Lead-lag relationship between domestic credit and economic growth: the case of Singapore

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Abstract:

The paper evaluates the causal relations and dynamic linkages between Economic growth proxied by real GDP per capita and four other macroeconomic and financial variables namely Gross Domestic Savings as a percentage of GDP, Domestic Credit to Private Sector as a percentage of GDP, Inflation and Real interest rates. The analysis relies on a time series technique, in particular, cointegration, error correction modelling, variance decomposition and a LRSM (Long-run structural modelling) technique to overcome limitations found in the former and seeking to quantify the theoretical relationship among the variables. The empirical results we obtained bear various implications on the issues of direction of causality and long term stability of dynamic linkages between macroeconomic and financial variables. The presence of cointegration between economic growth and these variables indicate a long-run predictability of the magnifying or reducing effect of economic growth. We find evidence that the supply leading condition is applicable to Singapore except if it is being proxied by Gross Domestic Savings instead of Domestic Credit to Private Sector as being used in this paper. We are aware that these variables are used interchangeably as a proxy for financial development. Subsequently, this would then suggest that Singapore is still at its early stage of economic development if following the supply-leading and demand-following hypothesis envisioned by Patrick (1966). This may appear as contradicting one's intuition as Singapore being a high income economy, will most likely be in its later stage of economic development vis-a-vis a demand following condition. In addition, we find evidence that Domestic Credit to Private Sector seems to be the least influential in affecting growth, in contrast, Gross Domestic Savings appear as a better option in driving growth in this economy. This finding is in line with Romer (1986), who points out that permanent increase in growth can be achieved by higher savings and capital accumulation. Therefore the potential rate of growth of output for Singapore can be significantly enhanced by pursuing an active policy of sound financial sector development, particularly focusing on ways to promote savings in contrast to leveraging.

Keywords: Domestic credit, economic growth, lead-lag, VECM, VDC, Singapore

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INTRODUCTION

We have observed that credit was one of the factors that triggered the crisis. With the ability to obtain credit, one can invest in homes and buy luxury goods which they would have been unable to acquire otherwise. In the absence of credits, the country in study will probably not witness the kind of economic growth they are enjoying at present. However the speed of the debt build-up has become a call for concern in this economy. In Aug 2013, Singapore's credit-GDP growth gap was Asia's largest. This is due to the fact that Singapore's domestic private credit-to-GDP ratio has risen sharply, from 101 percent in Q4 2008 to 149 percent in Q1 2013. As such there exist concerns over the speed of the debt build-up instead of the debt level. It was explained that Singapore's main monetary policy target is the exchange rate, and so its short-term interest rates closely mimic the near-rock bottom rates in the US. Unless the debt build-up is brought under control, Singapore will be very exposed when the US Fed eventually does raise rates.

Many studies have been conducted in regard to finding evidence on the causal relationship between economic growth and financial development (usually proxied by credit or savings). Proposed by Patrick (1966) who introduced the so-called 'supply-leading' and 'demand-following' hypotheses to explain the causal relationship between finance and growth, it is hypothesized that in the former, increase in the supply of financial services leads to economic growth commonly seen at an early stage of development, conversely in the later, economic growth stimulates demand for financial services and hence resulting in financial development at a later stage of development. The fact that Singapore is now highly urbanized with a higher per-capita income in comparisons to other European nations would probably make it fall under the category of a later stage of development, hence with the speed of the debt build up, we seek to find evidence if indeed the demand following hypotheses is applicable to this country. Notwithstanding the fact that we have seen many conflicting views with regard to discussing this topic globally and not limiting only to Singapore of which we will provide a background in the next section, therefore the issue of direction of causality remains unresolved. Hence in this paper, we will make an humble attempt to fill in the gap by addressing the issue in the context of Singapore.

The findings of this paper indicate that relying on the statistical results, the supply-leading condition is applicable to Singapore except if financial development is proxied by GDS (GDS and DCP are usually used interchangeable to represent financial development in most studies), however based on intuition, one would have guessed that Singapore being a high income economy would be in its later stage of economic development, hence pointing to the direction of supporting the demand following condition. Additionally, evidences from the analysis indicate that DCP is the least influential in affecting growth. In contrast, GDS appeared as a better option in driving growth in this economy. This would be in line with (Romer, 1986), who discovered that permanent increase in growth can be achieved by higher savings and capital accumulation. This matches with our statistical results which tend to imply that the potential rate of growth of output can be significantly enhanced by pursuing an active policy of sound financial sector development in a developed country like Singapore particularly focusing on ways to promote savings in contrast to leveraging.

The rest of the paper will be organized as follows. Next section we will review the related literature, section three will include the objective and motivation of research, section four we will elaborate on the theoretical underpinnings, section five and six will consist of the methodology and data, empirical results and discussions, we conclude in section seven with some policy implications followed by section eight highlighting the limitations of study and suggestions for future research.

