines (IM). These three variables are used as coefficient drivers to measure part of the indirect effects of bank credit for GDP transactions on GDP. The last part of the empirical results in Chapter 4 shows strong indirect effects of Proxy 10 on RGDP through IM.

In the next part of this chapter, we focus on the evidence found in Chapters 2, 3 and 4. We then highlight the policy implications of the findings.

5.2 Key findings and discussions

This section summarizes the key findings regarding the effects of aggregate and disaggregated measures of bank credit on economic growth in Mauritius. In the next part of this section, we discuss the policy implications of the results.

5.2.1 The effects of aggregate credit on economic growth using an ARDL model

The evidence presented in the first empirical study shows statistically strong negative effects of PSC or CBC on economic growth in the long-run while the effects were positive in the short-run. Overall, these findings cast doubt on the positive effects of aggregate credit on economic growth in Mauritius. The results point to the possibility that banks have increasingly been allocating credit to less productive sectors of the economy. However, the ARDL model we use in Chapter 2, being a fixed coefficient model, is unable to measure the time-varying relationship between PSC or CBC and RGDP which has evolved over time

[92] "At the meso level" implies intermediate between macro and micro level. Micro is at the level of *individual* firms, households, etc and we have not carried out such studies.

because of changing financial policies. In addition, fixed coefficient models are fraught with serious econometric problems such as non-stationarity and endogeneity.

5.2.2 The effects of aggregate credit on economic growth using a TVC model

The TVC estimation results show that the direct effects of PSC on RGDP are positive and significant while the indirect effects measured by the coefficient drivers PI, GFCF, PC and imports are all negative, which imply that credit has not worked effectively through the main channels of economic growth. The direct effects of CBC on RGDP are also positive, while all the indirect effects through PI, GFCF, PC and imports are negative. The negative significance of the coefficient drivers explains the vanishing effects of credit on growth. The overriding message of Chapter 3, therefore, is that the *uses* of credit matters enormously for economic growth in the country.

5.2.3 The link between bank credit and nominal and real GDP

The first set of empirical results confirm the predictions of QTDC and show that the total effects of Proxies 10 and 11 on GDP were strong in the early 1970s to about late 1980s, the time during which banks allocated a large amount of credit to primary and manufacturing industries which engaged heavily in GDP transactions. But the time path of the total effects of both Proxies 10 and 11 on GDP started to decline from the late 1980s to early 1990s as banks started to gradually shift credit to non-GDP transactions. The time path of the total effects of Proxy 11 on GDP shows a stronger deceleration as banks gradually increased their allocation of credit to the construction sector.

The second set of empirical results show that when we use disaggregated measures of investment, Proxy 10 outperforms Proxy 11 in explaining GDP, which proves that bank credit to the construction sector has weakened the positive effects of bank credit on the economy. The total effects of Proxy 10 on RGDP shows that when IM is used as the main coefficient driver it strongly sustained economic growth from the early 1970s and during the economic miracle years up to 1992. From 1992, the effects of bank credit on economic growth started to decline as banks shifted their allocation of credit to non-GDP transactions. The turning point in 1992/93 coincides with the removal of all forms of credit controls in the country. Overall, the findings when II, IM and RCREI are used as the main coefficient drivers to measure the indirect effects of bank credit on the economy are similar to the

findings of PI, GFCF and PC and are all negative, which shows that the *uses* of credit matters for GDP growth.[93]

5.3 Synthesis and implications of the findings

This thesis reminds us of the essential functions of the banking system in a modern economy and in particular about the function of commercial banks in providing credit for productive investment, as opposed to credit for real estate and financial transactions. Banks are widely seen as efficient financial intermediaries allocating savings to alternative capital projects and hence promote growth of the real economy. Policymakers have assumed that financial development is synonymous to more savings which lead to more bank credit for productive investment and hence more growth of the real economy. However, the findings in Mauritius show that banks have increasingly been allocating credit to less productive sectors of the economy.

Banks played a role in the early stages of economic development of the country but the contribution of bank credit to economic growth waned as banks significantly altered their composition of credit towards less productive investment. Contrary to the financial liberalization advocates of the late 1980s and early 1990s (see Fry and Roi, 1995) that the quantity of credit created and its allocation between different uses should be left to free market forces, the unrestrained allocation of bank credit by the free market has been harmful to the Mauritian economy. In modern banking systems, bank credit does not fund capital investment but the vast majority funds real estate and hence ultimately the purchase of the land on which it sits (see Jorda et al., 2016). Therefore, the challenge in modern banking economies is that if we allow a free credit market system to be unconstrained, it will produce too much credit for financial transactions.

One key aspect of the financial system which has been overlooked by monetary policymakers and is perhaps the most important aspect of all: the macroeconomic implications of bank credit for GDP transactions on GDP. QTDC shows the crucial importance of increasing bank

[93] It is informative to highlight the evolution of the empirical results from Chapters 2, 3 and 4. In Chapter 2, the fixed coefficient estimates of the effects of credit on growth suffer from the neglect of the indirect effects of the regressor on the dependent variable. In Chapter 3, we introduce TVC to estimate the total effects (including the indirect effects) of credit on growth. Yet, the models do not fully satisfy the two stringent rules of Zellner (1988) for establishing a causal law in econometrics i.e first, the significance of all the four $\pi's$ and second, very good forecasting. The models in Chapter 3 do not have significance of all the four $\pi's$ and the U statistic of the models is often higher than one. In Chapter 4, when TVC is used to test QTDC, we find that the two strict rules of Zellner are often satisfied. This can be seen from the results for the total effects of proxy 10 on NGDP, Models III, VI, XIII and XIV in Table 4.4. This is also true for Models III, VI and VII in Table 4.6. Therefore, the empirical results in Chapter 4 provide strong evidence of the empirical validity of the QTDC.

credit for GDP transactions in stimulating GDP. The gradual shift of bank lending to non-GDP transactions has led to vanishing effects of bank credit on GDP. Therefore, given that banks have a bias toward financial transaction interventions favouring other types of lending are warranted. The findings have shown that changes in the composition of bank credit have implications on the economic performance of the economy. Therefore, achieving a low and stable inflation using the interest rate cannot be the sole objective of central bank policy because bank balance sheets are also important.

One could argue that the most effective way to slow down a credit boom in real estate and construction is by raising interest rates. But as Turner (2016) argues the interest rate tool has a serious disadvantage: different categories of credit are likely to display very different elasticities of response to changing interest rates (Turner, 2016, p. 197). If borrowers expect that real estate prices will increase over the medium term by, say, 15% per year, changing the policy rate by only a few percentage points is not likely to change their behaviour, and varying it by more may cause severe harm to productive business investment long before it slows down the credit boom (Turner, 2016, p. 197). Therefore, we need to equip the Bank of Mauritius as a macro prudential authority with more tools and broader responsibilities.

