The Dynamics of the Debt-Service Ratio in the Canadian Economy

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ABSTRACT

With Canadian households accumulating historically high levels of debt at such a rapid pace, there has never been a more important time to understand the dynamics of the debt-service ratio. This paper explores the characteristics of household debt and uses a Vector Error Correction Model (VECM) to analyze the macroeconomic relationships that drive fluctuations in the Canadian debt-service ratio. We choose to model these relationships using a VECM specification due to the endogenous and non-stationary nature of the data as well as the presence of cointegration among the variables. We find short-run relationships among changes in the debt-service ratio and changes in disposable income per capita, net savings per capita, the prime interest rate, the affordability of housing, the unemployment rate, and core inflation. We also find that the estimated long-run relationship among the variables is statistically significant, implying that there exists an equilibrium or steady-state among these macroeconomic indicators. Using the results of our model we propose policy for reducing the debt-servicing costs of Canadians and provide concluding remarks.

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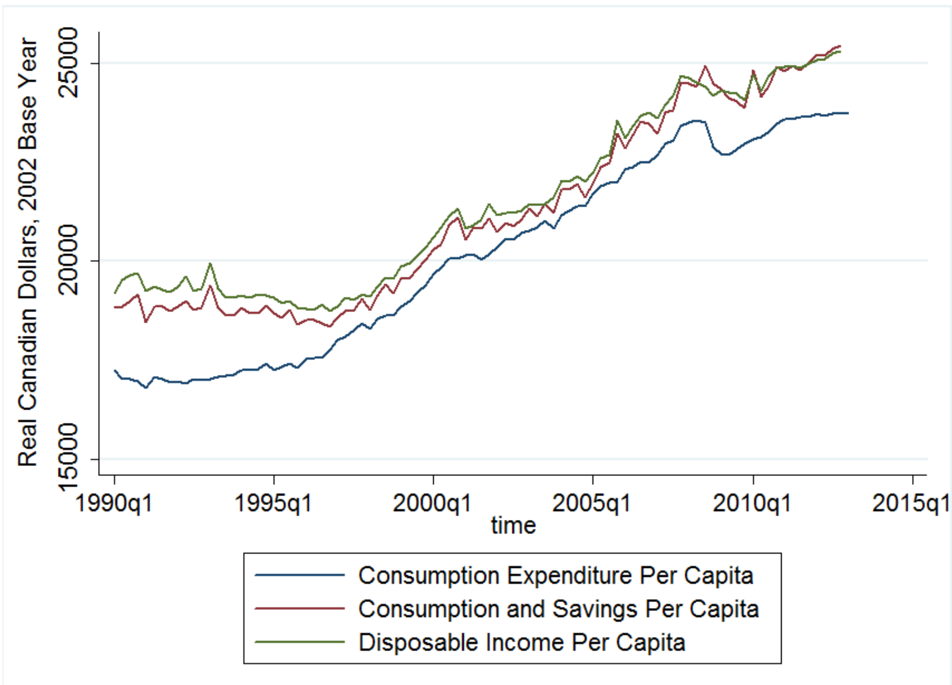
I INTRODUCTION

Debt is a part of almost every Canadian's life. Whether a mortgage, a credit card, or some other form of credit, Canadian's use debt to increase their consumption today at the expense of their future consumption. Specifically, the fundamental purpose of debt is to facilitate consumption smoothing. Consumption smoothing is the process whereby economic agents convert an uneven income stream into a stable consumption stream and is typically achieved by saving during times of high income and consuming those savings in times of low income. The standard age-earnings profile and lifetime consumption models predict that, in order to maximize lifetime utility, households will save during their employed years (typically aged 24 to 65 in Canada) and live off those savings after retirement. This theory has been supported empirically by the extreme popularity of pensions and registered retirement savings plans (RRSPs) and the strong tendency for most households to save part of their income. Further, many lifecycle earnings models have identified that the optimal consumption path for a consumer or household actually involves borrowing in the early years of employment against future earnings. Empirically, this is supported by the universal use of mortgages to secure homes and student loans to acquire education. Despite the possibility of consumption smoothing reducing the total amount of consumption over one's lifetime, consumers smooth consumption because it unambiguously increases lifetime utility under the (typically realistic) assumption of risk aversion and a concave utility function (Brown et al, 2013).

However, there can be too much debt. What constitutes 'too much' is currently a matter of speculation rather than fact, but several key indicators have proven useful in evaluating the amount of debt carried by households. Namely, these indicators are the debt-to-disposable income ratio and the debt-service ratio. The debt-to-disposable income ratio represents the aggregate stock of private debt in the economy divided by the aggregate disposable income, where disposable income is defined as income net of all taxes and other mandatory deductions (such as Canadian Pension Plan contributions). For example, an economy with a stock of private debt valued at one-billion dollars and an aggregate annual disposable income of a half-billion dollars has a debt-to-disposable income ratio of two-hundred percent. If the government were to immediately levy an income tax of twenty percent on this fictitious economy (assuming no tax was currently in place), then, ceteris paribus, the resulting disposable income of four-hundred million dollars would increase the debt-to-disposable income ratio to two-hundred fifty percent. As such, the debt-to-disposable income ratio provides a quick summary of how leveraged the average Canadian household is. This example also illustrates that the central flaw of the debt-to-disposable income ratio is its inability to provide insight into the financial stresses and consequences associated with high levels of debt.

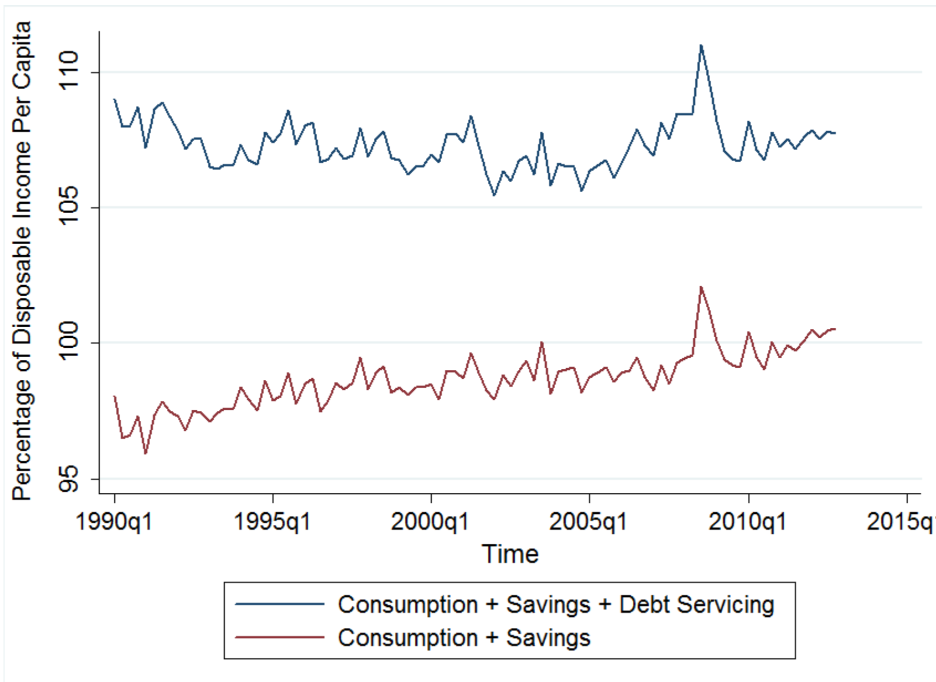
The debt-service ratio attempts to overcome this by measuring the proportion of disposable income that must be used to service the costs of debt. For instance, a household with a monthly disposable income of five thousand dollars and debt obligations totaling two thousand dollars (such as monthly mortgage, credit card, and car loan payments) has a debt-service ratio of forty, implying that forty percent of its disposable income must be used to service its existing debt. Since disposable income represents the resources that a household can allocate to consumption, saving, asset accumulation, and servicing its debt, it is quite obvious that a debt-service ratio of forty will have severely negative implications for the economy since income spent servicing debt is income that cannot be consumed or saved without incurring additional debt. Figure 1 plots disposable income per capita, consumption expenditure per capita, and net savings per capita from the first quarter of 1990 to the last quarter of 2012.

Figure 1 - Per Capita Disposable Income, Consumption Expenditure, and Savings



Immediately it is evident that almost all of household disposable income is consumed or saved. Since neither of these includes debt-servicing costs, only a miniscule portion of disposable income remains for households to service their debt. Over the period between 1990 and 2013, consumption expenditure and savings combined represented on average approximately ninety-eight percent of disposable income per quarter, leaving only two percent of disposable income to service debt. However, the debt-service ratio over the period averaged about eight and a half, implying that total household outlays since 1990 have been greater than disposable income. The steep upward trend in the debt-to-disposable income ratio observed since 1990 is thus unsurprising. Figure 2 plots the percentage of disposable income used for consumption and savings as well as these plus servicing debt. Figure 3 plots the rising debt-to-disposable income ratio since 1990.

Figure 2 – A Decomposition of Disposable Income

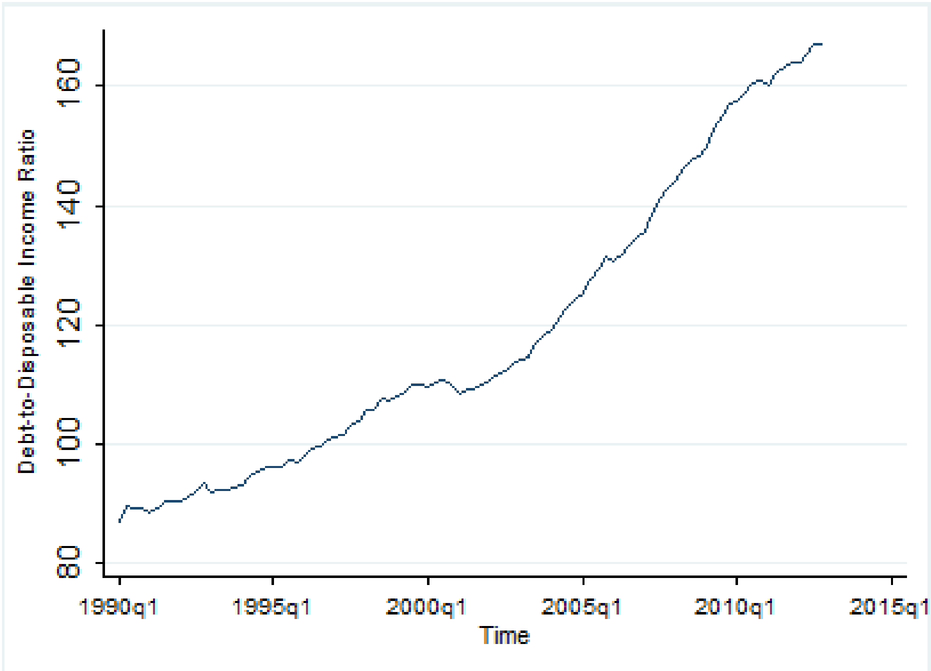


From the household's perspective, an increasing debt to disposable income ratio is not necessarily a problem and, in fact, can be welfare-enhancing in certain contexts[1]. However, extremely high levels of leveraging become an issue if the servicing costs of that debt become greater than households can afford without sacrificing either consumption or savings. If households must reduce consumption, savings, or both in order to meet their debt obligations, virtually any growth theory will predict a slowdown in economic growth and potentially a recession (or depression), depending on the extent

[1] These scenarios are discussed in more detail in the following section.