1. LITERATURE REVIEW

The link between financial development and economic growth is not a recent discovery. According to Rousseau (2002), although Bagehot (1873), Schumpeter (1911), and Gurley and Shaw (1955) motivated this relationship decades ago, it was economic historians such as Davis (1965), Cameron (1967), and Sylla (1969), among others, who gave empirical content to the idea. On that account, the literature on bank credit which is an instrument for financial development too can be traced back to the same timeframe. Most of the literatures on financial developments indicate that it is

positively correlated with economic growth. Levine et al. (2000), Khalifa (2002), Ang (2008) and Hsueh et al. (2013) are some of those who support this view.

There are however no consensus that domestic credit indeed aid economic growth. King and Levine (1993) indicate that the percentage of credit allocated to private firms and the ratio of credit issued to private firms to GDP are strongly and robustly correlated with growth. Conversely, Hassan et al. (2011) found that domestic credit to the private sector is positively related to growth in East Asia & Pacific, and Latin America & Caribbean, but is negatively related to growth in high-income countries. The authors uses panel regressions with cross-sectional countries and time-series proxy measures to study linkages between financial development and economic growth in low, middle and high-income countries as classified by the World Bank with the objective of documenting the progress in financial liberalization and exploring some policy implications.

In a much recent article, findings by Banu (2013) indicate that growth of credit influences economic growth and commented that any economy, no matter how advanced, cannot develop in the absence of credit. When credit grows, consumers can borrow and spend more, and enterprises can borrow and invest more. A rise of consumption and investments creates jobs and leads to a growth of both income and profit. Expansion of credit also influences the price of assets and hence increasing its value which in turn allowing the chance for the owner to borrow more, due to the increase in wealth. This cycle of credit expansion leads to investments, to the creation of new jobs, to prosperity, followed by a new loan, which produces the sensation of increased wealth. According to Banu (2013), all economic expansion induced by credit will come to an end when any of the economic sectors become incapable in paying off their debts.

Takáts and Upper (2013) in their working paper explained that while debt is normally "good", that is positively correlated with economic growth, excessive and misallocated debt has a darker side. He quoted that "Bad" debt, via debt overhang (as explained in Lamont (1995) and Philippon (2009)), zombie firms and excessive debt levels can all lower economic growth. This would suggest that while a normal increment of credit improves economic performance bad debt is detrimental. It was however noted in July 2013 that Singapore banks were able to maintain strong financial metrics, including low non-performing loan (NPL) ratios which dipped to 0.38 percent

the year before. Nonetheless, Moody's noted that asset quality has potentially peaked both in Singapore and in many of the regional markets local banks operate in, a scenario which may lead to a worsening of NPL ratios and higher credit costs. (Wong, 2013)

2. OBJECTIVE AND MOTIVATION OF RESEARCH

The main purpose of the study is to examine the relationship between domestic credits and economic growth in Singapore. Firstly, it aims at discovering the direction of causality between domestic credit to private sector and economic growth for the purpose of providing a critical assessment on how efforts placed in developing financial sector contributes to the economic growth which in turns has strong implications on policy implementation. Secondly, it seeks to find empirical evidence if domestic credit indeed contributes to economic growth and if so what is the strength of the relationship between these two variables that is, does it holds a weak or a strong contribution. Lastly, to the best of our knowledge, there is an absence of a study done in this area specifically meeting the stated objectives. In addition, due to the limitation of the methodology used in previous studies, we would like to adopt the methodology used by Masih et al. (2009) in making an attempt to improve on the existing time-series methodology used in resolving the causality issue. This will include the use of the vector error correction and generalized variance decompositions including the LRSM which is an improved and also an extension to the standard cointegrating techniques.

We are mainly motivated by two main factors. Firstly, as debt numbers soar, the alarming speed of the debt buildup in some of the countries mentioned in this study created a strong need to relook at the relationships between these variables, in hope to seek evidence if savings is able to play a similar role at par or better than credit in promoting growth in these regions. Secondly, many studies have evaluated the relation between credit and growth however their results appear to be inconsistent. The debate on supply-lending (financial development causes economic growth) and demand following (financial development a result of economic growth) is still unresolved till this date. There is no right or wrong answer to this prolonging debate. Hence, we seek to find evidence if Singapore differs in this context.

Significance of study may include findings that may have important implications on stabilization policies and would be relevant for other countries that witnessed similar patterns of hike in their level of domestic credit in relation to growth.

3. THEORETICAL UNDERPINNINGS

Although the main focus of the study is to identify the lead-lag relationship between financial development proxied by domestic credit to private sector and growth, we have also included other control variables in the study to observe the interactions amongst each other. Therefore, DCP (domestic credit to private sector) will be our focal variable; GDS (gross domestic savings) will be our core variable and both inflation and real interest rates as our supporting variables. GDS is included as the core variable as it is often being proxied as financial development as seen in many previous studies. In addition, intuition will tell us that both variables do promote growth but the marginal benefit from a rise in credit in comparisons to a rise in savings remains questionable. Although findings from Romer (1986) point out that permanent increase in growth can be achieved by higher savings and capital accumulation.