In the next section, we discuss the tools and policies that can be used in Mauritius.

5.4 Policy recommendations

The implications of the findings show that the current simplistic approach of inflation targeting is not enough and the Bank of Mauritius should be much more pro-active in managing the inefficiency of credit allocation. It is important to accept the fact that free markets do not guarantee a socially optimal quantity of private credit or its efficient allocation. In fact, policy decisions need to reflect judgments based on the evolving economic cycle. Therefore, the central bank needs a broader set of tools such as higher countercyclical buffer, higher capital weights against lending to real estate and financial lending, and constraints on borrowers such as limits on loan to income ratios[94] for mortgage lending.

The Basel III regime introduced for the first time a countercyclical buffer that can be increased in the face of rapid credit growth and can be removed if credit growth is anaemic. However, the maximum envisaged buffer of Basel III, set at 2.5%, will not be enough to

[94] Both Loan to income (LTI) and Loan to value ratios (LTV) constraints may have a role to play but there are strong arguments in principle for preferring LTI rules. Maximum LTV rules can still allow unsustainable growth of leverage relative to income and thus to debt servicing capacity since the denominator (property value) can itself increase. Maximum LTI rules more directly address the issue of debt servicing capacity and more clearly constrain the danger of self-reinforcing credit and asset price cycles (Turner, 2016, p. 271).

curtail a credit boom. The BoM should apply much larger countercyclical buffers if necessary to curtail real estate booms, and they should consider applying them if leverage is already high and credit is growing faster than GDP, even if credit is growing in line with past trends (Turner, 2016, p. 200).

The BoM needs to ensure that capital requirements against particular categories of lending take into account their many potential impacts on the economy. Current international capital rules are designed around a completely different philosophy (Turner 2016, p. 201). Under those rules "risk weights" are used to determine varying capital requirements by type of asset. Currently, the resulting risk weights used by banks for prime real estate loans can be as low as 10% or even 5%, versus 100% which is typical for lending to SMEs (Turner 2016, p. 202). Therefore, the BoM needs to ensure that capital requirements for different types of credit reflect macroeconomic consequences such as slower economic growth, which banks left on their own will never consider. This can be achieved by increasing risk weights for real estate and financial lending to a significantly higher level.

The effectiveness of countercyclical capital buffer and higher risk weights against real estate can be undermined if expectations of rising land and real estate prices fuel an increase in demand for credit to purchase them. Therefore, they need to be complemented by quantitative constraints that control borrower access to credit. Maximum loan-to-income limits can be applied in the residential and commercial real estate market. They could be applied either as standards held constant throughout the economic cycle or varied across cycles: tightened during real estate booms and relaxed in downswings (Turner 2016, p. 204).

Therefore, given the bias of banks toward real estate lending, a more radical policy recommendation would be to create institutions that are only allowed to lend money for non-real estate or other specific purposes. The Green Investment Bank in the UK has been established to lend to green energy projects. These types of institutions are not dangerous diversions from efficient free market capital allocation, but are essential to offset the misallocation that free markets can produce (Turner 2016, p. 207).

In fact, like Werner (2005), we believe that monetary policy is a powerful macroeconomic policy tool, since it not only affects economic growth, but can also reshape society. The fundamental principles of monetary policy should be to minimize inflation and maximize real economic growth, and for this credit should be encouraged primarily for productive purposes (Werner, 2005, p. 339). The Bank of Mauritius can strongly encourage the practice of

rediscounting private sector loans in priority sectors of a new economy. Bank credit should support the strategic priorities of a modern economy. Bank credit policies should be designed to drive advances in sectors such as precision agriculture, high-tech manufacturing, renewable technology, information and communication technology, and the ocean economy, amongst others. We now provide a brief discussion of the policies that can be introduced into a few priority sectors of a new economy in the 21st century.

According to the figures on external trade, in 2020, agricultural imports amounted to 21.7% of total imports, standing at Rs 35.8 billion in 2019 (Statistics Mauritius, 2020, Q4.). This is significant for a country of 1.3 million people in which a significant amount of arable land is unemployed. Bank credit should encourage the use of technology in bio-agricultural production and organic farming to increase the yield per hectare of land. For instance, using advanced technologies, smart farming (also known as precision agriculture) can allow the lowering of pesticides and fertilizers while increasing crop productivity.

The proportion of medium and high-tech industry (MHT) value added in total value added compiled by Statistics Mauritius in 2016 shows the proportion of MHT value added in total value added stood at 6.6% of GDP (Statistics Mauritius, 2016). High-technology exports as a % of manufactured exports stood at a meagre 2.1% in 2019 (World Bank, 2019). Bank credit can encourage the production of higher value-added goods such as electronic accessories for smartphones, computers and cars. Bank credit can encourage the leapfrogging of the country into high-tech manufacturing with a focus on the production of renewable technologies.

Indeed, the production and distribution of renewable energy could complement a high-tech manufacturing agenda. According to the Energy Observatory Report (2017, p. 21), 80.2% of electricity production in Mauritius is derived from fossil fuels and 19.8% from renewable energy sources. Bank credit should help to accelerate the energy transition, and should encourage investment in solar parks, wind parks, energy storage and smart grids.

The opportunities in the ICT sector should be identified and translated into tangible high value-added activities that will increase the share of the ICT sector in national output. According to Statistics Mauritius, the ICT sector contribution to GDP in 2019 stood at 5.8% and mainly comprised low value-added activities such as mobile phone subscriptions, internet bandwidth and fixed telephone providers (National Accounts Estimation, 2020). The percentage of total bank credit also allocated to the ICT sector is 0.6 % of total bank credit (Bank of Mauritius annual report, 2018, p. 52). In this respect, bank credit to software

companies, artificial intelligence, robotics and the internet of things should foster the creation of a vibrant tech-hub that will foster the use of technology-intensive activities.

According to data from Statistics Mauritius, fisheries account for most of the contribution of the ocean economy at 1% of GDP and contribute to about 19% of national exports (Ministry of Blue Economy, Marine Resources, Fisheries and Shipping, 2019). With an Economic Exclusive Zone of 2.3 million square kilometres, bank credit can be used to spearhead the expansion of the blue economy which alone can transform the country. The ocean can account for a major share of renewable energy production which could include the implementation of cost-efficient seawater air-cooling projects. The production of premium products from the sea such as cosmetics, pharmaceuticals and water bottling amongst others could also be encouraged.

Last but not least, it is important to highlight that one of the key challenges in attempting to increase bank credit to priority sectors is the fact that bank lending to finance non-real estate business investment requires complex assessment of discounted cash flows, and if the project fails, the assets financed often have little resale value (Turner, 2016, p. 71). On the other hand, real estate value usually has value for many competing users. Indeed, the presence of asymmetric information in bank lending to finance non-real estate business investment implies that taking security against real estate mitigates the adverse selection and moral hazard problems associated with non-real estate lending.