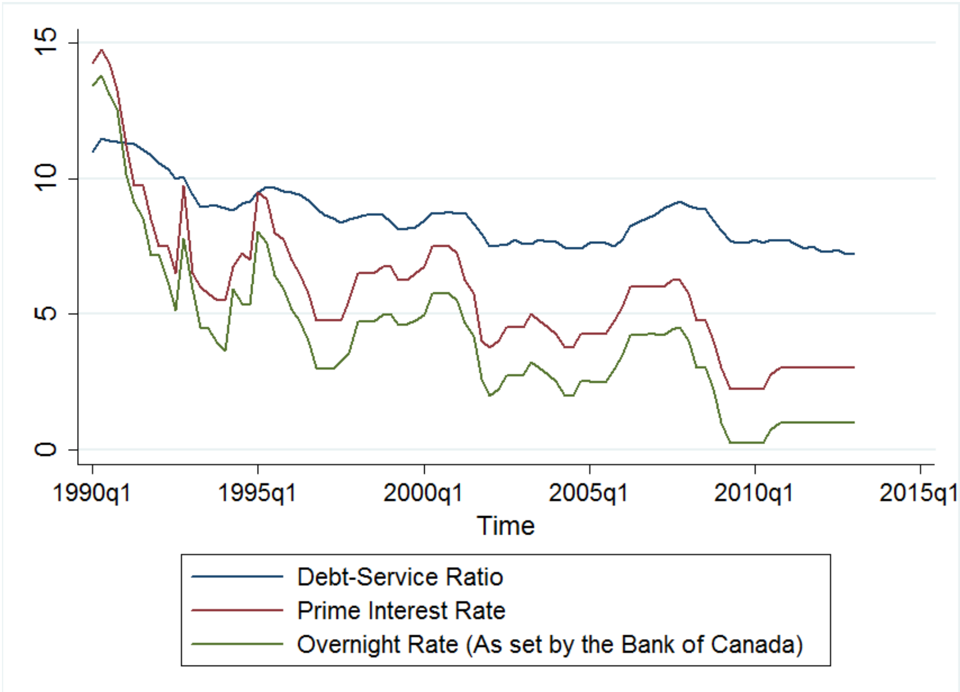
of the decreases. Canadian policymakers must therefore be concerned with the rapidly increasing debt carried by households and the impending economic implications.

Figure 3 – The Debt-to-Disposable Income Ratio Since 1990



Ceteris paribus, additional debt will put upward pressure on the debt-service ratio since new debt carries new servicing costs, whether it is in the form of interest payments on a line of credit or monthly payments on secured credit such as personal loans and mortgages. Despite this, the consistently increasing debt to disposable income ratio since 1990 has been matched with a slight downward trend in the debt-service ratio, albeit an erratic one. A graphical analysis of the debt-service ratio and the key interest rates in the Canadian economy brings this seemingly counterintuitive observation into context. Since interest rates are the cost of debt, we expect the debt-service ratio to follow them somewhat closely. Figure 4 illustrates this by plotting the debt service ratio with the overnight rate and prime interest rate.

Figure 4 – The Debt-Service Ratio, Prime Interest Rate, and the Overnight Rate



As expected, there is indeed co-movement between the debt-service ratio and interest rates. Of concern, however, is the apparent divergence between them which suggests that there are additional factors affecting the debt-service ratio. To the extent that consumers choose whether or not to accrue debt (and consequently take on additional debt-servicing costs), the debt-service ratio is a choice variable. Conversely, the evidence that there are additional factors that either cause or are correlated with fluctuations in the debt-service ratio implies that there exists an element of this ratio that consumers cannot control. This paper aims to identify and model this uncontrollable aspect of the debt-service ratio by analyzing it in the context of the Canadian macroeconomy. Specifically, we explore the characteristics of household debt and its potential impact on the Canadian economy and subsequently develop a time series empirical model to analyze the determinants of the household debt-service ratio at the aggregate level, taking the stock of private debt in the economy as exogenous.

Due to the lack of empirical literature surrounding the Canadian debt-service ratio and its relation to other macroeconomic variables, the following section of this paper surveys the economic literature surrounding household debt including its theoretical and practical characteristics, its dynamics in the macroeconomy, and the issues associated with overborrowing. It then explores and scrutinizes the existing empirical literature analyzing the determinants of household debt. The third and fourth sections describe the data used and the empirical model proposed to analyze the determinants of household debt in Canada. The fifth section discusses and analyzes its results. Section six expands the empirical analysis using impulse response functions to look at the estimated impacts of shocks to different components of the model. We then combine the literature and the model's results to propose policy for reducing household debt levels and the associated economic vulnerabilities and finally provide concluding remarks.

II EXISTING LITERATURE

The theoretical arguments for the household-level benefits of debt are largely derived from life cycle models that introduce income and borrowing constraints, especially during the early periods of a household's existence. Early work showed that, generally speaking, households theoretically facing liquidity and borrowing constraints on future income were subjected to lower-than-optimal consumption levels and therefore utility (Zeldes, 1989). In the same article, Zeldes also shows that this result holds empirically for a large portion of American households using a sample taken from the Panel Study of Income Dynamics collected by the University of Michigan. Another study that explores the effects of endogenous borrowing in a realistically calibrated lifecycle model of investment and consumption also showed that utility maximizing agents with bounded income processes over their lifecycle will choose to hold negative wealth when young (Cocco et al., 2005). Moreover, recent work has identified through empirically parameterized simulations that there exists a utility premium to owning a house rather than renting it, reinforcing the notion that debt can increase overall utility (Iacoviello and Pavan, 2013). Canadian data from 1999 to 2010 also empirically confirms the lifecycle tendency for households to borrow when they are young and repay that debt throughout their life. Specifically, a review by the Bank of Canada identified that in both 1999 and 2010, mean household debt increased for each four-year cohort to age thirty-five and steadily decreased thereafter, perfectly fitting the 'inverted U hypothesis' (Crawford & Faruqui, 2011).

In addition to its utility benefits at the individual level, the accessibility of credit in an economy has a fundamental influence on its ability to allocate resources efficiently. That is, household debt can encourage macroeconomic growth by encouraging higher levels of contemporaneous household consumption and providing greater capacity for individuals to capitalize on innovation in the marketplace by efficiently matching savers with borrowers. Of course, this is conditional on the assumption that households are able to service their debt using present and future income such that their savings rate does not decrease (Barba & Pivetti, 2009). Given that aggregate savings do not decrease due to the ability of household's to use debt to finance present consumption and that households are not faced with negative behavioural externalities, neoclassical growth theory suggests that economies can surpass the 'golden rule steady state' by increasing the aggregate amount of economic output (Jappelli, & Pagano, 1994). Empirically, the financial liberalization that has occurred over the past three decades in some form in virtually all of the developed economies in the world has increased the accessibility of credit to lower income households and is positively correlated with the growth enjoyed in many of these countries over the same time period (Large, 2004). If we believe that the positive relationship between the expansion of credit and boosted economic growth is causal to any extent, then the increasing aggregate debt-to-income ratio over the past three decades is simply a reflection of households transitioning to their optimal consumption paths given that financial liberalization has eased their liquidity and borrowing constraints (Barba & Pivetti, 2009).

This naïve perspective, however, has been widely disregarded since the onset of the financial crisis of 2007 which was largely the result of the extreme financial liberalization that had occurred in the United States. Moreover, although some expansion of credit may have been optimal in order to achieve faster economic growth and ultimately greater social welfare, the financial crisis is strong evidence that financial markets in 2007 were over leveraged and that the amount of debt extended to lower income households was beyond optimal. Recent studies have argued that the self-reinforcing cycle of debt-financed consumption stimulating economic growth and vice versa has fueled the increasing ratio of household debt holdings to disposable income seen in North America and Europe (Guttmann and Plihon, 2010). Despite the immediate economic benefits of household debt spending, an ever-increasing debt to disposable income ratio is unsustainable over time and can create uncertainty and instability in the macroeconomy due to the long-run requirement that the debt eventually be paid back by either sacrificing consumption or savings (Barba & Pivetti, 2009). Moreover, Starr (2010) asserts that debt-financed consumption sprees are not only costly in the long-run but can be in the medium run as well. Because of business cycle fluctuations, debt-financed consumption can easily increase the risk of economic and financial distress brought on by rising delinquencies, defaults, and foreclosures if a slow-down in consumption coincides with some other form of macroeconomic shock (Starr, 2010).

From a household's perspective, the most significant cost of holding debt is the associated servicing obligations which can potentially limit contemporaneous consumption and thus reduce welfare. If we make the assumption that all agents in an economy are rational utility maximizers with perfect information and foresight, no borrowing constraints, and no externalities, then we would expect everyone's debt holdings to be optimally chosen and societal welfare to be maximized. Realistically, however, we cannot make these assumptions. Primarily, perfect information and foresight are commonly relaxed assumptions due to their implausibility and the complexity of modern financial systems (Starr, 2010). Moreover, Starr (2010) discusses the observation by behavioural economists that household consumption trends are increasingly being dominated by a tendency to adhere to 'societal consumption norms' rather than simply reflecting the increased consumption capabilities associated with economic growth. The main mechanism through which consumers do this is emulation, whereby household's will mimic the consumption patterns of other successful households rather than perform their own utility optimizing exercise *ex ante* to determine an optimal consumption path. As a result, households are prone to overborrowing to achieve consumption standards that are potentially non-optimal (Starr, 2010).

Behavioural economics has also identified that a significant issue with household debt decisions is myopia, which has been connected with higher levels of financial vulnerability (Anderloni et al, 2012) and higher levels of debt (Meier & Sprenger, 2010). In behavioural economics, myopic (or short-sighted) preferences tend to result in consumer decisions that provide positive net utility today but underestimate the disutility or opportunity cost brought on by the action in the future, thereby resulting in the economic agent making a decision that may ultimately make them worse off in the long-run. During periods of very low interest rates the opportunity cost of borrowing decreases and thus rational agents will demand more borrowed funds. However, if interest rates remain low for longer periods of time and are expected to stay low, it is possible for myopic households to believe that they can service additional debt since they over-discount their future periods of higher debt servicing costs (Anderloni et al, 2012). Furthermore, Barba and Pivetti (2009) argue that households have displayed an aversion to reducing their standards of living and consumption patterns after experiencing shocks to their incomes or the growth of their incomes. In extended periods of low interest rates, this behavioural trait can become problematic since it is easier for households to maintain higher levels of consumption using debt. In the medium-to-long run if either interest rates increase or household incomes stagnate, it becomes more difficult to finance consumption using debt and thus households begin sacrificing savings which can have negative impacts on long-run economic growth (Barba & Pivetti, 2009).

Some literature has attempted to explore the determinants of household debt using cross-country panel data and claimed that this method is an improvement over the existing literature since unobservable heterogeneity is controlled for and sample size is increased (Crook & Hochguertel, 2007). However, as noted by Crook & Hochguertel (2007) and Duygan-Bump and Grant (2008) in their paper for the Federal Reserve Bank of Boston, institutions tend to play a strong role in determining the level of debt that households accrue. Consequently, a cross-country panel is counterproductive and invalid due to the lack of microdata (such as housing price and affordability indices) that can be collected and incorporated into a large, cross-country panel. Omitting microdata specific to each country from a regression analysis introduces omitted variable bias which leads to invalid results and incorrect policy implications and conclusions.

There are several recent studies that have focused their empirical analysis of household debt on single countries to avoid the issues of dealing with cross-country panels. This paper attempts to supplement this area of the literature by using more sophisticated and rigorous econometric techniques to ensure that the results are valid and the policy implications useful. Specifically, in their study of the determinants of US household debt, Turinetti and Zhuang (2011) propose a simple time series model that regresses the US debt-service ratio on several macroeconomic variables such as the unemployment rate, federal funds rate, disposable income per capita, two population share variables and two education variables. However, as identified in the following section of this paper, macroeconomic time series like disposable income and interest rates typically contain unit roots. The omission of any type of diagnostic testing on their data and their regression results all being significant at the one percent level make the results of Turinetti and Zhuang (2011) highly suspect and most likely invalid due to spurious correlation. Moreover, their reasoning for using four lags of each variable to model the debt-service ratio is simply because it represents one year and relies on no statistical or econometric reasoning.

To confirm the invalidity of their results, we gathered the Federal Reserve data used by Turinetti and Zhuang (2011) and tested it for unit roots using generalized least squares Dickey-Fuller tests. As suspected and summarized in Appendix A, the null-hypothesis of a unit-root cannot be rejected for many of the time series used in their study. In a time series regression setting, unit roots in the regressors typically result in highly significant but ultimately useless results due to spurious correlation between the variables with unit roots (Phillips & Moon, 1999). To remedy this, Turinetti and Zhuang (2011) should have run their regression using differenced variables.