To observe the interactions between the productivity channel and growth, we have included the real interest rates as one of the controlling variables. Chang and Huang (2010) and Costas and Smith (1998) showed theoretically that real interest rate levels do affect relationships between finance and real activity. In a regime where the real interest rates are higher (lower), the banking system has significantly positive (adverse) effects on output growth.

The other control variable that we have included is the rate of inflation. The correlation between inflation and growth is expected to be nonlinear. Fischer (1993) was one of the first authors to identify the possibility of the non-linear relationship. He argued that inflation helps economic growth when it is below a threshold value, but has a negative influence if it is above that threshold level.

We will test the lead-lag relationship between economic growth and the financial development (proxied by domestic credit to private sector) against the above mentioned theoretical underpinnings. The causality will be tested mainly through the error correction model by having five equations with each variable in turn being a dependent variable.

4. METHODOLOGY

We will attempt to apply a time series technique, in particular, cointegration, error correction modelling and variance decomposition, in order to find empirical evidence of the nature of relations between domestic credit and economic growth. This technique will assist us in capturing the correlation between financial development (proxied by CREDIT) and economic growth and testing the possible directions of causality between them.

There are various reasons as to why this technique is used in comparison to the traditional regression technique, one of which is the fact that most variables finance or economic alike are deemed as non-stationary hence adopting the ordinary regression will render the results as being inaccurate. While taking a differenced form of these variables may solve the problem, the long term trend is however being removed meaning the theoretical relationships will not be tested and hence only capturing the short term, cyclical or seasonal effects. Next, while the traditional regression technique assumes endogeneity and exogeneity of variables on the basis of theories, by engaging in the cointegration technique, this assumption will cease to exist as the data will determine the endogeneity and exogeneity of the variables and will be empirically proven. Lastly, unlike the traditional regression, the cointegration technique enables the dynamic interaction between variables which in the context of promoting economic growth is evidently necessary.

Additionally, Masih et al. (2009) reaffirmed that there is a major shortcoming in testing lead-lag relationship with the cross sectional approach as it deems inappropriate in capturing the dynamics of the variables involved, subsequently it also assumes that the parameters across countries remain constant. As such for the purpose of this study, we will adopt a time-series approach in the attempt to conduct a more appropriate testing for the temporal or lead-lag relationship between variables.

Furthermore, due to the limitations of the error correction/variance decompositions methods based on estimates of the cointegrating vectors, which are atheoretical in nature, a LRSM (Long-run structural modelling) technique will be used to overcome this major limitations. It seeks to quantify the theoretical relationship among the variables. This is done to enable comparisons between statistical findings and theoretical or intuitive knowledge.

5. DATA, EMPIRICAL RESULTS AND DISCUSSIONS

Quarterly data were collated for each variable for the period from quarter one in 1980 to quarter four in 2012 comprising a total of 132 observations sourced from DataStream. Where GDP is referring to GDP per capita (constant LCU) and defined as GDP divided by midyear population. Data are in constant local currency. DCP is referring to Domestic credit to private sector (% of GDP) and defined as financial resources provided to the private sector. It is derived by credit to private nonfinancial sector/nominal GDP. GDS is referring to Gross domestic savings (% of GDP) and defined as GDP less final consumption expenditure (total consumption). It is derived by national savings/nominal GDP. INF is referring to Inflation, defined as the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The idea of using CPI instead of inflation in computing INF is to overcome the issue of stationarity in its original form. It is therefore derived by taking the log [CPI this month] - log [CPI last month]. RIR refers to Real interest rate derived by bank deposit rate/CPI. In order to pass the unit root test, we have decided to take the logs of all the variables. Log-transforming the data is a common practice as it helps to overcome the detrimental effects of heteroscedasticiy and skewness in the level data on estimation and testing. Mayr and Ulbricht (2007)

5.1. TESTING STATIONARITY OF VARIABLES

The eight steps technique started off with the test of stationarity of the five variables. Ideally we would like to see that our variables are I(1) meaning they are non stationary in the level form and stationary in their first differenced form. As mentioned earlier we have taken logs in all the variables, among other things, to pass the unit root test as we were not able to pass this stage if it

is not log transformed. The differenced form is simply created by taking the difference of their log forms. An example of such is $DGDP=LGDP-LGDP_{t-1}$. The Augmented Dickey-Fuller (ADF) test is then performed on each variable both on its level and differenced form and below are the computed results, of which the details could be found in Appendix 1A to 1J.