One policy to circumvent the asymmetric information problem is to issue government guarantees to banks for bank loans to firms and industrial sectors that are often credit-constrained. Werner (2005) argued that in many countries, government guarantees to encourage loans to small manufacturing firms are a clear example, as these firms tend to be severely credit-rationed even in the best of times. As Werner (2005) explains “due to the positive feedback loop between credit, economic activity and hence the state of borrowers’ balance sheets, suitably executed policies of issuing government guarantees on bank loans are likely never to incur substantial liabilities: as the government guarantees loans to small firms, for instance, for productive investors, each loan carries a certain default risk…but as consequently total lending increases, and hence economic activity expands, borrowers’ balance sheets improve, hence reducing their risk of default” (Werner, 2005, p. 302).

5.5 Contribution of the study

In this study, we show that the shift of bank credit to non-GDP transactions explains the vanishing effects of credit on economic growth in the country. By using a TVC estimation technique and a substrand of the literature on finance and growth, namely on the QTDC, we contribute to the literature in the following major ways:

(i) Existing studies on finance and growth in Mauritius have used fixed coefficient models (see Jouan, 2005; Jankee, 2006; Seetanah et al., 2008; Nowbutsing et al., 2010) to estimate the effects of finance on growth. In this study, we show that all fixed and variable coefficient models used to measure the effects of finance on growth are misspecified and ignore the indirect effects of credit on growth. In that respect, the time-varying coefficient (TVC) estimation we use in this study estimates the total effects of credit on growth. Furthermore, in contrast to the existing empirical literature on the indirect effects of finance and growth (see Sarwar et al., 2020), the TVC model uses coefficient drivers to measure more precisely the partial indirect channels through which finance can affect economic growth. The TVC estimation shows that the functional form of the relationship between bank credit and economic growth in Mauritius is non-linear and that the negative indirect effects of bank credit on economic growth which is significantly measured by PI, GFCF, PC and IMPORTS partly explains that non-linear relationship. Hence, we suggest that bank credit policies should be designed to drive investment into productive sectors to stimulate economic growth.

(ii) This study uses the QTDC to disaggregate bank credit into bank credit for GDP transactions and bank credit for non-GDP transactions for Mauritius, which no prior study in the country has done before. Since Werner (1992) formulated QTDC in 1992, QTDC has been put to test for various countries (Bezemer and Werner, 2009; Lyonnet and Werner, 2012; Werner, 2014). However, Werner and others have used fixed coefficient models in testing the QTDC which means that Werner and others have estimated only the direct effects of increases in bank credit for GDP transactions on NGDP growth. Therefore, unlike the QTDC studies which have ignored the indirect effects of bank credit for GDP transactions on NGDP, this study is the first study which measures the total effects of bank credit for GDP transactions on NGDP. We show that the indirect effects of bank credit for GDP transactions on NGDP measured by PI, GFCF, PC and IMPORTS are negative. In addition, we also measure the total effects of two competing measures of bank credit for GDP transactions on GDP (NGDP and RGDP) and prove that bank credit to the construction sector is a major non-GDP sector.

This study also uses the proposition of Turner (2014, p. 28) and disaggregates Gross Fixed Capital Formation (GFCF) into three measures of investment – RCREI, IM and II – which are used as coefficient drivers in order to have a mesoscopic look at the indirect effects of bank credit for GDP transactions on GDP. This is the first study that attempts to accurately pin down the specific indirect channels of investment through which finance affects economic growth in a country. We show specific evidence that monetary policy should increase bank credit for GDP transactions and specifically target productive investment like IM to reignite economic growth in the country.

5.6 Limitations of the study and areas for future research

The major challenge of this study has been the application of QTDC and the separation of bank credit that flows to GDP transactions from bank credit that flows to non-GDP transactions given the limitations of the Bank of Mauritius (BOM) reporting structure. For example, loans by commercial banks for real estate activities have been reported under the construction category. However, this category does not differentiate between loans for the purchase of existing real estate and loans for the construction of new real estate. The former is purely a non-GDP transaction while the latter includes elements of GDP transactions and certainly has an impact on GDP. Therefore, to address the limitations imposed by the data, we provide two alternative measures of bank credit for GDP transactions using Werner's QTDC. The first measure, proxy 10, includes bank credit for GDP transactions but excludes both bank credit to the construction sector and bank credit to the financial sector. The second measure, proxy 11, includes bank credit for GDP transactions and bank credit to the construction sector but excludes bank credit to the financial sector. In general, the exercise of disaggregating bank credit into GDP and non-GDP transactions remains a complex task as granular bank credit data is not available, which means that sectoral disaggregation is the best approximation that we can make to the true breakdown by type of expenditure.

The other limitations of this study which still relates to the QTDC framework need to be mentioned. In our QTDC study, we do not consider two types of cross flows: recirculation and funding cross flows. For recirculations, it is conceivable that, during the accounting period of measurement, money lent by banks for non-GDP transactions becomes income of some institution or agent which spend the funds on GDP transactions, and vice versa. In terms of funding cross flows, one could conceive the possibility that money lent by banks to, for example, non-bank financial intermediaries, is relent for GDP transactions. We abstract from these two types of cross flows in the construction of our proxies, either because data is

unavailable and/or because the methodology to deal with those two issues is currently non-existent.

As a relatively novel theory, QTDC is still in its nascent stage and we have to think of it as a simplified counterpart of the money (M) framework in which commercial banks' credit consists of the majority of new purchasing power that is created in modern banking economies. Werner's QTDC is essentially a narrow and implicit version of the "money counterpart analysis", a well-known method to study monetary developments (see Miles and Bull, 1978; Goodhart, 1989; ECB, 2012). Werner's approach is narrow in the sense that loans are assumed to be the only relevant counterpart to M, and it is implicit because the framework is not recognized as such. However, the consolidated balance sheet of banks is the net result of the creation and destruction of money through all balance sheet counterparts, not just loans. For example, banks create money when they purchase securities and money is destroyed when non-banks buy banks' equity (see McLeay et al., 2014, p. 4). Therefore, QTDC has yet to include all the mechanics that can make M increase or decrease.

The TVC model has been applied for the first time in the empirical literature of finance and growth. There are numerous indirect channels through which measures of financial development can affect economic growth and this study has explored only a few of those channels. This study has also focused exclusively on the effects of finance on growth and not viceversa[95]. Patrick (1966) suggested that at later stages of financial development, as real GDP growth increases it also increases financial development. Therefore, the TVC model can also be applied to explore the different channels through which growth affects finance.