Another recent study on the determinants of household debt by Meng and Mounter (2009) analyzes the Australian experience since the late 1980s. Meng and Mounter (2009) assert that the effect of macroeconomic variables such as interest rates or inflation on household debt is implicit in the choice to accrue debt and consequently omit it from their regression. Instead, their regression model focuses on household specific variables such as consumption expenditures, disposable income, and several different assets typically held by households. Unlike Turinetti and Zhuang (2011), Meng and Mounter (2009) follow a rigorous diagnostic procedure and identify unit roots in their variables and test for cointegrating vectors to ensure their results are valid. Despite their rigour, Meng and Mounter (2009) regress their debt variable on both consumption and disposable income simultaneously and in doing so introduce severe multicollinearity into their model. The two Australian time series were collected to confirm that the series are collinear and a correlation test identifies a correlation coefficient of 0.9985 over the time period analyzed by Meng and Mounter (2009). Consequently, their coefficient estimates for these two variables are unreliable for interpretation and policy implications. A simple correlation test using the Canadian data used in this paper identifies a 0.9973 correlation coefficient between consumption expenditure per capita and disposable income per capita. To avoid multicollinearity, this paper omits consumption expenditures per capita from its regressions since consumption and disposable income are so closely related.

III DATA

The data used in this paper has been collected from the Statistics Canada's CANSIM database and Reuter's Thomson One database. Table 1 summarizes the variables used, their source, and provides some summary statistics. All data is seasonally adjusted so that the empirical results do not simply capture the quarterly variation in household debt-service ratio and the other variables. All nominal variables have been converted into real terms using 2002 as the base year and disposable income and net savings have been converted to per capita terms to control for the increasing population over the time period.

Table 1 - Variables, Summary Statistics, and Sources

Variable	Obs	Mean	Min Value	Max Value	Standard Deviation	Source
Debt-Service Ratio	92	8.64	7.19	11.49	1.11	(1)[2]
Disposable Income Per Capita	92	21458.22	18760	25291	2246.35	(1)
Net Savings Per Capita	92	1061.11	215	2354	524.88	(1)
Affordability Index[3]	92	3.04	2.4	6.0	0.64	(2)[4]
Prime Interest Rate	92	5.87%	2.25%	14.75%	2.63%	(1)
Unemployment Rate	92	8.2%	5.9%	12.1%	1.6%	(1)
Core Inflation	92	0.47%	-0.1%	1.03%	0. 26%	(2)

Following the logic of Turinetti and Zhuang (2011) this paper uses the debt-service ratio rather than the debt-to-disposable income ratio to empirically study household debt. The first benefit to using the debt-service ratio rather than the debt-to-disposable income ratio is that the debt-service ratio consists only of flow variables whereas the debt-to-disposable income ratio relates a stock variable to a flow variable. The issue with the stock nature of the debt-to-disposable income ratio is that changes to the prime interest rate or other economic variables in the system are more likely to take longer to impact the total amount of debt held by households, whereas the changes are more likely to have an (almost) immediate impact on their ability to service the debt they already hold. More importantly, the debt-to-service ratio better illustrates the financial environment faced by households as it represents their ability to repay debt, providing insight into the financial vulnerability of households and, to some extent on an aggregate level, the economy (Scott and Pressman, 2013). The fundamental drawback to using the

[2] (1) indicates the data was extracted from Statistics Canada's CANSIM database
[3] The affordability index has been scaled up by a factor of ten to make the coefficient estimates more comparable to those of the other variables. The original index as published by the Bank of Canada ranged from 0.24 to 0.60 over the 1990 to 2013 period.
[4] (2) indicates the data is released by the Bank of Canada and was extracted from the Reuter's database Thomson One.

debt-service ratio is that Statistics Canada has only collected this data since the first quarter of 1990, limiting this empirical analysis to ninety-two observations after differencing.

Disposable income per capita is included as a regressor under the belief that the amount of available cash a household has will influence its decision to finance consumption through debt and, consequently, the servicing costs associated with that debt. This relationship has been explored and it has been argued that households with less disposable income typically suffer from more severe interest costs on the debt they hold which tends to make their servicing costs relatively greater than upper income households (Scott and Pressman, 2013). Thus at the macro level, it can be expected that changes in disposable income per capita will be correlated with changes in the debt-service ratio. Moreover, including disposable income allows us to draw some insight into the relationship among different income levels, debt servicing costs, and other economic variables believed to be correlated with debt servicing costs. In the model, disposable income is log-transformed to incorporate the notion that level increases in disposable income have diminishing effects on the debt-service ratio over the range of disposable incomes.

As discussed in section two of this paper, there is strong evidence that a household’s income allocation decisions are correlated with its debt-servicing costs (Meng & Mounter, 2009). However, to avoid the statistical issues created by the almost perfectly multicollinear relationship between consumption expenditure and disposable income, we use net savings per capita to account for the potential relationship between the mean household savings and the debt-servicing costs since, ceteris paribus, greater savings is likely associated with less spending and consequently a greater ability to reduce debt and thus its servicing costs. Correlation tests identify that net savings per capita is not perfectly collinear with disposable income, having only a correlation coefficient of -0.2346.

Since interest rates are literally the cost of debt, it is vital that they be represented in the model. Unlike Turinetti and Zhuang (2011) who use the federal funds rate as a regressor on the American household debt-service ratio, we forego including Canada's key policy rate and instead use the prime interest rate due to its more direct relationship with the interest rates faced by Canadian households.

The affordability index developed by the Bank of Canada is a non-linear transformation of house prices, mortgage payments, household disposable income, and the appropriate interest rate during that period. Correlation tests identify that the affordability index is not multicollinear with any of the other variables in this study and will not create biases in the regression results. Moreover, the house price and mortgage payment data used to create the index was not publicly available during the creation of this paper and thus this index provides a way to integrate this data into the empirical model and simultaneously avoid omitted variable bias in its results. This paper is the first to use a household affordability index to model the Canadian household debt-service ratio.

The unemployment rate is included in the model to account for the fact that higher levels of unemployment are likely negatively correlated with the debt-service ratio. Since being unemployed limits the income of a worker, it is less likely that an unemployed person will be approved for new credit and, even if they are, choose to accumulate more debt. Therefore, because new debt is the primary driver of higher debt-servicing costs, it can be expected that a higher unemployment rate will be correlated with lower debt-service ratios in the short-run. However, the long-run relationship is more ambiguous since long-run unemployment could lead to persons spending their savings and relying on credit to survive during later parts of their job search. Unfortunately, the nature of this model will not allow us to explore this potential longer-run relationship.

Lastly, we include core inflation in the model for several reasons. First, although core inflation over the period under analysis was not highly volatile, if the phenomenon of debt-financed consumption discussed earlier in this paper is present in the Canadian economy, then even small increases in the price level could cause the aggregate debt-service ratio to increase. We expect this to be the case despite our variables being measured in real units since consumers may resort to higher levels of debt to achieve their consumption demands if real incomes do not grow at their expect rate. Consequently, this effect is expected to be small but significant. Second, we use core inflation rather than inflation since it does not capture the price fluctuations of highly volatile commodities (such as energy and food) whose consumption is less elastic and thus likely to be more proportional to income regardless of price changes.

IV MODEL

As with most macroeconomic variables, the data used in this study is non-stationary and likely subject to significant endogeneity. The results of generalized least squares Dickey-Fuller tests identify that each of the series[5] contains a unit root and can be found in Appendix B**.** Rather than approach the issue of endogeneity via instrumental variables, a common methodology in macroeconomic studies is the use of system-based regressions such as Vector Autoregression (VAR) or Vector Error Correction Models (VECM) (Naka & Tufte, 1997). One of the benefits of system-based empirical models is that they assume endogeneity and thus do not generate biased coefficients because of it unlike standard regression models. Not only do system models provide a unique perspective on the interaction between the variables under analysis, but these approaches when properly specified can provide greater insight into a system's dynamics through impulse response functions (IRFs), Granger causality tests, and forecast error variance decomposition (FEVD).

Recent research in systems-based empirical models has identified that cointegration amongst regressors generally makes VAR results meaningless (Naka & Tufte, 1997; Johansen,1995; Johansen, 2005). Cointegration is a statistical property whereby there exists a linear combination of (at least) two non-stationary time series that are integrated of order one which produces a vector that is integrated of order zero (Engle & Granger, 1987). Empirically, this manifests itself in time series that tend toward a stationary equilibrium relationship in the long-run despite potentially displaying erratic behaviour in the short-run. This long-run equilibrium relationship can be estimated by VECM and is referred to as the impact matrix which is a collection of the cointegrating vectors that exist within the system of variables and their corresponding disequilibrium adjustment parameters. In short, when cointegration exists among regressors and a VAR

[5] However, the evidence for core inflation is not conclusive, with non-stationarity being rejected only at the first lag.

is used to model the system, the omission of the impact matrix creates bias in the resulting coefficients in a manner similar to omitted variable bias in an ordinary least squares (OLS) regression. To remedy this issue, Johansen developed VECM which controls for and estimates the impact matrix. Not only does VECM allow for system-based analysis in the presence of cointegration, but its estimates of the cointegrating vectors provide insight into the long-run equilibrium relationships among the variables.

Since six of the seven variables being analyzed in this model contain unit roots, the probability that any of the series are cointegrated is high. More specifically, as illustrated by Figure 4, there appears to be co-movement between at least the debt-service ratio and the prime interest rate. Because of the severe ramifications of cointegration in a VAR model, it is vital to identify cointegration if it exists. Before calculating statistics to test for cointegration, an order-selection test is run on the variables in the system which calculates several information criteria to provide evidence towards the optimal lag-length of the system. Appendix C contains the results of this test. Due to its higher power in small samples, the Akaike information criterion’s suggestion of six lags is accepted (Cheung & Lai, 1993). To test for cointegration, the Johansen trace statistic and maximum eigenvalue statistic are calculated using six lags of each variable. The results of the Johansen tests can be found in Table 2 and identify that there exists either one or two cointegrating vector(s). Consequently, a VECM specification must be used rather than a VAR.

Table 2 - Johansen Trace and Maximum Eigenvalue Tests

Maximum Rank	**Trace Statistic**	**5% CV**	**1% CV**	**Adjusted 5% CV**	**Adjusted 1% CV**
0	207.69**	124.24	133.57	229.79	247.04
1	108.82	94.15	103.18	174.13	190.84
2	65.96*	68.52	76.07	126.73	140.69
3	37.95	47.21	54.46	87.32	100.73
4	17.13	29.68	35.65	54.89	65.94
5	7.10	15.41	20.04	28.50	37.06
6	0.90	3.76	6.65	6.95	12.30
Maximum Rank	**Maximum Eigenvalue**	**5% CV**	**1% CV**	**Adjusted 5% CV**	**Adjusted 1% CV**
0	98.87	45.28	51.57	85.04	96.86
1	42.86*,**	39.37	45.10	73.94	84.71
2	28.01	33.46	38.77	62.84	72.82
3	20.82	27.07	32.24	50.84	60.55
4	10.03	20.97	25.52	39.39	47.93
5	6.20	14.07	18.63	26.43	34.99
6	0.90	3.76	6.65	7.06	12.49

* = Significant using regular critical values
** = Significant using critical values adjusted for finite-sample bias

In his Monte Carlo study, Reimers (1993) observes that Johansen's trace and maximum eigenvalue statistics suffer from finite-sample bias despite being the most efficient tests for cointegration. This finite-sample bias inflates both test statistics which results in the over-rejection of lower ranks of cointegration (Reimers, 1993). However, Reimers (1993) simulations show that this over-rejection is severely reduced by adjusting the critical values of the trace statistic by a factor of $0.11 + 0.89 * T/\,(T - n\rho)$ and the critical values of the maximum eigenvalue statistic by $0.08 + 0.92 * T/\,(T - n\rho)$ where T is the number of observations, n is the number of variables, and ρ is the number of lags. The adjusted trace statistics can also be found in Table 2 and indicate that there is either one cointegrating vector or zero. Due to the proximity of the rank-zero trace statistic to its five-percent critical value as well as the result of the maximum eigenvalue test, the

VECM is calibrated for six lags of each variable and one cointegrating vector. The VECM proposed to analyze the Canadian debt-service ratio is as follows.

$$\Delta Y_t = \alpha(\beta' Y_{t-1} + \mu) + \sum_{s=1}^{\rho-1} [\Gamma_s \Delta Y_{t-s}] + \gamma + \varepsilon_t \qquad (\mathbf{1})$$

Where Y_t contains the following variables:

$dsr =$ the debt-service ratio
$lndispinc =$ disposable income per capita transformed by the natural logarithm
$lnnetsave =$ net savings per capita transformed by the natural logarithm
$afford =$ the Bank of Canada's housing affordability index
$primerate =$ the prime interest rate
$uer =$ the unemployment rate
$coreinf =$ core inflation

On the left-hand side of this equation, Δ is the first difference operator and Y_t is the matrix of the non-stationary variables under analysis as noted above. On the right-hand side, $\alpha(\beta' Y_{t-1} + \mu)$ is the impact matrix where α represents the speed of adjustment parameters (the coefficients in the regression relating changes to the estimated cointegrating equations to the dependent variables) and $\beta' Y_{t-1} + \mu$ is the set of estimated cointegrating equations that represent the stationary equilibrium relationship(s) among the variables with μ being an unrestricted constant term. For identification purposes, the vectors in the β matrix are normalized in order to give more meaningful interpretation to the α parameters (Naka & Tufte, 1997). This also allows μ to be backed out by using the estimates of α and β values of Y_{t-1} such that the entire term, on average, is equal to zero. The term $\sum_{s=1}^{\rho-1} [\Gamma_s \Delta Y_{t-s}] + \gamma + \varepsilon_t$ represents the core of the regression, with Γ_s being the set of parameters that reflect the short-run relationships among the variables and ρ being the number of lags of the dependent variables in the regression. Finally, γ represents a vector of constant terms in the regression equations and $\boldsymbol{\varepsilon_t}$ is the error term which is assumed to be independent and identically distributed.