Variable	Test Statistic	Critical Value	Results
Variables in Level Form			
LGDP	-2.0862	-3.4458	Variable is non-stationary
LGDS	-3.0288	-3.4458	Variable is non-stationary
LDCP	-2.9624	-3.4458	Variable is non-stationary
LINF	-1.2229	-3.4458	Variable is non-stationary
LRIR	-2.0781	-3.4458	Variable is non-stationary
Variables in Differenced Form			
DGDP	-5.6172	-2.8845	Variable is stationary
DGDS	-3.6999	-2.8845	Variable is stationary
DDCP	-4.8629	-2.8845	Variable is stationary
DINF	-7.8006	-2.8845	Variable is stationary
DRIR	-4.4639	-2.8845	Variable is stationary

Table 1: ADF Test

By using the AIC and SBC criteria, we are able to conclude that the above variables are I(1) and therefore, we will now in the next section proceed with the setting of the order of VAR and proceed with the testing of the cointegration. By setting the null hypothesis for the variables in the level form as non-stationary, we are not able to reject the null as all the test statistics for the five variables listed in the level forms are all lower than the critical value. On the other hand, the test statistics for the variables in the differenced form appear higher than the critical value and therefore, will be able to reject the null and conclude that the variables are indeed stationary.

6.1.1 PHILLIPS PERRON TEST

In terms of testing stationarity of variables, we could also apply the Phillips Perron Test. This test will correct both the autocorrelation and heteroscedasticy problems by using Newey-West adjusted-variance method whilst on the other hand the ADF test as mentioned above will only correct the autocorrelation problem. In addition, according to Valadkhani and Chancharat (2007) the PP test also ensures good handling of the higher order of serial correlation in the ADF equation. The null hypothesis of the PP test is, the variable is non-stationary. As such referring to Table 2 as indicated below, we have identified that both INF and RIR turned out to be stationary. Despite the fact that these can probably be resolved by effecting an adjustments towards the truncation lags, we would like to inform that such adjustment was not effected as we deem it as unnecessary since this test only serve as a purpose of complementing the earlier ADF test and the earlier test has taken care of the autocorrelation problems. Heteroscedascity problem commonly exists in cross section data whereas this study is involving time series data. Therefore concluding that only three variables (GDP, GDS, DCP) are I(1) under the PP test. (See Appendix 1K)

Variable	Test Statistic (p-value)	Implication (5% significance level)
LGDP	0.028	Variable is non-stationary
LGDS	0.000	Variable is non-stationary
LDCP	0.000	Variable is non-stationary
LINF	0.839	Variable is stationary
LRIR	0.496	Variable is stationary

Table 2: PHILLIPS PERRON Test

5.2. DETERMINATION OF ORDER OF THE VAR MODEL

Step 2 involved the determination of the order of vector auto regression (VAR), we will refer to the optimal order sets out by AIC and SBC and identify if there are any conflicting results before we proceed to test the serial correlation for each of the variables. As shown below, AIC suggests an optimal order of 4 whereas SBC suggests an optimal order of 1.

	Choice Criteria	
	AIC	**SBC**
Optimal order	4	1

Table 3: Order of VAR

Hence, we now proceed to test the serial correlation for each of the variables. See Appendix 2A to 2F for details. Out of which the results are tabulated as per the following:

Variable	Chi-Sq p-value	Result (@10%)
DGDP	0.000	There is serial correlation
DGDS	0.143	There is no serial correlation
DDCP	0.131	There is no serial correlation
DINF	0.067	There is serial correlation
DRIR	0.272	There is no serial correlation

Table 4: Tests of serial correlation

We are able to detect autocorrelations in 2 out of the 5 variables tested, incidentally, adopting a lower order may induce the effects of serial correlation and choosing a higher order have a downside of risking over-parameterization. Hence, given the relatively large observations, we will proceed with the higher order of 4.

5.3. TESTING COINTEGRATION

Purpose of testing cointegration is to examine if the variables move together in the long term. This tests the theoretical relationship among the variables. For the purpose of this assignment we have identified two types of cointegration test which are the Johansen test and the Engle-Granger test.

5.3.1. JOHANSEN TEST FOR COINTEGRATION

Step 3 includes the test for cointegration. The mandatory requirement for this step is that the variables must be I(1) which we have identified and fulfilled in the previous sections.

Criteria	Number of cointegrating vectors
Maximal Eigenvalue	1
Trace	1
AIC	3
SBC	0
HQC	1

Table 5: Number of cointegrating vectors

In the case of Maximal Eigenvalue and Trace, the test statistic for null of r = 0 is greater than the 90% critical value. For AIC, SBC and HQC, the number of cointegrating vectors is derived by referring to the highest numbers. (See Appendix 3)

Besides the SBC criteria which reflect nil cointegrating vectors, the other sets of criteria clearly indicate the presence of at least one cointegrating vector. Intuition will tells us that the five variables used in this study are indeed in some way or another related. Hence with the statistical result displayed on the table, we would like to assume that there is at least one cointegrating vector therefore pointing out that the variables are theoretically related and move together in the long run. Since these variables are cointegrated, it eventually will realign themselves into a long-term (theoretical) relationship with one another. Therefore, the impact from any policy changes made to any of the variables would only result in satisfying short term goal and probably solve issues arising during that short period of time.