5.7 Concluding remarks

This thesis has shown that the *uses* of bank credit matters greatly for economic growth in Mauritius. From what we learnt from the economic miracle years, we believe that the reintroduction of a productive system of credit allocation is a necessary but not sufficient condition to reignite economic growth. It should be accompanied by the introduction of an industrial policy that focuses on the production and exports of high value-added goods and on the promotion of high quality FDI that would promote the absorption of knowledge and ideas

[95] Furthermore, we did not explicitly explore how changes in the business cycle or changes in the interest rate influence credit though we should mention that the results very likely reflect them. For example, during downturns, the role of phenomena like liquidity would play a role: low interest rates would have diminished effect on inducing demand for credit. Credit would play a diminished role. Future investigation could consider the interest rate as the main regressor in the TVC model while bank credit could be the main coefficient driver that would absorb the partial indirect effects of interest rates on economic growth.

from abroad. The industrial policy should also include a training and reskilling programme that will meet the needs of a vibrant technologically driven economy.

The early success of economic policies in Mauritius has been made possible by the resulting political stability, rule of law, and the presence of strong domestic institutions. According to Subramanian and Roy (2001, p. 29), Exports Processing Zones (EPZs) failed in most countries because institutions were not able to prevent rent-seeking, corruption, and inefficiency. Therefore, without independent domestic institutions run by people of integrity and competence, it would be likely that the benefits of a productive system of credit allocation would remain muted. It is important to mention that given the peculiar context of Mauritius during the current time[96], government or central bank direction of credit can drive inept misallocation of credit to favoured cronies. As examples, in Indonesia and the Phillipines, there has been preferential credit to political supporters which financed wasteful investment projects (Turner, 2016, p. 140).

Thus, there is a very strong case for regulators to design regulatory frameworks that would ensure bank credit is used optimally for productive investment. Bank credit should be used to spearhead the process of creative destruction in Mauritius, about which Schumpeter (1942) has written so eloquently. As he stated "the organizational development from the craft shop to such concerns as U.S. Steel illustrate the same process of industrial mutation, if I may use that biological term, that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one...this process of creative destruction is the essential fact about capitalism" (Schumpeter, 1942, p. 8). If bank regulators in Mauritius are pragmatic and ingenious, they should be able to channel more bank credit in areas such as precision agriculture, high-tech manufacturing, pharmaceuticals, information and communication technology, renewable technology, and the ocean economy, amongst others, which should significantly increase the catch-up growth rate of the country in the 21st century.

[96] In March 2021, the V-Dem Institute placed Mauritius among the ten most rapidly autocratizing countries in the world (V-Dem Institute, 2021).

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Appendices

Appendix 1: Derivation of the relationship between savings, investment and growth

$$Y = AF(K,N) \quad \ldots(A.1.1)$$

Equation (A.1.1) shows that output Y depends on inputs capital (K), labour (N) and the level of technology (A), often called productivity. It shows that more inputs lead to more outputs and that the marginal product of capital (MPK) and labour (MPL) are both positive. Equation (A.1.1) relates to the level of output with the level of inputs and technology. We now transform Equation (A.1.1) into the relationship between input and output growth (the growth accounting equation):

$$\Delta Y = MPL\ x\ \Delta N + MPK\ x\ \Delta K + F(K,N)\ x\ \Delta A$$

$$\frac{\Delta Y}{Y} = \frac{MPL}{Y}\ \Delta N + \frac{MPK}{Y}\ \Delta K + \frac{\Delta A}{A}$$

$$\frac{\Delta Y}{Y} = \left(\frac{MPL\ x\ N}{Y}\right)\frac{\Delta N}{N} + \left(\frac{MPK\ x\ K}{Y}\right)\frac{\Delta K}{K} + \frac{\Delta A}{A}$$

$$\frac{\Delta Y}{Y} = \left[(1-\theta)\ x\frac{\Delta N}{N}\right] + \left(\theta\ x\ \frac{\Delta K}{K}\right) + \frac{\Delta A}{A}$$

$$\frac{\Delta Y}{Y} = \left[(1-\theta)\ x\frac{\Delta N}{N}\right] + \left(\theta\ x\ \frac{\Delta K}{K}\right) + \frac{\Delta A}{A} \quad \ldots(A.1.2)$$

Equation (A.1.2) describes growth in total output. We now transform Equation (A.1.2) into a GDP per capita equation as the notion of standard of living generally refers to well-being of the individual. In order to translate Equation (A.1.2) into per capita terms, we subtract population growth, $\frac{\Delta N}{N}$ from both sides of Equation (A.1.2) and rearrange the terms:

$$\frac{\Delta Y}{Y} - \frac{\Delta N}{N} = \theta\ x\ \left[\frac{\Delta K}{K} - \frac{\Delta N}{N}\right] + \frac{\Delta A}{A} \quad \ldots(A.1.3)$$

Denoting per capita terms by small case letters, we arrive at:

$$\frac{\Delta y}{y} = \theta\ x\frac{\Delta k}{k} + \frac{\Delta A}{A} \quad \ldots(A.1.4)$$

Equation (A.1.4) shows that there is a direct correspondence between changes in capital and technology on the growth of GDP per capita. Now for mathematical analysis, it is generally assumed that technology is labour augmenting, which means that technology increases the productivity of labour. Thus, equation (A.1.1) is modified as Y= F (K,AN) and Equation (A.1.4) is modified as follows:

$$\frac{\Delta y}{y} = \theta\, x \frac{\Delta k}{k} + (1-\theta)\, x\, \frac{\Delta A}{A} \qquad \ldots(A.1.5)$$

The assumption so far has been that A (the level of technology) is exogenously determined. We now change this assumption to incorporate recent changes to the growth literature by making technology endogenous, which means that technology is proportional to capital, i.e. A = αk. The key assumption here is that better technology is a by-product of capital investment and hence we can specify an equation in which technology depends on capital and population growth:

$$\frac{\Delta A}{A} = \frac{\Delta K}{K} - \frac{\Delta N}{N} \qquad \ldots(A.1.6)$$

Combining Equations (A.1.5) and (A.1.6), we get the following:

$$\frac{\Delta y}{y} = \theta\, x \frac{\Delta k}{k} + (1-\theta)\, x\, \frac{\Delta k}{k}$$

$$\frac{\Delta y}{y} = \frac{\Delta k}{k} \qquad \ldots(A.1.7)$$

Equation (A.1.7) shows that the numerator and denominator of *y/k* grow at an equal rate, and hence *y/k* is a constant. Interestingly, *y/k =F(K,AN)/K = F(K/K, AN/K)*. Note that it is assumed that technology is proportional to the level of capital per worker in the economy overall, A= $\alpha K/N$, and therefore we can write *y/k=F(1,* α*) and* $F(1,\alpha) \equiv a$ where a is a constant which represents the marginal product capital as in Y= aK, which is the AK model of Romer (1986).