It should be said that since the data in this analysis begins in the first quarter of 1990 and the optimal lag length has been identified as six quarters, there is no value in attempting to identify a structural break or regime change with the passing of the Bank Act in the fourth quarter of 1991. The single observation prior to the Bank Act's passing is far too small a sample to generate a valid empirical representation of the "regime", if it even existed, and to provide a meaningful interpretation of the effects of the Bank Act on the debt-service ratio and the other macroeconomic variables being analyzed in this paper.

V RESULTS

The results of Equation (1) are summarized in Tables 3, 4, and 6. Table 3 presents the short-run parameter estimates for the debt-service ratio equation and some summary statistics. The coefficient estimates for the remaining equations in the system have been omitted from the body of this paper since we are concerned with the debt-service ratio alone and can be found in Appendix D. Table 4 provides the parameter estimates for the cointegrating equations which represent the estimated long-run equilibrium relationships among the variables. Table 6 contains the adjustment parameters which represent the short-run response of the variables when the system is out of equilibrium.

Table 3 – VECM Regression Short-Run Coefficient Estimates, DSR Equation

Variable	Coefficient	Variable	Coefficient
LD.dsr	0.418 (0.167)**	LD.primerate	0.087 (0.049)*
L2D.dsr	0.075 (0.154)	L2D.primerate	0.054 (0.041)
L3D.dsr	0.072 (0.159)	L3D.primerate	0.031 (0.041)
L4D.dsr	-0.098 (0.154)	L4D.primerate	0.085 (0.038)**
L5D.dsr	-0.290 (0.139)**	L5D.primerate	0.102 (0.037)***
LD.lndispinc	6.014 (2.991)**	LD.uer	-0.010 (0.076)
L2D.lndispinc	10.478 (2.733)***	L2D.uer	0.019 (0.072)
L3D.lndispinc	7.637 (3.107)**	L3D.uer	0.064 (0.065)
L4D.lndispinc	0.377 (2.764)	L4D.uer	-0.010 (0.068)
L5D.lndispinc	0.879 (2.730)	L5D.uer	-0.048 (0.064)
LD.lnnetsave	-0.404 (0.104)***	LD.coreinf	-0.327 (0.110)***
L2D.lnnetsave	-0.158 (0.100)	L2D.coreinf	-0.122 (0.111)
L3D.lnnetsave	-0.098 (0.097)	L3D.coreinf	-0.114 (0.099)
L4D.lnnetsave	0.266 (0.101)***	L4D.coreinf	-0.069 (0.087)
L5D.lnnetsave	-0.019 (0.104)	L5D.coreinf	-0.016 (0.067)
LD.afford	-0.177 (0.197)	Constant	0.007 (0.029)
L2D.afford	-0.290 (0.173)*		
L3D.afford	0.068 (0.165)		
L4D.afford	-0.245 (0.157)		
L5D.afford	-0.139 (0.149)		

Standard errors in parentheses
* *p*<0.1; ** *p*<0.05; *** *p*<0.01
Observations = 86; Lags = 6; Cointegrating Equations = 1
R-squared for DSR Equation = 0.775

The short-run parameter estimates in Table 3 cannot be individually interpreted similarly to standard regression results due to the highly endogenous and simultaneous nature of the system (Sims, 1980). Consequently, the quantitative interpretation of these results will be reserved for the following section with the use of impulse response functions as per Liitkepohl and Reimers (1992). Also, since this paper is concerned with analyzing the Canadian debt-service ratio, only the results pertaining directly to it will be discussed in detail. However, immediately we can see that the regression results identify significant positive relationships between changes in the debt-service ratio and its first lag as well as changes in the first, second, and third lag of disposable income, the fourth lag of net savings, and the fourth and fifth lag of the prime interest rate. The results also identify significant negative relationships between changes in the debt-service ratio and its fifth lag as well as changes in the first lag of disposable income, the second and fourth lag of the housing affordability index, and the first lag of core inflation.

Qualitatively, we can extract some initial insights into the dynamics of these variables from these results. For the sake of avoiding repetition, each of the scenarios in the following paragraphs refers strictly to ceteris paribus changes. The coefficients on the debt-service ratio's lags suggest that changes in the debt-service ratio will net out over time. For example, a one-unit increase in the debt-service ratio today will have an additional positive effect lasting approximately four quarters and then return to its initial value plus the unit shock in the following quarter. Since the debt-service ratio summarizes the aggregate choice of consumers' debt-servicing burden, this result is intuitive as it reflects the fact that consumers will not choose to change their debt-servicing costs in the long-run if their circumstance is not changing.

The coefficients relating changes in the natural logarithm of disposable income to the debt-service ratio indicate that changes to disposable income have strictly positive short-term effects on the debt-service ratio that compound over time. This suggests that, in the aggregate, higher levels of disposable income are correlated with higher debt-service ratios and thus greater debt-servicing burdens.

The estimated short-run relationship between changes in net savings and changes in the debt-service ratio implies that an increase in net savings is correlated with a lower debt-service ratio in the following quarter which is only partially offset by an increase in the debt-service ratio four quarters later. It is possible that this suggests that, in the long-run, higher net savings implies that consumers are reducing consumption and consequently have less demand for debt (since, as discussed earlier, the primary function of debt is to smooth consumption).

To reiterate, the housing affordability index developed by the Bank of Canada is inversely related to the actual affordability of houses. That is, higher values of the affordability index imply a less affordable housing market. The negative coefficient relating the affordability index and the debt-service ratio thus indicates that decreases in the affordability of housing are correlated with decreases in the debt-service ratio. Since mortgage debt is the primary driver of the debt-servicing costs faced by households, this result is highly intuitive as less affordable housing reduces the amount of housing demanded and thus, indirectly, the demand for mortgages.

Although not applicable to all forms of credit, the prime interest rate generally reflects the cost of debt in the Canadian economy. As such, the positive coefficients on the fourth and fifth lags of the prime interest rate are expected since higher interest rates should result in more expensive debt. Even more interesting is that the insignificance of the first three lags of the prime interest rate reinforces the Bank of Canada's assertion that changes in interest rates typically take several quarters, sometimes upwards of six to eight, to have significant impacts on the macroeconomy. The delay in the relationship between changes in the prime interest rate to changes in the debt-service ratio likely reflects the fact that the debt-servicing costs of all fixed-rate credit will only increase after it has been re-financed.

The negative coefficient on the first lag of core inflation represents the relationship between inflation and interest rates. Holding the prime interest rate constant, an increase in inflation reduces the real interest rate being paid on existing debt, consequently reducing its servicing costs. The insignificance of the remaining lags of changes in the rate of core inflation reflects the fact that a one-time change in inflation will only have a one-time effect on the debt-servicing costs.

However, these short-run relationships only represent a fraction of the entire system's dynamic behaviour. As discussed earlier, the fundamental notion of cointegration is that a linear combination of a set of non-stationary variables can produce a stationary variable that represents a long-run equilibrium relationship. The parameters in Table 4 represent this model's estimate of that linear combination.

Table 4 – VECM Regression Beta Vector Coefficient Estimates

	β
dsr	1
	(.)
lndispinc	127.232
	(17.433)***
lnnetsave	-8.624
	(1.663)***
afford	-27.782
	(2.987)***
primerate	8.324
	(0.976)***
uer	4.253
	(0.783)***
coreinf	-11.905
	(4.341)***
_cons	-1207.92
	(.)

Standard errors in parentheses
* *p*<0.1; ** *p*<0.05; *** *p*<0.01

Specifically, Equation (2) below represents the estimated cointegrating equation that defines the equilibrium relationship among the seven variables.

$$dsr_t + 127.23 * lndispinc_t - 8.62 * lnnetsave_t - 27.78 * afford_t + 8.32 * primerate_t + 4.25 * uer_t - 11.91 * coreinf_t - 1207.92 = e_{1t} \quad (\mathbf{2})$$

Although direct interpretation of these coefficients in isolation is meaningless, two interesting relationships arise in the equation. The first noteworthy relationship is generated from the positive coefficient on disposable income per capita and the negative coefficient on the net savings per capita. The opposite signs imply that the equilibrium of this system depends on the spread between disposable income and net saving which is intuitive since, as discussed earlier in the paper (see Figure 1), disposable income less savings is the amount of resources that can be used to consume or service debt. Correspondingly, if the spread between disposable income and savings decreases (suggesting an increase in the savings rate) the model predicts an increase in the debt-service ratio due to the reduced amount of disposable income available to service debts. The second relationship of interest is between the prime interest rate and core inflation. Again, the positive coefficient on the prime interest rate and the negative coefficient on core inflation imply that equilibrium is dependent on the spread between these variables which, in this case, is approximately equal to the real interest rate. This result is remarkably intuitive given that consumers are expected to base their long-run income allocation decisions on real interest rates rather than nominal ones.

For Equation (2) to be stationary, this linear combination must have a time invariant mean and variance. If the cointegrating equation does not sum to its mean in any given time period, then the variables are considered “out of equilibrium” and the resulting residual values are referred to as the cointegrating errors, denoted e_{1t}. Figure 5 plots Equation (2)’s cointegrating errors and Figure 6 plots its autocorrelation function.

Figure 5 – The Cointegrating Errors

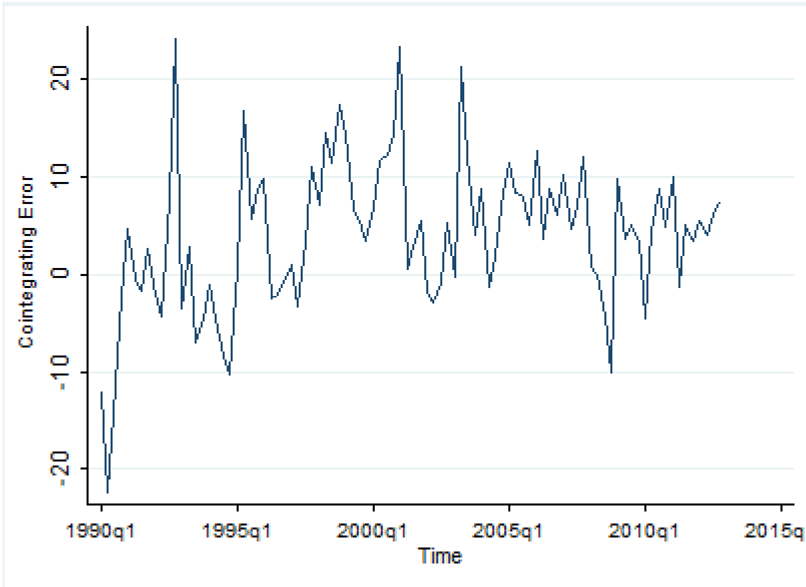


Figure 6 – Equation (2)'s Autocorrelation Function

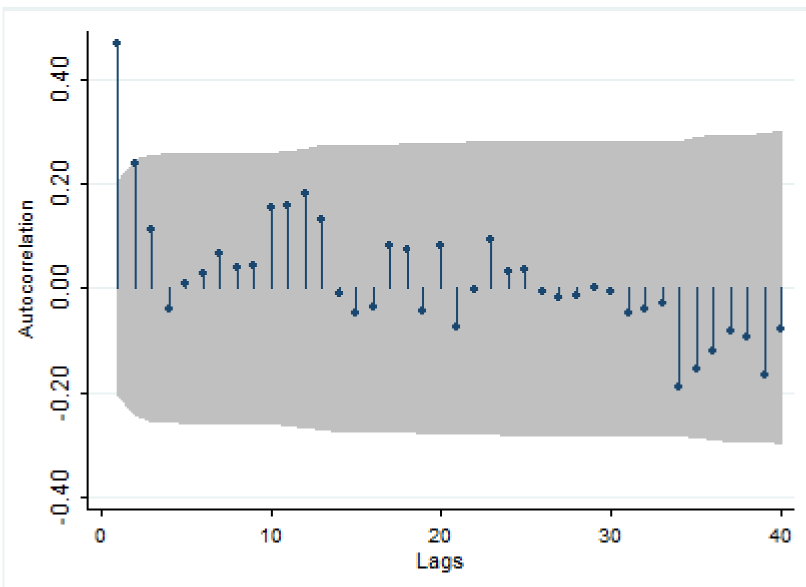


Table 5 – GLS Dickey-Fuller Tests on Cointegrating Errors

Original Regression	Lag(s)	DF-GLS mu Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Cointegrating Equation	1	-2.343**	-2.603	-2.124	-1.817