5.3.2. ENGLE GRANGER TEST FOR COINTEGRATION

The Engle Granger test is derived from the residual-based ADF method proposed by Engle and Granger (1987). Since there are five variables, there will be five equations with each variable in turn being a dependent variable. The null hypothesis of the EG test is that the error term is non-stationary, therefore, implying that if residual/error term is stationary, it provides evidence of cointegration. Based on table 6 as shown below, we are not able to reject the null as the t-stats for all the five equations are smaller than the critical value, suggesting that cointegration does not exist. Nevertheless, we made a conclusion that there is at least one cointegrating vector as seen from the Johansen test and will use this conclusion to proceed to the next step. It is good to however recap that whilst the EG test uses residual based approach, it can only identify one cointegration, in contrast to Johansen test, it uses maximum likelihood and therefore it can identify more than one cointegration. (See Appendix 3A to 3E)

Equation	**T-Stat**	**Critical Value**	**Implication**
LGDP CONS LGDS LDCP LINF LRIR	-0.84980	-3.4458	No Cointegration
LGDS CONS LGDP LDCP LINF LRIR	-3.4366	-3.4458	No Cointegration
LDCP CONS LGDP LGDS LINF LRIR	-3.0959	-3.4458	No Cointegration
LINF CONS LGDP LGDS LDCP LRIR	-2.0948	-3.4458	No Cointegration
LRIR CONS LGDP LGDS LDCP LINF	-2.7916	-3.4458	No Cointegration

Table 6: Engle Granger Test

6.4. LONG RUN STRUCTURAL MODELLING (LRSM)

Whilst step 3 identifies the relationship among the variables, step 4 will attempt to quantify the theoretical relationship between the variables. This is achieved by comparing statistical findings against theoretical or intuitive expectations. By normalizing our variable of interest (DCP – domestic credit to private sector) and made it equal to one, below is the tabulated results. (See Appendix 4A to 4E)

Variable	Coefficient	Standard Error	t-ratio	Result
LGDP	1.2701	0.47104	2.69637	***Variable is significant***
LGDS	0.31345	0.20595	1.52197	***Variable is significant***
LDCP	-	-	-	-
LINF	-0.80005	0.50311	-1.5902	***Variable is not significant***
LRIR	-0.13176	0.063238	-2.0836	***Variable is significant***

Table 7: LRSM – Exact Identifying

Based on the t-ratios, we have identified three variables (GDP, GDS and RIR) to be statistically significant. Although the findings matched our intuitions, we remain inquisitive and our instinct tells us to explore further by the means of using the over identifying restriction to verify if the findings hold. The results appear to be consistent and the same three variables (GDP, GDS and RIR) continue to be significant as detailed in table 8. (See Appendix 4B to 4E).

By setting the over-identifying restriction, we test the long-run coefficients of the variables against the theoretically expected values and see if these variables are statistically significant. As shown in table 8 below, besides INF, the remaining variables of GDP, GDS and RIR are significant. This finding is in line with the theory by Fischer (1993) which depicts the correlation between inflation and growth, Fischer was one of the first authors to identify the possibility of the non-linear relationship. He argued that inflation helps economic growth when it is below a threshold value, but has a negative influence if it is above that threshold level

Variable	Chi-Sq p-value	Implication
LGDP	0.000	***Variable is significant***
LGDS	0.000	***Variable is significant***
LDCP	-	-
LINF	0.207	***Variable is insignificant***
LRIR	0.000	***Variable is significant***

Table 8: Over-identifying restriction

From the above analysis, we now arrive at the following cointegrating equation (numbers in parentheses are standard deviations).

$$DCP + 1.27GDP + 0.31GDS - 0.13RIR \rightarrow I(0)$$
$$(0.47) \quad (0.21) \quad (0.06)$$

6.5. VECTOR ERROR CORRECTION MODEL (VECM)

To recap, we have identified at least four variables being cointegrated to a significant extent; this would include DCP, GDP, GDS and RIR. Nevertheless, cointegration only tests if indeed the variables move together in the long run, it however does not tell which variable is leader (exogenous/independent) and which variable is the follower (endogenous/dependent). Hence with VECM, we will be able to identify the causality between the variables. The causality results will enable better forecasting or prediction for the policy makers. Policy maker would be keen to know which financial development variable is the leading variable and which are the followers as by identifying the lead/lag relationship, it would bear important implications on the expected movements of the other variables. For example the exogeneous variable will have strong influence on the movement of the other variables.

On top of that, VECM technique will also be able to differentiate between short and long run causality. Essentially, Granger causality will be able to determine the extent to which the change in one variable is caused by another variable in a previous period. By referring to the error correction term, e_{t-1}, for each variable and checking if it is significant, we found that there is only one endogenous variable, RIR as shown in table 9 below. The remaining four variables (GDP, GDS, DCP, and INF) appear to be insignificant and are exogenous. (See Appendix 5A to 5E)

Variable	ECM(-1) t-ratio p-value	Results
LGDP	0.259	Variable is exogenous
LGDS	0.298	Variable is exogenous
LDCP	0.502	Variable is exogenous
LINF	0.190	Variable is exogenous
LRIR	0.077	Variable is endogenous

Table 9: Exogeneity and Endogeneity of variables

RIR is endogenous since its error correction term is significant (p-value below 10% significance level), whereas the remaining four variables (GDP, GDS, DCP and INF) are all exogenous as the error correction terms appears to be insignificant (p-value above 10% significance level). Exogenous variables would transmit the effects of the shock to other endogenous variables when they receive shocks from the market. For instance, policy makers may wish to look at any fluctuations in GDP, GDS, DCP and INF as these variables may likely influence the movements in RIR.