Appendix 2: Correlation results

Table A.2.1: Correlation results in Chapter 2

				CORRELATION RESULTS IN CHAPTER 2								
Covariance Analysis: Ordinary												
Date: 08/17/21 Time: 01:08												
Sample: 1970 2019												
Included observations: 50												
Correlation												
t-Statistic												
Probability	INFLATION_RATE____	LN__EX_	LN__PI_	LN__GFCF_	LN__IM_	LN__LLBPC_	LN__PRC_	LN_PSCPC_	LN__RGDPPC_	LN__TRADE_	LN_CEXPI_	LN_REEXR_	LN_CBCPC_
INFLATION_RATE____	1												

LN__EX_	0.217964	1											
	1.5473	-----											
	0.1284	-----											
LN__PI_	0.288462	0.406723	1										
	2.087253	3.084515	-----										
	0.0422	0.0034	-----										
LN__GFCF_	0.358808	0.507878	0.929017	1									
	2.663234	4.0847	17.39405	-----									
	0.0105	0.0002	0	-----									
LN__IM_	0.28735	0.681184	0.670177	0.719851	1								
	2.078477	6.446255	6.255887	7.184935	-----								
	0.043	0	0	0	-----								
LN__LLBPC_	-0.413474	-0.143502	0.161606	0.020787	0.198019	1							
	-3.146163	-1.004605	1.134554	0.144046	1.399628	-----							
	0.0028	0.3201	0.2622	0.8861	0.1681	-----							
LN__PRC_	-0.191617	-0.756188	-0.329194	-0.433058	-0.226407	0.410808	1						
	-1.352628	-8.006393	-2.415348	-3.328629	-1.610411	3.121744	-----						
	0.1825	0	0.0196	0.0017	0.1139	0.003	-----						
LN_PSCPC_	-0.425908	-0.188608	0.149065	-0.002225	0.167868	0.996739	0.446025	1					
	-3.261369	-1.330594	1.044424	-0.015413	1.179766	85.578	3.452609	-----					
	0.002	0.1896	0.3015	0.9878	0.2439	0	0.0012	-----					
LN__RGDPPC_	-0.434334	-0.242723	0.13598	-0.029782	0.113674	0.987736	0.459022	0.993089	1				
	-3.340715	-1.73347	0.950932	-0.206428	0.792695	43.8286	3.579594	58.62195	-----				
	0.0016	0.0894	0.3464	0.8373	0.4319	0	0.0008	0	-----				
LN__TRADE_	0.271361	0.941466	0.564854	0.650721	0.887913	0.002596	-0.580898	-0.039847	-0.097995	1			
	1.953336	19.34887	4.742444	5.937338	13.3728	0.017987	-4.944347	-0.276287	-0.682214	-----			
	0.0566	0	0	0	0	0.9857	0	0.7835	0.4984	-----			
LN_CEXPI_	0.506222	0.067492	0.007347	-0.0342	-0.215207	-0.686361	-0.32997	-0.678867	-0.623274	-0.053453	1		
	4.066781	0.468668	0.050904	-0.23708	-1.526771	-6.538575	-2.421738	-6.405527	-5.521934	-0.370864	-----		
	0.0002	0.6414	0.9596	0.8136	0.1334	0	0.0193	0	0	0.7124	-----		
LN_REEXR_	-0.028676	-0.641462	-0.490629	-0.526252	-0.58764	-0.093098	0.456472	-0.082654	-0.034543	-0.67026	0.154935	1	
	-0.198755	-5.793072	-3.900969	-4.287728	-5.031729	-0.647816	3.554456	-0.574612	-0.239467	-6.257279	1.086544	-----	
	0.8433	0	0.0003	0.0001	0	0.5202	0.0009	0.5682	0.8118	0	0.2827	-----	
LN_CBCPC_	-0.425716	-0.17711	0.153551	0.006051	0.173787	0.997493	0.435082	0.999768	0.991652	-0.029925	-0.686639	-0.087515	1
	-3.259572	-1.246761	1.076598	0.041926	1.222633	97.65239	3.347814	321.6282	53.28079	-0.207418	-6.543573	-0.608659	-----
	0.0021	0.2185	0.287	0.9667	0.2274	0	0.0016	0	0	0.8366	0	0.5456	-----

Appendix 3: Forecasting equation in Chapter 3

From Equations (3.4) and (3.5) in Swamy and Tinsley (1980), for the post-sample period $T+s$ Equation (3.4) can be written as:

$$y_{T+s} = \boldsymbol{x}'_{\boldsymbol{T+s}} \ \boldsymbol{\gamma}_{\boldsymbol{T+s}}$$

and Equation (3.5) can be written as

$$\boldsymbol{\gamma}_{\boldsymbol{T+s}} = \Pi \boldsymbol{z}_{\boldsymbol{T+s}} + \boldsymbol{u}_{\boldsymbol{T+s}}$$

Substituting the right-hand side of Equation (3.5) for $\boldsymbol{\gamma}_{\boldsymbol{T+s}}$ in Equation (3.4) gives

$$y_{T+s} = \boldsymbol{x}'_{\boldsymbol{T+s}} \ \Pi \boldsymbol{z}_{\boldsymbol{T+s}} + \boldsymbol{x}'_{\boldsymbol{T+s}} \ \boldsymbol{u}_{\boldsymbol{T+s}}$$

Rao's (1973) book on Linear Statistical Inference and Its Applications gives the matrix identity

$$\boldsymbol{x}'_{\boldsymbol{T+s}} \ \Pi \boldsymbol{z}_{\boldsymbol{T+s}} = (\boldsymbol{z}'_{\boldsymbol{T+s}} \otimes \boldsymbol{x}'_{\boldsymbol{T+s}}) \ vec(\Pi)$$

where $vec(\Pi) = \boldsymbol{\pi}$, the column stack of Π and $\otimes$ denotes the Kronecker product defined in any matrix algebra book (see, for example, Greene, 2012, pp. 994–995). For example, A $\otimes$ B means multiply every element of A by B. Therefore, if we replace the Rao matrix identity in the preceding equation, we get:

$$y_{T+s} = (\boldsymbol{z}'_{\boldsymbol{T+s}} \otimes \boldsymbol{x}'_{\boldsymbol{T+s}})\boldsymbol{\pi} + \boldsymbol{x}'_{\boldsymbol{T+s}}\boldsymbol{u}_{\boldsymbol{T+s}}$$

One advantage of TVC models is that anyone who uses those models can assess the accuracy of their coefficient estimates by also using forecasting. Therefore, in this study, we use the out-of-sample forecasting method that we describe below as a complementary measure to check for the significance of a model. According to Zellner (1988, p. 8), a model is "good" if it satisfies the following two conditions: (i) its structure does not involve logical or mathematical contradictions, and (ii) it is capable of yielding explanations of past data and verifiable predictions of as yet unobserved data. The conventional forecasting method summarized in Greene (2012, pp. 80–88) is invalid. We first present the reasons why this is true. Let $\boldsymbol{b} = (X'X)^{-1}X'y$ be the least squares estimator of $\boldsymbol{\beta}$ in the regression $y_t = x'_t\boldsymbol{\beta} + \boldsymbol{\varepsilon}_t$, X is a $T \times K$ matrix of observations on the included regressors of the regression and $\boldsymbol{y}$ is a $T \times 1$ vector of observations on y_t. Then the predictor $\boldsymbol{x}^{0'}\boldsymbol{b}$ of the value y^0 in $y^0 = \boldsymbol{x}^{0'}\boldsymbol{\beta} + \varepsilon^0$ chosen by Greene (2012, p. 81) is inconsistent because of the following reason: When