Second Regression	Lag(s)	DF-GLS mu Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Cointegrating Equation 1	1	-1.037	-2.603	-2.137	-1.832
	2	-0.704	-2.603	-2.126	-1.821
	3	-0.691	-2.603	-2.112	-1.809
	4	-0.441	-2.603	-2.098	-1.796
	5	-0.445	-2.603	-2.083	-1.782
	6	-0.474	-2.603	-2.068	-1.767
	7	-0.817	-2.603	-2.052	-1.752
	8	-0.842	-2.603	-2.035	-1.736
Cointegrating Equation 2	1	-1.98*	-2.603	-2.124	-1.817

* p<0.1; ** p<0.05; *** p<0.01

The plot of Equation (2)'s residuals suggests that the cointegrating vector is a stationary series. Reinforcing this result is the relatively low autoregressive coefficient on the first lag of its autocorrelation function and its low persistence. The results of a generalized least squares Dickey-Fuller tests[6] in Table 5 confirm that the cointegrating equation is indeed stationary. To confirm our use of the adjusted critical values proposed by Reimers (1993), we run the VECM regression calibrated for two cointegrating vectors rather than one and find that only one of the cointegrating vectors is stationary (at the ten percent significance level) using the same testing procedure, the results of which are also in Table 5. Since non-stationary cointegrating vectors are strong evidence of model

[6] A lag-order selection test was run to determine the optimal lag-length of the test. AIC, HQIC, and SBIC information criteria all indicate an optimal lag length of one for the cointegrating equation in our proposed regression and lag lengths of eight and one for the two cointegrating equations in the second specification which is identical to the first but specified to include two cointegrating vectors.

misspecification, we accept our original conclusion that only one cointegrating relationship exists among the variables.

Table 6 – VECM Regression Alpha Vector Coefficient Estimates

	α
D_dsr	-0.022
	(0.006)***
D_lndispinc	0.002
	(0.000)***
D_lnnetsave	0.021
	(0.014)
D_afford	0.016
	(0.006)***
D_primerate	-0.095
	(0.029)***
D_uer	-0.006
	(0.013)
D_coreinf	0.009
	(0.010)

Standard errors in parentheses
* p<0.1; ** p<0.05; *** p<0.01

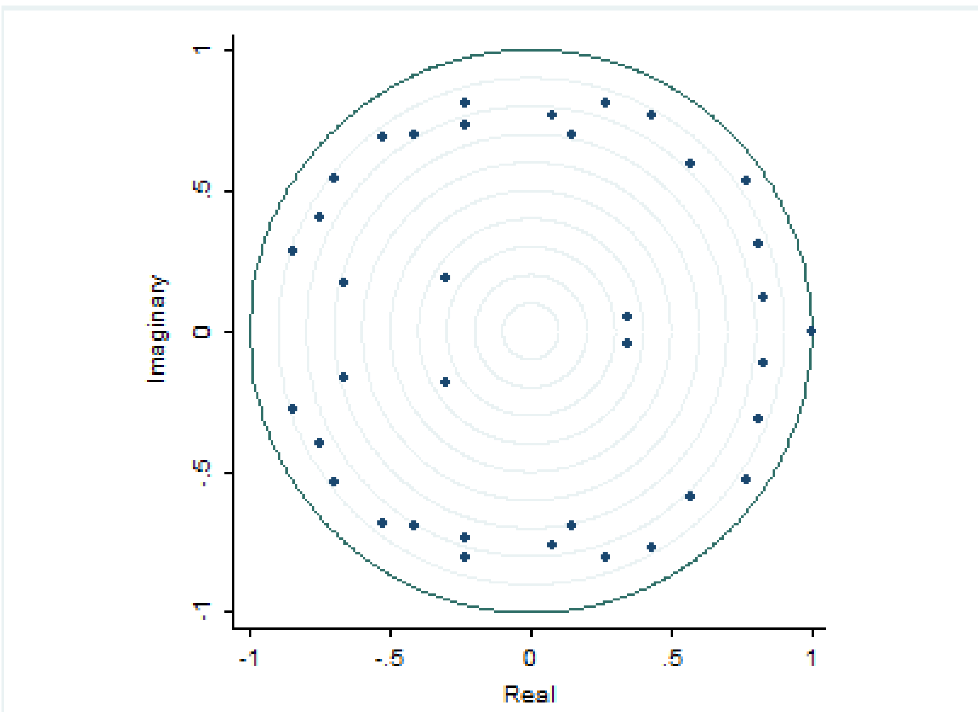
The adjustment parameters in Table 6 are the coefficients relating the dependent variable of each equation to the cointegrating errors. These coefficients are called adjustment parameters since they represent how each dependent variable responds when the variables are out of equilibrium (or the cointegrating error is non-zero). Interestingly, the insignificant adjustment parameters suggest that net savings per capita, the unemployment rate, and core inflation do not directly respond to disequilibrium. The negative and significant adjustment parameter in the debt-service ratio equation implies that when the variables are out of equilibrium such that the cointegrating error is positive, the debt-service ratio will be impacted negatively in the following period. For example, starting from equilibrium, if the prime interest rate was to increase above its equilibrium value by one percentage point then, ceteris paribus, the resulting cointegrating error of 8.32 would be correlated with a decrease in the debt-service ratio in the following period of approximately -0.18 (8.32 multiplied by the adjustment parameter -0.022). Ultimately, this implies that the debt-service ratio corrects for about two percent of the cointegrating error within one quarter. However, as discussed earlier, an isolated analysis such as this is not particularly useful due to the dynamic nature of the system and thus the aggregate effects of shocks are explored in more detail in the following section. The negative adjustment parameter in the prime interest rate equation interprets in a similar manner with the exception that the coefficient of -0.095 implies that the prime interest rate corrects for almost ten percent of the cointegrating error in the following quarter. The positive and significant parameters on disposable income per capita and the affordability index do not have clear interpretations since they mathematically imply slightly explosive behaviour in disequilibrium. Thus, rather than correct for the cointegrating error, these variables slow the system's return to equilibrium.

In addition to studying the estimated cointegrating vector, it is also necessary to test the model's residuals to ensure that the assumptions underlining the asymptotic distributions of the test statistics hold. Table 7 summarizes the results of the serial correlation test and Figure 7 illustrates the model's stability conditions which validate our findings. The actual eigenvalues and moduli values contained in Figure 6 can be found in Appendix E.

Table 7 – Serial Correlation Test on Regression Residuals

Lag	Chi^2 Statistic	P > Chi^2
1	42.827	0.720
2	40.378	0.805
3	40.813	0.791
4	48.254	0.503
5	36.878	0.899
6	30.453	0.983
7	30.491	0.982
8	33.439	0.956

Figure 7 – Roots of the Companion Matrix



The serial correlation test provides evidence that the assumption of independent and identically distributed (IID) errors holds, suggesting that the asymptotic assumptions underlying our results are valid. Since the IID assumption is central to the distributional properties of the test statistics in a VECM (Johansen, 2012), we plot the residuals of our regression and their autocorrelation function and perform a DF-GLS test to ensure that the errors are in fact IID and our results meaningful. As illustrated in Figures 8 and 9 and Table 8 below, the residuals of our regression are indeed stationary, reinforcing our assertion that the assumption holds and our results are valid.

Finally, we test the assumption that the model's errors are normally distributed, the results of which are in Appendix F. Of the seven equations in our system, five equations have Gaussian residuals and two do not. Moreover, the tests show that the two non-Gaussian residuals are symmetric but suffer from irregular tails. Although VECM assumes Gaussian errors, this assumption is not crucial for inference as it does not impact the coefficient estimates (Johansen, 2012). Further, since the majority of the equations have Gaussian residuals, including our equation of focus, we are not concerned that this test brings our main results into question.

Figure 8 – VECM Regression Residuals

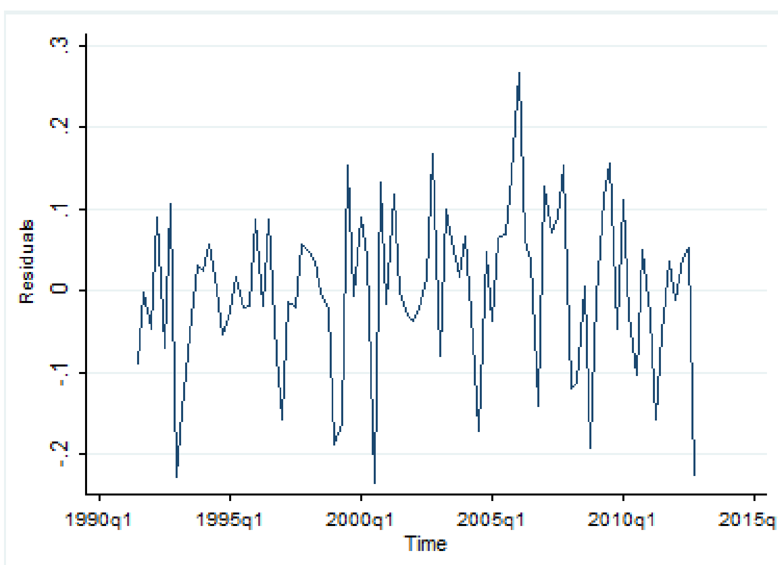


Figure 9 – VECM Regression Residuals Autocorrelation Function

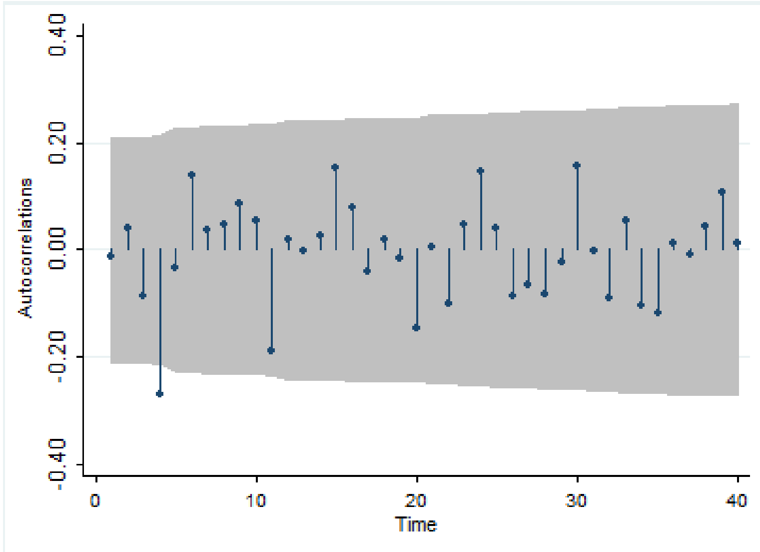


Table 8 – GLS Dickey-Fuller Test on Regression Residuals

	Lag(s)	DF-GLS mu Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Regression Residuals	0	-7.609***	-2.605	-2.141	-1.834