The result also implies that we have more than one variable which is leading. As it is having more than one leader would be chaotic in any kind of circumstances. It is however good to note that VECM cannot tell the relative endogeneity/exogeneity of the variables. In essence, it would not be able to tell which variable is the strongest leader and which variable is the weakest follower. This will be tackled in step 6 under variance decomposition.

Incidentally, the coefficient of e_{t-1} tells us how long it takes to get back to equilibrium if that particular variable is to be shocked. The coefficient represents proportion of imbalance corrected at each period. For instance, in the case of DCP -.0031084 implied that it would take an average of 0.03 quarters to get back to equilibrium with the other variables.

6.6. VARIANCE DECOMPOSITION (VDC)

Although we have identified the exogeneous variables, we have not been able to identify which variable is the strongest leader and which variable is the weakest follower (by ranking the variables based on the degree of dependence on their own past lags), hence with VDC we will be able to achieve this objective. Relative endogeneity can be obtained by means of the VDC in decomposing the variance of the forecasted error of each variable into proportions attributable to shocks from each variable in the system, including its own. The least endogenous variable is thus the variable whose variation is explained mostly by its own past variations.

There are two approaches in this technique (orthogonal and generalized VDCs). While orthogonal depends on the particular ordering of the variables in the VAR, it also made assumptions that when a particular variable is shocked; all other variables in the system are switched off. On the other hand, the generalized approach does not depend on the particular ordering of the variables in the VAR and it does not make assumptions on the switching off of the other variables in the system.

By applying orthogonalized VDCs we are able to obtain the following results (see Appendix 6A to 6E). For the below two tables, the rows implies the percentage of the variance of forecasted error of each variable into proportions attributable to shocks from other variables (in columns), including its own. The columns read as the percentage in which that variable contributes to other variables in explaining observed changes. The diagonal line of the matrix (in bold) represents the relative exogeneity. We have been able to obtain results based on 2 time horizons (24 and 32) as shown in tables 10 and 11 below.

Forecast at Horizon = 24

	GDP	**GDS**	**DCP**	**INF**	**RIR**
GDP	**35.88%**	28.70%	15.85%	14.60%	4.97%
GDS	2.38%	**66.68%**	23.42%	1.68%	5.84%
DCP	5.57%	8.90%	**45.65%**	14.22%	25.70%
INF	11.97%	1.06%	19.32%	**48.17%**	19.47%
RIR	14.02%	33.38%	3.97%	3.86%	**44.79%**

Table 10: Orthogonalized Variance Decomposition at horizon 24

Forecast at Horizon = 32

	GDP	GDS	DCP	INF	RIR
GDP	**35.12%**	28.82%	15.83%	14.95%	5.29%
GDS	1.95%	**65.43%**	24.84%	1.64%	6.14%
DCP	5.04%	9.27%	**41.79%**	15.23%	28.68%
INF	11.20%	1.27%	21.41%	**45.65%**	20.47%
RIR	14.13%	35.74%	5.08%	4.34%	**40.71%**

Table 11: Orthogonalized Variance Decomposition at horizon 32

Accordingly, the ranking of variables by extent of exogeneity (variation is explained by its own past variations) is captured in table 12 as indicated below.

Ranking	Variables
1	GDS
2	INF
3	DCP
4	RIR
5	GDP

Table 12: Ranking from Orthogonalized VDC after horizon 32

When comparing to the earlier step (VECM), the result appear to be rather consistent since GDS indeed falls under one of the four variables that we have identified as being exogenous in the earlier step. However, it is important to acknowledge that there are two limitations with regards to the orthogonalized VDCs. As mentioned earlier, firstly, it depends on the particular ordering of the variables in the VAR and secondly, it made assumptions that when a particular variable is shocked; all other variables in the system are switched off. Due to this downside, we proceed to engage the second approach which is the Generalized VDCs. This approach is invariant to the ordering of the variables and do not make the switched off assumptions as earlier mentioned. Results were obtained as per Appendix 6F to 6J. The difference with this approach in terms of its computations is that we will need to perform manual adjustments as the numbers do not add up to 100%. This is simply derived by dividing the number for that variable against the total numbers of the given row multiply by 100. Results are tabulated in tables 13 and 14 as shown below. (See Appendix 6F to 6J)