ε^0 is made up of omitted relevant regressors, as in (Equation 3.2), x^0 is correlated with ε^0 because of Pratt and Schlaifer's (1984) result that x^0 cannot be uncorrelated with every omitted relevant regressor. In this case, Greene's claim that $\boldsymbol{x}^{0'}\boldsymbol{b}$ is the minimum variance linear unbiased estimator of $\boldsymbol{x}^{0'}\boldsymbol{\beta}$ is false. The actual drawing for the post-sample period $T + s$ after combining Equations (3.4) and (3.5) is:

$$y_{T+s} = (\boldsymbol{z}'_{\boldsymbol{T+s}} \otimes \boldsymbol{x}'_{\boldsymbol{T+s}})\boldsymbol{\pi} + \boldsymbol{x}'_{\boldsymbol{T+s}}\boldsymbol{u}_{\boldsymbol{T+s}}$$

Where the vectors $\boldsymbol{x}_t$ and $\boldsymbol{z}_t$ are as defined in Equations (3.4) and (3.5) respectively, $\otimes$ is the Kronecker product, and $\boldsymbol{\pi}$ is the column stack of Π in Equation (3.5).

Because of assumption (3.7), $\boldsymbol{x}_t$ is conditionally independent of $\boldsymbol{u}_t$, given $\boldsymbol{z}_t$ for all *t*. Under this condition, we use Swamy and Tinsley's (1980, pp. 111 and 112) derivation to come up with the minimum mean square error linear predictor of $\boldsymbol{u}_{\boldsymbol{T+s}}$.[97] The feasible predictor of y_{T+s} is obtained by using the sample estimates of, $\boldsymbol{\pi}$, Φ, and $\sigma_a^2\Delta_a$ in place of their true values used in Swamy and Tinsley's minimum mean square error linear predictor of y_{T+s}. Using the feasible version of this predictor, we evaluate the forecasting performance of the TVC models.

We remove the last 12 values of RGDP_t from the 50 sample observations used for estimation in the models and treat these 12 values as yet unobserved. First, we re-estimated the TVC models containing the appropriate coefficient drivers using the reduced 38 (= 50-12) observations. Next, we applied the feasible minimum mean square error linear predictor of Swamy and Tinsley (1980, pp. 111–112) to these re-estimated models to obtain the forecasts of as yet unobserved 12 values of their dependent variables which are the same as RGDP_t. The root mean squared error of these forecasts have an obvious scaling problem explained in Greene (2012, p. 88). Several measures that are scale-invariant are based on the Theil U statistic given in Greene (2012, p. 88). Forecasts are perfect if their U statistic is zero. When U < 1 it means that the forecasts are excellent as they are on average closer to the actuals instead of away from the actuals. If U is less than 1, then $\sqrt{\sum_{t=1}^{12}(y_t - \hat{y}_t)^2} < \sqrt{\sum_{t=1}^{12} y_t^2}$ where $\hat{y}_t$ is the forecast of y_t given by any one of our models.

[97] For an extensive discussion of the limitations of different criteria of prediction, see Swamy and Schinasi (1989).

Appendix 4: Endogeneity and TVC model in Chapter 3

It is correct to interpret the error term of every econometric equation as made up of omitted but relevant regressors.

An Equation with Full Set of Regressors:

$$y_t^* = \alpha_{0t}^* + \sum_{j=1}^{K-1} x_{jt}^* \alpha_{jt}^* + \sum_{\ell=1}^{L_t} w_{\ell t}^* \omega_{\ell t}^* \qquad \ldots(A.4.1)$$

where *t* indexes time, y_t^* denotes a dependent variable, the variables x_{jt}^* are called "the included regressors," α_{jt}^* is the coefficient of x_{jt}^*, the variables $w_{\ell t}^*$'s are the so-called "omitted but relevant regressors," $\omega_{\ell t}^*$ is the coefficient of $w_{\ell t}^*$, and L depends on *t* because the number of omitted relevant regressors can change over time. All the determinants of y_t^* including known, unknown, observed, and unobserved are included in Equation (A.4.2). To avoid ignoring any omitted relevant regressors, we assume that L_t is unknown. The term $\sum_{\ell=1}^{L_t} w_{\ell t}^* \omega_{\ell t}^*$ is the error term of Equation (A.4.1). It was proved by Pratt and Schlaifer that the included regressors cannot be independent of every omitted regressor. Therefore, there is the endogeneity or the simultaneity problem with Equation (A.4.1) and the following equation is appropriate:

Stochastic Law

$$w_{\ell t}^* = \lambda_{\ell 0t}^* + \sum_{j=1}^{K-1} x_{jt}^* \lambda_{\ell jt}^* \quad (\ell = 1, \ldots, L_t) \qquad \ldots(A.4.2)$$

which relates each omitted relevant regressor ($w_{\ell t}^*$) to the included regressors (x_{jt}^*'s) using flexible coefficients.

Substituting the right-hand side of Equation (A.4.2) for $w_{\ell t}^*$ in Equation (A.4.1) gives

$$y_t^* = \alpha_{0t}^* + \sum_{\ell=1}^{L_t} \lambda_{\ell 0t}^* \omega_{\ell t}^* + \sum_{j=1}^{K-1} x_{jt}^* (\alpha_{jt}^* + \sum_{\ell=1}^{L_t} \lambda_{\ell jt}^* \omega_{\ell t}^*) \qquad \ldots(A.4.3)$$

where $\sum_{\ell=1}^{L_t} \lambda_{\ell 0t}^{*} \omega_{\ell t}^{*}$ is the error term. It is a function of the remainders ($\lambda_{\ell 0t}^{*}$) of the $w_{\ell t}^{*}$'s obtained after subtracting from each one of them the effect $\sum_{j=1}^{K-1} x_{jt}^{*} \lambda_{\ell jt}^{*}$ of the x_{jt}^{*}'s. Even though the x_{jt}'s cannot be not independent of the $w_{\ell t}^{*}$, the former can be independent of the remainders ($\lambda_{\ell 0t}^{*}$'s) of the latter. Thus, the included regressors of Equation (A.4.3) are independent of its error term and there is no simultaneity problem with it.