* p<0.1; ** p<0.05; *** p<0.01

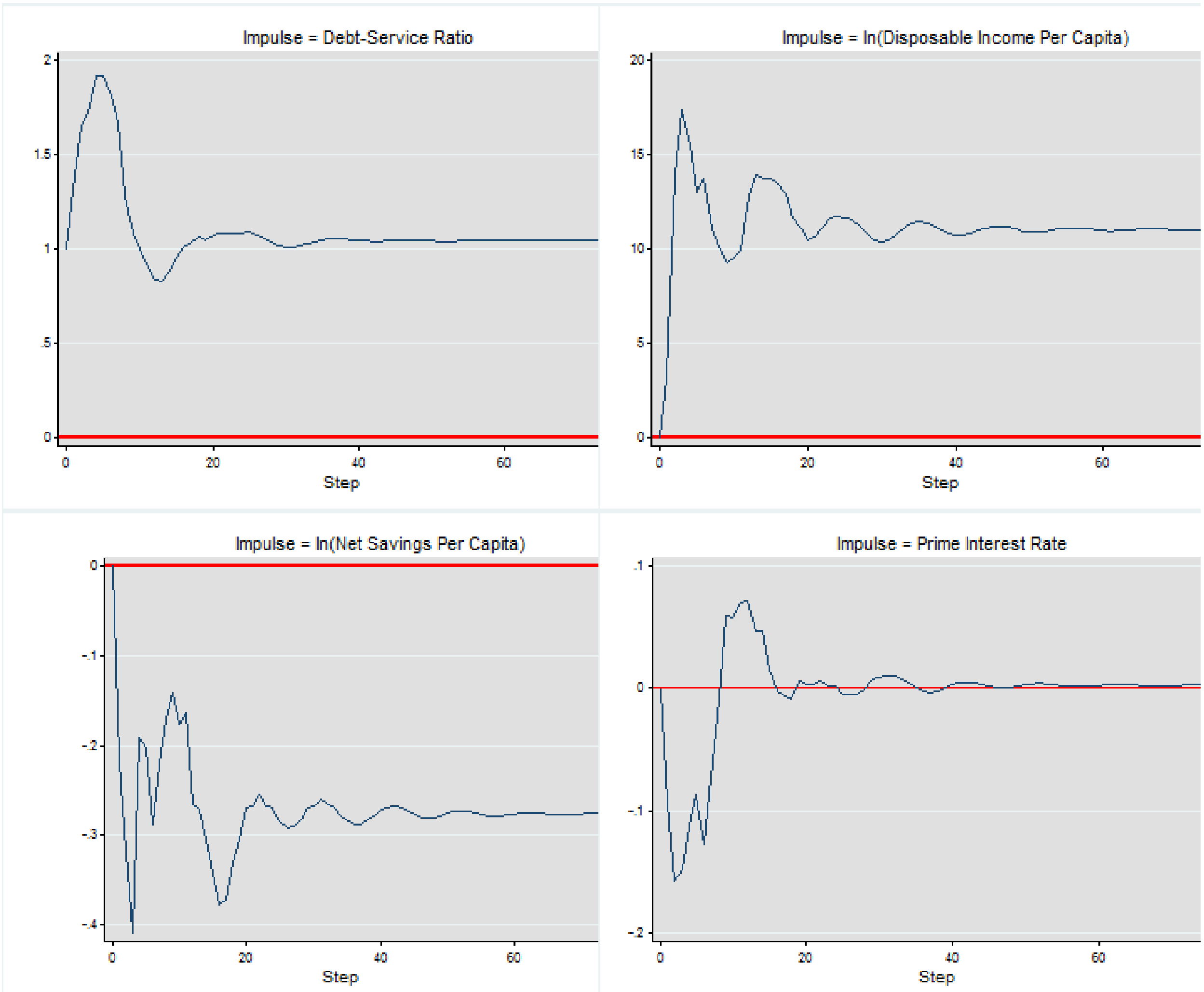
VI IMPULSE RESPONSE FUNCTIONS

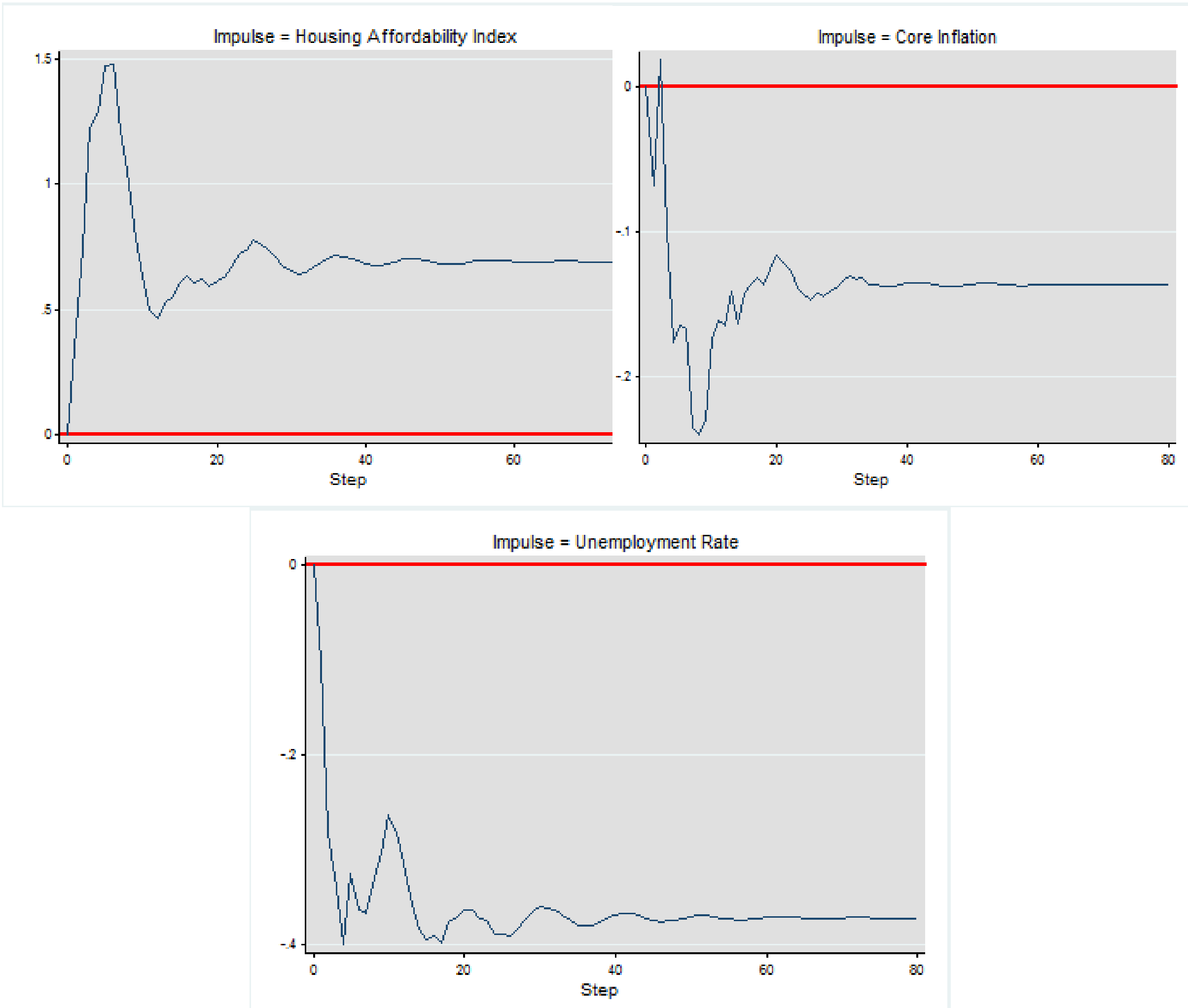
The underlying VAR specification of VECM preserves its ability to generate impulse response functions (IRFs). In fact, due to the complexity of the interactions among the variables in a VECM specification, IRFs are regarded as an effective way to analyze their results since the individual coefficient estimates carry little analytical value (Sims, 1980; Liitkepohl & Reimers, 1992; Naka & Tufte, 1997). Using the coefficient estimates from the VECM regression, IRFs simulate the effect of a permanent one-unit increase in one variable on another. The variable that is shocked is referred to as the 'impulse' variable and the variable that responds to the shock is referred to as the 'response' variable.

Unlike standard VAR models, the presence of cointegration can cause impulses to have permanent effects on the levels of the other variables (Naka & Tufte, 1997). This occurs because the underlying long-run relationship between the cointegrated variables requires that a change in one variable be offset with changes among the other variables to maintain the stationarity of their cointegrating vector(s) in the long-run. When cointegration is not present, a properly specified VAR consists of a system of stationary variables which implies by definition that a unit-change cannot have a permanent effect on the other variables in the system; otherwise, their mean would become time-dependent and the system would no longer be stationary.

Although our model relies on a relatively short time horizon, Naka and Tufte (1997) performed a Monte Carlo experiment analyzing the efficiency of VAR and VECM impulse response functions in small sample settings when cointegration is present. Their findings indicate that, generally speaking, VECM remains efficient over short and long IRF time horizons in the presence of cointegration whereas VAR impulse response functions begin to diverge from efficiency after approximately eight periods. Moreover, Naka and Tufte (1997) show that system-based specifications can have long IRF horizons despite the data generating process containing very few lags of each variable. Since our model employs six lags of each variable, we correspondingly generate eighty-step IRFs to simulate the effect of one-unit impulses to our variables on the Canadian debt-service ratio over a twenty year horizon. The horizontal red lines identify zero on the Y-axis to aid in distinguishing positive and negative responses. Figure 10 illustrates the response of the debt-service ratio to impulses in each of the variables in the system.

Figure 10 - Impulse Response Functions with Debt-Service Ratio as the Response





It should be said before we begin our analysis of the impulse response functions that the impulse response functions illustrated in Figure 10 are not orthogonalized. The process of orthogonalizing impulse response functions refers to the orthogonalization of the variance-covariance matrix of a system's residuals such that the residuals are uncorrelated across both time and equations (Sims, 1980). This process ensures that the calculated response of one variable to a unit-impulse in another variable does not capture the additional effects that may be created by correlation in the residuals. These additional effects arise since cross-correlation among the residuals causes a shock to one residual to impact the remaining residuals and consequently alter the initial variable's response to the impulse. Of course, this is problematic if the objective of the analysis is to isolate the response of one variable to an impulse in another.

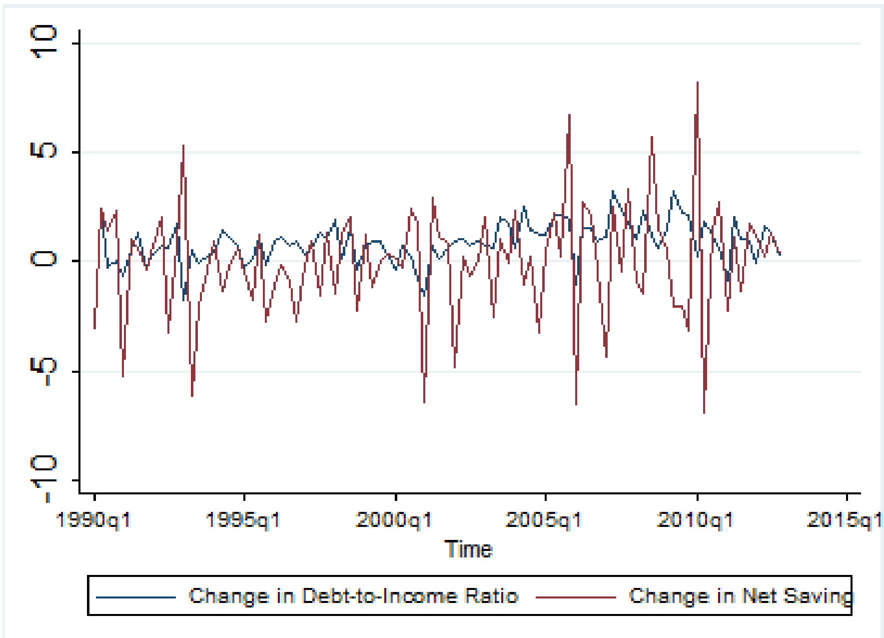
This analysis, however, is not concerned with isolating the response of the Canadian debt-service ratio to orthogonal impulses in the other variables in this study. Rather, our focus is to model the dynamics of the debt-service ratio within the Canadian macroeconomy and subsequently analyze how the different components of that model interact to ultimately enhance our understanding of the determinants of the debt-service ratio at the macroeconomic level. To this end, it is in the interest of this study to analyze the general impulse response functions because the responses will account for the dynamic effects of an impulse, better reflecting the non-orthogonal nature of a real economy. This approach also eliminates the causal ordering issue that arises in orthogonal impulse response analysis (Sims, 1980). Lastly, Appendix G contains the plots of the orthogonalized impulse responses which, in most cases, are almost identical in shape to their standard counterparts.