Forecast at Horizon = 24

	GDP	**GDS**	**DCP**	**INF**	**RIR**
GDP	**46.16%**	4.84%	28.61%	16.30%	4.09%
GDS	3.67%	**68.71%**	6.80%	8.84%	11.98%
DCP	7.68%	5.09%	**41.38%**	23.47%	22.38%
INF	9.96%	5.69%	24.06%	**43.58%**	16.72%
RIR	21.68%	13.58%	2.18%	4.77%	**57.79%**

Table 13: Generalized Variance Decomposition at horizon 24

Forecast at Horizon = 32

	GDP	GDS	DCP	INF	RIR
GDP	**45.67%**	4.49%	28.65%	16.77%	4.42%
GDS	3.08%	**68.19%**	6.69%	8.97%	13.06%
DCP	6.98%	4.98%	**37.06%**	24.95%	26.03%
INF	9.32%	5.87%	25.91%	**40.94%**	17.97%
RIR	22.64%	15.56%	3.17%	5.45%	**53.18%**

Table 14: Generalized Variance Decomposition at horizon 32

The ranking based on Generalized VDCs by relative exogeneity are as tabulated below.

Ranking	At Horizon = 24	At Horizon = 32
1	GDS	GDS
2	RIR	RIR
3	GDP	GDP
4	INF	INF
5	DCP	DCP

Table 15: Ranking from Generalized VDC after horizon 32

Following are the key observations deriving out of the above results:

- The Generalized VDCs confirm the results of the VECM in terms of GDS being one of the exogenous variables identified in VECM.
- The relative ranking in terms of exogeneity is seen as somewhat consistent between the period of horizon 24 and 32.
- Interestingly, GDS remain as the most exogenous variable in both the ranking derived from Generalized and Orthogonalized VDC

- The Generalized VDCs confirm some interesting fact that the variable of interest (DCP) is at the extreme lowest ranking in terms of its exogeneity, in contrast to GDS being at the top of the ranking for exogeneity. It is good to note that both of these variables are usually used interchangeably as proxy for financial development.
- At horizon 24, we noticed that the most exogenous variable and the least exogenous (or most endogenous) variable are separated by about 27.33%. A fairly significant percentage in terms of comparing the relative lead/lag relationship between the variables and the gap is seen as even larger when compared to horizon 32, which indicate 31.13%.
- While GDS being the most exogenous, DCP (our variable of interest) being at the lowest place in terms of ranking for exogeneity indicates that the variation in DCP is least explained by itself and mostly influenced by the other four variables (GDP, GDS, INF and RIR).

The above results depicts that GDS is the strongest leader (exogenous/independent) amongst the variables in study, followed by RIR and GDP. It is somewhat surprising that INF and DCP being the least influential. Theory however tells us that while inflation helps economic growth when it is below a threshold value, it has a negative influence if it is above that threshold level. Conversely, based on the surge in the debt buildup, intuition tells us that DCP seems to be playing the lead role in terms of being the preferred mechanisms of choice when handling its macroeconomic policy. Notwithstanding these evidences, the differences in relative exogeneity imply that these variables are highly cointegrated and that they tend to affect each other.

6.7. IMPULSE RESPONSE FUNCTIONS (IRF)

The impulse response functions (IRFs) produces the same information as the VDCs, except that they can be presented in graphical form. For the sake of completeness, we have included the various graphs of IRFs in Appendix 7A to 7E.

6.8. PERSISTENCE PROFILE

While VDCs uses a variable-specific shock as in shocking one variable and seeing the impact on others, PP on the other hand utilizes the system-wide shock, whereby the shock are coming from the external source to the cointegrating vectors. We then refer to the time horizon to identify how much time it takes for the variables to come back to equilibrium. This is being illustrated in table 16 as shown below. The chart indicates that it would take approximately 20 quarters for the cointegrating relationship to return to equilibrium following a system wide shock.