Appendix 5: Stationarity and TVC model in Chapter 3

An advantage of Equation (A.4.4) is that the series having the realizations y_t and x_{1t} in Equation (A.4.4) can be non-stationary. This is due to the differencing of the TVC model which is as follows:

$$y_t = \gamma_{0t} + x_{1t}\gamma_{1t} = \boldsymbol{x_t' \gamma_t} \qquad \ldots(A.4.4)$$

$$\Delta y_t = y_t - y_{t-1} = \gamma_{0t} - \gamma_{0t-1} + x_{1t}\gamma_{1t} - x_{1t-1}\gamma_{1t-1} + x_{1t}\gamma_{1t-1} - x_{1t}\gamma_{1t-1}$$

$$= \Delta\gamma_{0t} + x_{1t}\Delta\gamma_{1t} + \Delta x_{1t}\gamma_{1t-1} \qquad \textbf{OR}$$

$$\Delta y_t = y_t - y_{t-1} = x_t'\gamma_t - x_{t-1}'\gamma_{t-1} = x_t'\gamma_t - x_{t-1}'\gamma_{t-1} + x_t'\gamma_{t-1} - x_t'\gamma_{t-1}$$

$$which\ gives: \Delta y_t = x_t'\,\Delta\gamma_t + \Delta x_t'\,\gamma_{t-1}$$

The process $\Delta y_t = x_t'\,\Delta\gamma_t + \Delta x_t'\,\gamma_{t-1}$, is non-stationary. This is because the mean and variance of any variable of the process $\Delta y_t = x_t'\,\Delta\gamma_t + \Delta x_t'\,\gamma_{t-1}$, if they exist, are not constants and the covariance between any two variables of the same process, if it exists, depends on the time parameter. From the equation, $\Delta y_t = x_t'\,\Delta\gamma_t + \Delta x_t'\,\gamma_{t-1}$ it follows that differencing y_t any number of times does not make it stationary.

The above derivation shows that when $y_t = \gamma_{0t} + x_{1t}\gamma_{1t}$ is differenced, it does not become stationary. This means that γ_{0t} and γ_{1t} can be made the functions of the coefficient drivers z_{it} and z_{jt}, respectively, to keep y_t as nonstationary. Even after γ_{0t} and γ_{1t} are made the functions of the coefficient drivers z_{it} and z_{jt}, respectively, they (γ_{0t} and γ_{1t}) remain nonstationary. This is what we want. We do not want to make y_t, γ_{0t}, or γ_{1t} stationary.

Therefore, to estimate Equation (A.4.4), we do not need any stationarity transformations. We need some extra information. To get this information we find appropriate coefficient drivers. If the coefficient drivers are appropriate, then they provide needed extra information about γ_{0t} and γ_{1t} over and above the information about them already contained in y_t and x_{1t}. Remember we need to estimate the total effects of PSC or CBC on RGDP. γ_{1t} measures such total effects. By our construction, γ_{0t} is a function of z_{it} and γ_{1t} is a function z_{jt}. The meaning of a function is that z_{it} and z_{jt} has some information about γ_{0t} or γ_{1t}. This information is not appropriate unless the coefficient driver is appropriate.

Appendix 6: Sectoral composition of credit

Table A.6.1: Sectoral composition of credit for each proxy of bank credit for GDP transactions in Chapter 4

	Proxy 1	Proxy 2	Proxy 3	Proxy 4	Proxy 5	Proxy 6	Proxy 7	Proxy 8	Proxy 9	Proxy 10	Proxy 11
Mauritius Sugar Syndicate	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Sugar Industry	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Other agricultural interests	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Agricultural Development Certificate	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Agro-based Industrial Certificate Holders	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Sugarcane Planters	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Other Plantation	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Animal Breeding	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Fishing	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Other	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
TOTAL CREDIT TO PRIMARY SECTOR	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Export Processing Zone	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Export Enterprise Certificate Holders	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Holders of Development Certificates	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Export Service Certificate	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Pioneer Status Certificate Holders	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Strategic local Enterprise Certificate Holders	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Small and Medium Enterprise Certificate Holders	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Small Scale Industries	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Ex- DC	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Furniture & Wood Products	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Printing & Publishing	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Steel/Metal Products	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Food & Beverages	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Plastic Products	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Pharmaceuticals & Health Care	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Jewelry & Precision Engineering	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Electronics	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Leather Products & Footwear	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Paints	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Cement	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Other industries	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Other industries and manufacturers	☑	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
TOTAL CREDIT TO MANUFACTURING SECTOR	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Education	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Human Resource Development Certificate Holders	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑

Health Development Certificate Holders	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Media, Entertainment and Recreational Activities	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Transport	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Airlines	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Buses, Lorries, Trucks & Cars	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Shipping & Freight Forwarders	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Other transport	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Airport infrastructure development	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Port Development	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Power Generation	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Water Development	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Road Development	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Other infrastructure development	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Hotels	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Hotel Management Certificate	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Tour Operators & Travel Agents	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Hotel Development Certificate Holders	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Restaurants	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Duty-Free Shops	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Other tourism	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Telecommunications	☑	☐	☐	☑	☑	☑	☐	☐	☐	☐	☐
Internet	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
E-Commerce	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Information Technology - Hardware	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Information Technology - Software	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Personal Computers	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Other ICT	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
Accounting & Consultancy Services	☑	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑
TOTAL CREDIT TO TERTIARY SECTOR (EXCLUDING FINANCIAL SECTOR)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Financial Institutions	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Stock brokers & Stock broking companies	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Insurance Companies	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Non-bank Deposit-Taking Institutions	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Mutual funds	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Investment in private sector	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Investment companies	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Public financial corporations	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Other	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Offshore companies GBC 1	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
Offshore companies GBC 2	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
TOTAL CREDIT TO FINANCIAL SECTOR	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Building contractors, commercial premises and real estate developers	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Building & Housing Contractors	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Property Development - Commercial	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑

Property Development - Residential	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Property Development - Land Parceling	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Rodrigues Housing	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Housing	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Housing - Staff	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Housing Development Certificate Holders	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Industrial Building Enterprise Certificate Holders	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Building Supplies & Materials	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Stone Crushing and Concrete Products	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
Other	☑	☐	☑	☑	☑	☑	☐	☐	☐	☐	☑
TOTAL CREDIT TO CONSTRUCTION SECTOR	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Traders	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Marketing Companies	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Wholesalers	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Retailers - Hypermarkets	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Retailers - Supermarkets	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Retailers - Shops & Snacks	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Retailers - Pharmaceuticals and Chemists	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Retailers - Others	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Automobile Dealers & Garages	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Petroleum and Energy Products	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Tyre Dealers and Suppliers	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
Other	☑	☐	☐	☑	☑	☑	☐	☑	☑	☑	☑
TOTAL CREDIT TO TRADERS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Personal and Professional	☑	☐	☐	☐	☑	☑	☐	☐	☑	☑	☑
Personal	☑	☐	☐	☐	☑	☑	☐	☐	☑	☑	☑
Professional	☑	☐	☐	☐	☑	☑	☐	☐	☑	☑	☑
TOTAL CREDIT TO INDIVIDUALS AND PROFESSIONALS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Government	☑	☐	☐	☐	☐	☑	☐	☐	☐	☑	☑
Foreign currency loan to government	☑	☐	☐	☐	☐	☑	☐	☐	☐	☑	☑
Statutory and Parastatal bodies	☑	☐	☐	☐	☐	☑	☐	☐	☐	☑	☑
State and Local Government	☑	☐	☐	☐	☐	☑	☐	☐	☐	☑	☑
Statutory and Parastatal bodies	☑	☐	☐	☐	☐	☑	☐	☐	☐	☑	☑
Public Nonfinancial Corporations	☑	☐	☐	☐	☐	☑	☐	☐	☐	☑	☑
TOTAL CREDIT TO GOVERNMENT	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Regional Development Certificate Holders	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Regional Headquarters Certificate Holders	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Freeport Enterprise Certificate Holders	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Modernisation & Expansion Enterprise Certific Holders	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Foreign bills	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Other customers	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
TOTAL CREDIT TO OTHERS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
TOTAL PRIVATE SECTOR CREDIT	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Appendix 7: ARDL model in Chapter 4