Starting with the first graph in Figure 10, a one-unit impulse to the debt-service ratio ultimately results in a permanent one-unit increase in itself. However, in the short-run the initial impulse compounds over the following periods hitting its maximum increase of 1.92 after five quarters, and then begins to decrease back towards the initial impulse of one. Since there is no reason to believe that the debt-service ratio could receive such an exogenous shock, there is little analytical value to be derived from this particular impulse response.

Since the disposable income per capita and net savings per capita variables have been transformed by the natural logarithm, a one unit increase in either variable corresponds to an increase in their real value by a factor of approximately 2.72 (the base of the natural logarithm) which is a highly implausible impulse. Instead, an impulse of 0.1 units is analyzed, representing an increasing in real disposable income or real net savings of about 10.5%. Given a 0.1 unit impulse to disposable income per capita, the debt-service ratio is expected to increase by approximately 1.7 units in the short-run and by approximately 1.1 units in equilibrium, with fluctuation between 0.9 and 1.4 units occurring in between. This result implies that an exogenous impulse to disposable income encourages consumers to accumulate debt, driving their relative servicing costs upwards.

In regards to net savings per capita, the impulse response function identifies that a 0.1 unit impulse results in a decrease in the debt-service ratio by approximately 0.04 units over the first three quarters, followed by a period of fluctuation between 0.015 and 0.038 for about thirty quarters until finally stabilizing around an equilibrium value of 0.028. Relative to the estimated response of an impulse to disposable income, an impulse in net savings has a significantly smaller effect on the debt-service ratio. This result is intuitive, however, since increased net savings is likely associated with decreased relative debt holdings (otherwise, there would be no incentive to save since the expected return on savings is usually much less than the expected cost of borrowing). Correspondingly, lower relative debt holdings means smaller debt-servicing costs. To confirm this hypothesized relationship, Figure 11 plots the quarter-over-quarter changes in the real debt-to-income ratio and real net savings from the first quarter of 1990 to the last quarter of 2012. As expected, over the time period we often observe positive changes to savings matched with negative changes to the debt-to-income ratio and vice-versa.

Figure 11 - The Relationship Between Changes to Debt-to-Income Ratio and Savings



The response of the debt-service ratio to an impulse in the prime interest rate is the only transitory impulse hypothesized by our model and yet it yields the most dynamic response in the system. A one-unit increase in the prime interest rate corresponds to a decrease in the debt-service ratio for six quarters, followed by a steady return to its initial value over the following two quarters. Between the eighth and fifteenth quarters after the impulse, the increased prime rate causes the debt-service ratio to increase above its initial value after which the effect of the impulse disappears. As erratic as this response may appear, the result is remarkably consistent with economic intuition. Since the prime interest rate generally reflects the cost of debt in the economy (and thereby the opportunity cost of converting future income to current consumption), an increase in the prime interest rate is expected to be immediately associated with a decreased amount of debt demanded. Moreover, because debt is a stock variable that cannot be erased in the short-run, the increased debt-service ratio between the eighth and fifteenth quarters (two to four years after the impulse) reflects the fact that fixed-rate long-term debt (such as mortgages and car loans) undergo refinancing periodically, thereby increasing the servicing costs of that debt. The transitory nature of this impulse thus appears to be driven by these two forces (less debt demanded and higher debt costs) crowding each other out in equilibrium.

An impulse to the housing affordability index invokes a strictly positive response in the debt-service ratio. This positive response compounds over the six quarters immediately following the impulse and decreases thereafter until the twelfth quarter, at which time the response begins to approach its equilibrium value of approximately 0.69. The nature of the housing affordability index makes a precise interpretation of a one-unit impulse impossible. However, since higher values of the housing affordability index represent a less affordable housing market in Canada, the positive impulse response suggests that a negative shock to housing affordability ultimately increases the debt-service ratio in equilibrium. Since less affordable housing is associated with a lower quantity of housing demanded (and thus indirectly a lower quantity of mortgages demanded), our model suggests that this downward pressure on the debt-service ratio is dominated by the upward pressure created by less affordable housing (or higher priced housing) requiring consumers to accumulate additional mortgage debt.

The negative response to an impulse in core inflation reinforces the implicit relationship between the real interest rate and the debt-service ratio. Prior to the prime interest rate being able to fully adjust, higher core inflation allows consumers to enjoy a lower real interest rate on their current stock of debt, putting downward pressure on the aggregate debt-service ratio in the short-run. After eight quarters, the impulse response function suggests that adjustments in the system (likely in the prime interest rate) begin offsetting some of the downward pressure, resulting in the debt-service ratio converging to its new equilibrium level.

Following an impulse in the unemployment rate, the debt-service ratio decreases sharply over three quarters towards its new equilibrium value. Although there is some medium run variation, the rapid level shift in the debt-service ratio brought on by an increase in the unemployment rate likely represents a sudden slowdown in debt-financed consumption due to the greater uncertainty regarding future incomes. Moreover, since these impulses are not orthogonalized, it is likely that the decrease in the debt-service ratio is partly magnified by any decrease in real disposable incomes per capita brought on in the short-run by an increase in the unemployment rate.

Although our impulse response analysis is based on non-orthogonal impulses, the extreme similarity of the non-orthogonal and orthogonal impulses[7] makes it worthwhile to study the decomposition of our forecast error variance. Like impulse response functions, forecast error variance analysis uses orthogonalized impulses (representing impulses of one standard deviation) to generate a response in the variable being analyzed. Rather than plotting that response over time, it instead calculates the mean-square error generated from the impulses at each step of the response horizon and then calculates the

[7] See Appendix G for plots of the orthogonalized IRFs.

fraction of the total mean-square error that each impulse represents. Lütkepohl (2006, p. 63) provides a more detailed and mathematical exposition of the procedure.

Table 9 - Forecast Error Variance Decomposition of Shocks to the Debt-Service Ratio

Step	ln(Disposable Income)	ln(Net Savings)	Affordability Index	Prime Rate	Unemployment Rate	Core Inflation	Debt-Service Ratio
1	0	0	0	0	0	0	1
2	0.002	0.029	0.017	0.044	0.008	0.004	0.896
3	0.043	0.040	0.046	0.077	0.038	0.002	0.754
4	0.067	0.047	0.098	0.073	0.044	0.003	0.669
5	0.095	0.032	0.124	0.061	0.045	0.005	0.638
6	0.095	0.026	0.147	0.051	0.041	0.006	0.634
7	0.093	0.025	0.160	0.051	0.041	0.006	0.623
8	0.091	0.024	0.166	0.048	0.042	0.008	0.620
16	0.109	0.031	0.189	0.030	0.053	0.013	0.575
24	0.104	0.042	0.193	0.025	0.067	0.013	0.557
32	0.102	0.044	0.201	0.022	0.074	0.013	0.544
40	0.101	0.046	0.205	0.020	0.078	0.012	0.537
48	0.100	0.048	0.208	0.019	0.081	0.012	0.532
56	0.099	0.049	0.210	0.018	0.083	0.012	0.529
64	0.098	0.049	0.212	0.017	0.085	0.012	0.526
72	0.098	0.050	0.213	0.017	0.086	0.012	0.524
80	0.098	0.050	0.214	0.016	0.087	0.012	0.522

Table 9 contains the results of the forecast error variance decomposition of the response of the debt-service ratio to impulses in each of the variables in our model. For the sake of space, we present the decomposition of the response in each quarter of the first two years and then at the end of each two year period thereafter. The decomposition identifies that, aside from exogenous impulses in itself[8], an impulse to the prime interest rate represents the largest source of variation in the debt-service ratio in the initial

[8] Since exogenous shocks to the debt-service ratio do not represent any plausible economic scenario, the remainder of forecast error variance decomposition analysis provided here ignores the variance in the debt-service ratio accounted for by an impulse to itself.

quarters. This strengthens our previous discussion that the short-run response of the debt-service ratio brought on by an increase in interest rates is largely the result of an immediate decline in the quantity of debt demanded. However, in the fourth and subsequent quarters, the total variation in the debt-service ratio becomes dominated largely by the impulses in the housing affordability index and disposable income per capita, suggesting that consumers on average take approximately one year to begin re-optimizing their debt decisions due to increased disposable incomes and less affordable housing.

After approximately four years (step sixteen), the fraction of the variation in the debt-service ratio due to impulses in savings per capita and unemployment begin to amplify and the response to the impulse in the prime interest rate begins to fade. The gradual response to increased net savings captures the relationship discussed earlier (see Figure 10) that consumers who save more are likely reducing their total debt holdings and consequently its servicing costs. The reason for the gradually increasing proportion of the response to a higher unemployment rate is less clear, perhaps simply reflecting a slow consumer adjustment process to diminished employment opportunities. In the other direction, the fading amount of variation accounted for by the impulse to the prime interest rate simply reflects the impulse's transitory nature.

Unlike the other variables in the system, core inflation accounts for an almost negligible proportion of the variance in the debt-service ratio over the entire response horizon. At the end of the response horizon, the affordability index accounts for most of the variation in the debt-service ratio, followed by disposable income per capita, the unemployment rate, and finally net savings per capita; after twenty years, the impulse to the prime interest rate and core inflation combined represent less than three percent of the variation in the debt-service ratio.

VII POLICY IMPLICATIONS

The results of our model suggest that there are several ways in which policy can be implemented to help ensure that the debt held by Canadian households does not become too expensive and consequently impact economic performance. Our model also illustrates that there are several 'exogenous' upward pressures on the debt-service ratio in the short and medium term that policymakers must be aware of.

As mentioned earlier, it is difficult to characterize exactly what level of the debt-service ratio represents "too high" due to the complex relationships among household income, expenditure, their accrual and servicing of debt, and overall macroeconomic performance. However, since the debt-to-disposable income ratio has reached its historical peak in Canada and is among the highest in the world, it is clear that increasing household debt further is not ideal. Without accruing additional debt relative to disposable income, the standard economic identity that income equals expenditures plus savings must hold. This implicitly suggests that in order to facilitate some deleveraging or at least maintain the current ratio of household debt-to-disposable income, any increase in the cost of servicing debt relative to disposable income must be offset by a decrease in either consumption or savings relative to disposable income. Consequently, any upward pressure on the debt-service ratio poses a potential risk to the standard of living and financial stability of Canadian households. Moreover, due to the slowing pace of

Canada's economic expansion since the end of the most recent recession, any significant reductions in household consumption are likely to put additional strain on Canada's economic growth, encompassing an entirely different set of problems for Canadian households. With each of these issues in mind, policy must aim to negate any upward pressure on the debt-service ratio over the short and medium term while Canadian households remain vulnerable to economic shocks.

If we assume that Canada will continue to experience at least a small amount of real economic growth over the next few years, it can be expected that real disposable incomes will as well. This is estimated to put continuous upward pressure on the debt-service ratio given the results of our model. Furthermore, the Bank of Canada's decision to hold interest rates at extremely low levels as a stimulus response to the most recent recession will undoubtedly be eased in the coming years. Canada's return to its potential economic performance will begin to put greater inflationary pressures on Canadian prices and interest rates will need to be increased in order to maintain the Bank of Canada's two percent inflation target. Although our results indicate that higher interest rates will put downward pressure on the debt-service ratio in the short-run, once consumers being refinancing their debt the expected upward spike in debt-servicing costs in the medium run could have potentially destabilizing effects, especially if some households do not or cannot accrue additional debt.

In the context of our model's results, the Canadian Federal Government's most effective and desirable avenues for policy to reduce the debt-service ratio are encouraging private savings and boosting the affordability of houses. With regards to private savings, the introduction of the tax-free savings account (TFSA) and its massive popularity in recent years represents the simplest and likely one of the most effective methods of stimulating private savings. Namely, increasing the annual TFSA contribution limit would unambiguously increase private savings[9] and put downward pressure on the debt-service ratio as indicated by our model. This would also have the convenient property of not imposing substantial initial costs on the Federal Government since consumers contribute to TFSAs using after-tax income, meaning the only significant cost to the government would be the foregone tax revenues from the reduced consumption. Fiscal policy could also expand savings by increasing mandatory Canadian Pension Plan (CPP) contributions or expanding the availability and required contributions of private pension plans. Higher CPP contributions also represent a source of contemporaneous revenue which is especially beneficial over the short and medium term. However, higher CPP contributions also represent relatively higher government expenditures in the long term as CPP contributions are paid back to households. The long-term efficacy of higher CPP contributions as a method to stimulate savings significantly should be explored in future studies[10].