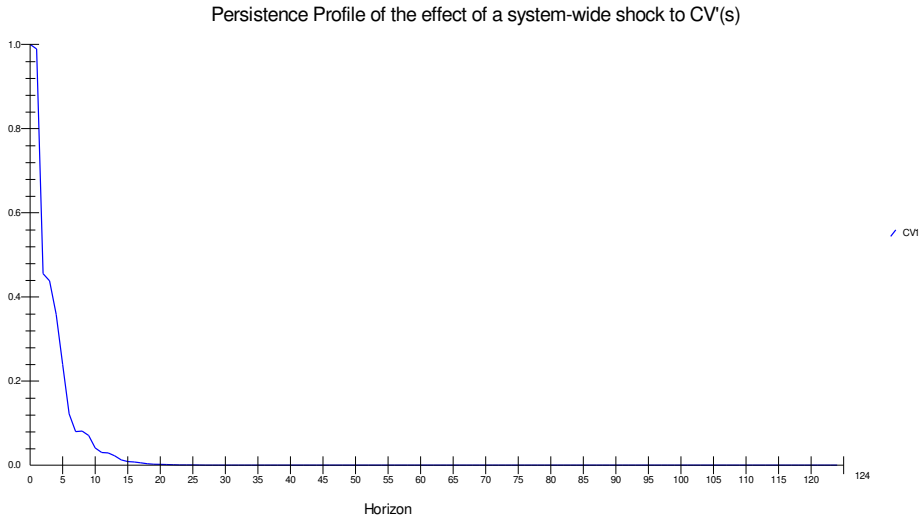

Table 16: Persistence profile for the cointegration equation

7. CONCLUSIONS AND POLICY IMPLICATIONS

This study examines the causal relations and dynamic linkages between Economic growth proxied by real GDP per capita and four other macroeconomic and financial variables namely Gross domestic savings as a percentage of GDP, domestic credit to private sector as a percentage of GDP, Inflation and Real interest rates. The analysis relies on a time series technique, in particular, cointegration, error correction modelling and variance decomposition. However due to the limitations of the error correction/variance decompositions methods based on estimates of the

cointegrating vectors, which are atheoretical in nature, a LRSM (Long-run structural modelling) technique were being applied to overcome this major limitations. It seeks to quantify the theoretical relationship among the variables. This is done to enable comparisons between statistical findings and theoretical or intuitive knowledge.

Concluding the analysis, we would like to address the two main questions posed at the beginning of the study. The empirical results we obtained bear various implications on the issues of direction of causality and long term stability of dynamic linkages between macroeconomic and financial variables. The presence of cointegration between economic growth and these variables indicate a long-run predictability of the magnifying or reducing effect of economic growth.

I. In terms of discovering the direction of causality between domestic credit to private sector and economic growth, to recap, the pioneering work of Patrick (1966), it suggests that a supply-leading condition is likely to prevail at the early stage of economic development, while a demand-following condition is likely to prevail at the later stage of economic development. Although the statistical results points out that indeed the supply-leading condition is applicable to Singapore except if financial development is proxied by GDS (which is usually the case in place of credit), based on intuition, one would have guessed that Singapore being a high income economy would be in its later stage of economic development, hence pointing to the direction of supporting the demand following condition.

II. Regarding the strength of the relationship between GDP and DCP and if it holds a weak or a strong contribution, our findings points out that DCP is the least influential in affecting growth. In contrast, GDS appeared as a better option in driving growth in this economy. This would be in line with (Romer, 1986), who points out that permanent increase in growth can be achieved by higher savings and capital accumulation. This match with our statistical results which tend to indicate that the potential rate of growth of output can be significantly enhanced by pursuing an active policy of sound financial sector development in a developed country like Singapore particularly focusing on ways to promote savings in contrast to leveraging.

With regards to policy implications, policy makers will need to consider any shocks in the economic and financial variables affecting growth in an economy. Singapore in particular, has been seen as a small and open economy that is extremely vulnerable to global contagion effects. Any forms of crisis will tend to create irregularity in the interactions between economic growth and the macroeconomic and financial variables. Therefore, by excluding the crisis year, we would be able to note some consistent patterns of interactions between these variables as the crisis may only create temporal irregularities between the interactions between the variables. Though this is solely based on intuition and to state this conclusively would be rather untimely as more data and analysis would be required to meet the objectives, creating rooms for future research.

8. LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FUTURE RESEARCH

Notably this paper comes with caveats, readers should be mindful of a relatively limited dataset (which was due to inherent data limitations) used for this study. Also, because of the presence of some minor violation in structural stability, results should be interpreted with caution to a certain degree. Due to time constraints, as mentioned in the earlier section we have not excluded the crisis years in this study. Therefore, future research could include dummy variables to address this concern so as to provide a more accurate analysis.

Additionally, the choice of variables is solely upon one's discretion. As such, many other macroeconomic variables could have also been considered to check on the variations in interactions between them. For example, while Singapore's economic growth record to date has been admirable, it has prioritized its quantitative goals over its qualitative by-product and the distribution among beneficiaries. Notably, growth does not always necessarily portray goodness and it is rather vague in terms of for whom the growth is meant for. For instance, people for growth and growth for the people (as a means of achieving better welfare for mankind as a whole especially citizen workers and consumers). The assumption that the former will in anyway lead to the latter should be re-examined and future research could analyze this.

Apart from that, the type of growth a nation chose should be sustainable both financially (ideally without saddling the economy as a whole with higher inflation through the import of excess labor and capital) and environmentally (at the expense of negative externalities which end of day would deter competitiveness and healthy growth). Henceforth, the best process for growth is one that do not put the national savings at stake especially knowingly the accumulations were done over generations of restrained consumptions. It is therefore important for Singapore to build a unique niche in the regional and world economy that can possibly results in the inability of others to duplicate, however much they try to emulate the strategies. Ultimately, growth and identity are intertwining.

Eventually, it would be useful if future research could be done to compare a similar relationship with other high income countries with similar stock of money supply to see if there are any significant differences in their credit implications towards economic growth. Reason being it is important to stay cautious of any possible destabilizing effects of monetary shocks on the economy as a whole.

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