Table A.7.1: The effects of disaggregated bank credit on RGDP

Model D1 includes lnPROXY 10, INF., lnPI, lnPRC and lnEX as independent variables.

Model D2 includes lnPROXY 10, INF., lnPI, lnPRC and lnIM as independent variables.

Model D3 includes lnPROXY 10, INF., lnPI, lnPRC and lnOMT as independent variables.

Model D4 includes lnPROXY 10, INF., lnGFCF, lnPRC and lnEX as independent variables.

Model D5 includes lnPROXY 10, INF., lnGFCF, lnPRC and lnIM as independent variables.

Model D6 includes lnPROXY 10, INF., lnGFCF, lnPRC and lnOMT as independent variables.

Model D7 includes lnPROXY 10, INF., lnGFCF, lnPRC and lnCEXPI as independent variables.

Model D8 includes lnPROXY 11, INF., lnPI, lnPRC and lnEX as independent variables.

Model D9 includes lnPROXY 11, INF., lnPI, lnPRC and lnIM as independent variables.

Model D10 includes lnPROXY 11, INF., lnPI, lnPRC and lnOMT as independent variables.

Model D11 includes lnPROXY 11, INF., lnPI, lnPRC and lnREEXR as independent variables.

Model D12 includes lnPROXY 11, INF., lnGFCF, lnPRC and lnEX as independent variables.

Model D13 includes lnPROXY 11, INF., lnGFCF, lnPRC and lnOMT as independent variables.

Model D14 includes lnPROXY 11, INF., lnGFCF, lnPRC and lnREEXR as independent variables.

Model D15 includes lnPROXY 11, INF., lnGFCF, lnPRC and lnCEXPI as independent variables.

Notes: Proxy 10 is total commercial bank credit minus bank credit to the financial sector and minus bank credit to the construction sector.

Proxy 11 is total commercial bank credit minus bank credit to the financial sector.

Table A.7.2: ARDL model and long-run results

Dependent variable: Real GDP	*Proxy 10*	*Proxy 11*	*Diagnostic checks*	
MODEL D			Serial correlation	Heteroscedasticity
D1	-0.09 (0.00)[a]	-	(0.7451) (0.2879)	(0.9316) (0.8252)
D2	-0.07 (0.00)[a]	-	(0.4652) (0.1557)	(0.7658) (0.6649)
D3	-0.06 (0.00)[a]	-	(0.4561) (0.0519)	(0.9489) (0.8481)
D4	-0.13 (0.00)[a]	-	(0.7939) (0.4946)	(0.9782) (0.9384)
D5	-0.12 (0.00)[a]	-	(0.2024) (0.066)	(0.7115) (0.6363)
D6	-0.12 (0.00)[a]	-	(0.9302) (0.8164)	(0.9984) (0.9944)
D7	0.07 (0.62)	-	(0.4160) (0.0840)	(0.6441) (0.5413)
D8	-	-0.06 (0.00)[a]	(0.5409) (0.0869)	(0.9433) (0.8379)
D9	-	-0.08 (0.00)[a]	(0.7765) (0.4892)	(0.9396) (0.8739)
D10	-	-0.07 (0.00)[a]	(0.5693) (0.1023)	(0.9931) (0.9590)
D11	-	-0.12 (0.01)[a]	(0.2287) (0.0543)	(0.9994) (0.9976)
D12	-	-0.12 (0.02)[b]	(0.7372) (0.4527)	(0.8848) (0.8031)
D13	-	-0.13 (0.00)[a]	(0.94480 (0.8504)	(0.9712) (0.9354)
D14	-	-0.14 (0.01)[a]	(0.4850) (0.2434)	(0.8159) (0.7410)
D15	-	0.30 (0.47)	(0.6812) (0.2872)	(0.7610) (0.6438)

Note: Significance of the coefficients at the 1%, 5% and 10% level are denoted by the superscripts a, b and c respectively.
The p value for F and Chi square tests for serial correlation and heteroscedasticity are given in parentheses. All exceed 5% and we reject the null hypotheses of serial correlation and heteroscedasticity.

Table A.7.3: ARDL model and short-run results

Dependent variable: RGDP	*ECT*	*Proxy 10*	*Proxy 11*
MODEL D	**-**	**-**	**-**
D1	-0.93 (0.00)[a]	0.07 (0.03)[b]	-
D2	-0.78 (0.00)[a]	0.48 (0.00)[a]	-
D3	-1.41 (0.00)[a]	0.04 (0.18)	-
D4	-0.43 (0.00)[a]	0.07 (0.01)[a]	-
D5	-0.43 (0.00)[a]	0.06 (0.09)[c]	-
D6	-0.48 (0.00)[a]	0.09 (0.01)[a]	-
D7	-0.20 (0.00)[a]	0.16 (0.00)[a]	-
D8	-1.31 (0.00)[a]	-	0.06 (0.00)[a]
D9	-0.72 (0.00)[a]	0.07 (0.03)[b]	0.06 (0.05)[b]
D10	-1.32 (0.00)[a]	0.48 (0.00)[a]	0.05 (0.10)[c]
D11	-0.45 (0.00)[a]	0.04 (0.18)	0.03 (0.28)
D12	-0.33 (0.00)[a]	0.07 (0.01)[a]	0.07 (0.02)[b]
D13	-0.45 (0.00)[a]	0.06 (0.09)[c]	0.10 (0.01)[a]
D14	-0.36 (0.00)[a]	0.09 (0.01)[a]	0.08 (0.02)[b]
D15	-1.31 (0.00)[a]	0.16 (0.00)[a]	0.20 (0.00)[a]

Note: Significance of the coefficients at the 1%, 5% and 10% level are denoted by the superscripts a, b and c respectively.