The affordability of housing is a more complicated approach to reducing the debt-service ratio; however, as indicated by the impulse response analysis and forecast error variance decomposition, it represents the largest driver of changes in the debt-service ratio. Since the affordability of housing is, in part, determined by interest rates, the expected increases in interest rates over the next few years will not only put upward pressure on the debt-service ratio in the medium run but will, ceteris paribus, also

[9] Although the magnitude of the effect of such an increase would need to be the subject of another study entirely.

[10] We make this recommendation because it is possible that increased mandatory CPP contributions could simply result in a substitution away from other sources of long-term savings, such as RRSPs. This issue, however, cannot be addressed by our study.

decrease the affordability of housing in the short and medium run by making new (rather than existing) mortgages immediately more expensive, also reinforcing this upward pressure. To avoid the financial stability issues associated with the over-liberalization of lending rules (as discussed in the second section of this paper), the Canadian Federal Government could use a supply-side approach to increasing the affordability of housing. In particular, fiscal policy aimed at reducing the barriers to entry in housing construction by providing subsidies to smaller construction companies may, through competition driving down housing prices, offset the decrease in affordability brought on by higher interest rates, helping reduce the debt-servicing costs of Canadian households. Since a demand-side approach should also avoid liberalizing mortgage lending rules to boost the affordability of housing, Canadian policy should explore creating tax incentives for renting real estate to reduce demand for housing (and thereby its associated debt) through substitution. As the demand for housing falls, house prices would naturally decrease and, in the aggregate, housing affordability would increase thereby contributing to a lower debt-service ratio. Moreover, by indirectly reducing the demand for mortgage debt this approach to increasing the affordability of housing could help negate some of the negative externalities created by myopic or other forms of irrational preferences that result in households overborrowing[11].

Lastly, it is vital that the Bank of Canada fully consider the inflationary (or disinflationary) effects of the increasing debt-servicing costs of Canadians prior to increasing its policy rate. Although increasing its policy rate will eventually be necessary to ease the inflationary pressures associated with Canada's improving economic performance, if interest rates increase too rapidly or too soon, it is possible that their

[11] These behavioural issues are discussed in detail on page 10 and 11 of this study.

positive medium term effects on the debt-service ratio could force Canadian households to reduce consumption and/or savings by more than anticipated. This could subsequently amplify the intended disinflationary effects of increasing interest rates, potentially having negative consequences on Canada's economic performance.

VIII CONCLUSION

With Canadian households accumulating historically high levels of debt at such a rapid pace, there has never been a more important time to understand the dynamics of the debt-service ratio. This paper has explored the characteristics of household debt and created an empirical model to analyze the macroeconomic relationships that drive fluctuations in the Canadian debt-service ratio. We choose to model these relationships using a VECM specification due to the non-stationary nature of the data as well as the presence of cointegration among the variables.

Our findings indicate that short-run changes in the debt-service ratio are correlated and potentially caused by changes in disposable income per capita, net savings per capita, the prime interest rate, the affordability of housing, the unemployment rate, and core inflation, although the time frame in which these variables interact is different for each variable. We also find that the estimated long-run relationship among the variables is statistically significant, implying that there exists an equilibrium or steady-state among these macroeconomic indicators.

Using these findings, we propose policy to aid in reducing the debt-servicing costs faced by Canadian households in order to relieve some of the economic pressures they have created and prevent more extreme macroeconomic consequences.

Due to data limitations at the time this paper was completed, we were unable to explore the distributional component of household debt in Canada. If the data ever becomes available, it would be worthwhile to analyze how these macroeconomic variables affect the distribution of debt in Canada, particularly among the households who already carry very high debt-servicing costs relative to their disposable income. For example, if a shock increases the aggregate debt-service ratio only slightly due to a very sharp increase in the debt-service ratio of a small portion of the population, then the policy response would likely be quite different than if the increased debt-service ratio was evenly spread among Canadian households.

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Appendix A – Testing Results for American and Australian Data

United States – GLS Dickey Fuller Tests For Stationarity

Variable	Lag(s)	DF-GLS mu Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Debt-Service Ratio	1	-0.909	-2.596	-2.076	-1.766
	2	-1.304	-2.596	-2.069	-1.759
	3	-1.511	-2.596	-2.061	-1.752
	4	-1.849*	-2.596	-2.053	-1.745
	5	-1.85*	-2.596	-2.044	-1.736
Disposable Income Per Capita	1	-1.69	-3.542	-2.977	-2.687
FOR	1	-1.113	-2.596	-2.074	-1.764
	2	-1.431	-2.596	-2.067	-1.758
	3	-1.474	-2.596	-2.059	-1.75
Consumer Sentiment Index	1	-1.09	-2.596	-2.073	-1.762
Housing Price Index	1	0.663	-2.596	-2.075	-1.765
	2	0.676	-2.596	-2.068	-1.759
	3	-0.339	-2.596	-2.06	-1.751
	4	-0.318	-2.596	-2.052	-1.744
Unemployment Rate	1	-2.573**	-2.596	-2.074	-1.764
	2	-2.962***	-2.596	-2.067	-1.758
	3	-2.797***	-2.596	-2.059	-1.75

* p<0.1; ** p<0.05; *** p<0.01

Australia – Correlation Between Disposable Income and Consumption Per Capita

Correlation	Income	Consumption
Income	1	
Consumption	0.9985	1

Appendix B – GLS Dickey Fuller Test Results

Variable	Lag(s)	DF-GLS mu Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Debt-Service Ratio	1	-0.415	-2.603	-2.124	-1.817
	2	-0.599	-2.603	-2.113	-1.808
Disposable Income Per Capita	1	-1.291	-3.61	-3.035	-2.743
	2	-1.265	-3.61	-3.017	-2.727
Net Savings Per Capita	1	-1.52	-2.603	-2.142	-1.836
	2	-1.313	-2.603	-2.129	-1.825
	3	-1.093	-2.603	-2.116	-1.813
	4	-0.98	-2.603	-2.101	-1.799
	5	-1.032	-2.603	-2.086	-1.785
	6	-1.1	-2.603	-2.07	-1.77
	7	-1.071	-2.603	-2.053	-1.754
	8	-0.84	-2.603	-2.037	-1.738
	9	-1.073	-2.603	-2.02	-1.721
	10	-1.005	-2.603	-2.003	-1.705
Affordability Index	1	-0.406	-2.603	-2.126	-1.819
	2	-0.348	-2.603	-2.115	-1.809
Prime Rate	1	-0.186	-2.603	-2.122	-1.815
Unemployment Rate	1	-1.409	-2.603	-2.126	-1.819
	2	-1.638	-2.603	-2.115	-1.809
	3	-1.609	-2.603	-2.103	-1.798
Core Inflation	1	-2.867***	-2.603	-2.133	-1.827
	2	-1.944*	-2.603	-2.122	-1.817
	3	-1.71	-2.603	-2.109	-1.805
	4	-0.983	-2.603	-2.095	-1.793
	5	-0.727	-2.603	-2.081	-1.779
	6	-0.354	-2.603	-2.066	-1.765
	7	-0.424	-2.603	-2.05	-1.75

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Appendix C – Lag-order Testing for Cointegration Tests and VECM Specification

Lag	AIC	HQIC	SBIC
0	5.19109	5.272	5.39225
1	-6.55495	-5.90765*	-4.94567*
2	-6.79436	-5.58068	-3.77697
3	-6.75304	-4.97297	-2.32753
4	-6.61478	-4.26833	-0.78115
5	-6.86541	-3.95258	0.376334
6	-7.22781*	-3.74859	1.42205
7	-7.05228	-3.00668	3.0057

* Indicates optimal lag selected by each information criteria

Appendix D – VECM Results, All Equations

	Equations						
Variables	D_dsr	D_lndispinc	D_lnnetsave	D_afford	D_primerate	D_uer	D_coreinf
L._ce1	-0.0218***	0.00153***	0.0212	0.0157***	-0.0954***	-0.00633	0.00901
	(0.00610)	(0.000445)	(0.0142)	(0.00589)	(0.0293)	(0.0127)	(0.0105)
LD.dsr	0.418**	-0.00689	0.0135	0.301*	1.302	-0.600*	0.113
	(0.167)	(0.0122)	(0.387)	(0.161)	(0.800)	(0.348)	(0.286)
L2D.dsr	0.0751	0.0214*	0.385	-0.166	0.422	0.963***	-0.101
	(0.154)	(0.0112)	(0.357)	(0.148)	(0.737)	(0.321)	(0.263)
L3D.dsr	0.0716	-0.00591	-0.291	0.0560	-0.261	-0.488	0.0580
	(0.159)	(0.0116)	(0.370)	(0.154)	(0.764)	(0.333)	(0.273)
L4D.dsr	-0.0980	-0.00337	-0.0754	-0.0768	-1.154	0.150	-0.363
	(0.154)	(0.0112)	(0.356)	(0.148)	(0.736)	(0.320)	(0.263)
L5D.dsr	-0.290**	0.0108	0.348	-0.204	-1.183*	0.345	0.347
	(0.139)	(0.0101)	(0.322)	(0.134)	(0.665)	(0.290)	(0.238)
LD.lndispinc	6.014**	-0.580***	-16.45**	-2.665	17.74	-0.317	-10.74**
	(2.991)	(0.218)	(6.941)	(2.884)	(14.33)	(6.243)	(5.123)
L2D.lndispinc	10.48***	-0.392**	-9.661	1.508	53.53***	-3.986	4.441
	(2.733)	(0.199)	(6.343)	(2.635)	(13.10)	(5.704)	(4.681)
L3D.lndispinc	7.637**	-0.0604	-3.020	-4.467	36.44**	-0.610	0.913
	(3.107)	(0.226)	(7.210)	(2.996)	(14.89)	(6.484)	(5.321)
L4D.lndispinc	0.377	0.0679	6.316	-4.632*	5.461	-1.351	7.538
	(2.764)	(0.201)	(6.415)	(2.665)	(13.24)	(5.769)	(4.734)
L5D.lndispinc	0.879	-0.272	5.067	-2.106	-3.285	3.574	-8.396*
	(2.730)	(0.199)	(6.336)	(2.632)	(13.08)	(5.698)	(4.676)
LD.lnnetsave	-0.404***	0.00780	-0.0964	0.0411	-0.729	0.252	0.203
	(0.104)	(0.00755)	(0.241)	(0.1000)	(0.497)	(0.216)	(0.178)
L2D.lnnetsave	-0.158	0.00788	-0.0571	0.0721	-0.767	0.303	-0.0227
	(0.0997)	(0.00726)	(0.231)	(0.0961)	(0.478)	(0.208)	(0.171)
L3D.lnnetsave	-0.0975	-0.00426	-0.139	0.187**	-0.357	0.321	0.381**
	(0.0968)	(0.00705)	(0.225)	(0.0934)	(0.464)	(0.202)	(0.166)
L4D.lnnetsave	0.266***	-0.00786	-0.411*	0.234**	0.342	0.191	-0.153
	(0.101)	(0.00733)	(0.233)	(0.0970)	(0.482)	(0.210)	(0.172)

	Equations						
Variables	D_dsr	D_lndispinc	D_lnnetsave	D_afford	D_primerate	D_uer	D_coreinf
L5D.lnnetsave	-0.0186	0.00557	-0.285	-0.0646	-0.113	0.249	0.125
	(0.104)	(0.00755)	(0.241)	(0.1000)	(0.497)	(0.216)	(0.178)
LD.afford	-0.177	0.0352**	0.638	0.393**	-0.932	-0.546	0.106
	(0.197)	(0.0143)	(0.457)	(0.190)	(0.944)	(0.411)	(0.338)
L2D.afford	-0.290*	0.0195	0.390	0.0404	-2.012**	0.131	0.0155
	(0.173)	(0.0126)	(0.401)	(0.167)	(0.828)	(0.361)	(0.296)
L3D.afford	0.0679	0.0251**	0.178	0.549***	0.294	-0.357	0.738***
	(0.165)	(0.0120)	(0.383)	(0.159)	(0.791)	(0.344)	(0.283)
L4D.afford	-0.245	0.00756	-0.0173	-0.116	-1.412*	0.302	-0.0372
	(0.157)	(0.0115)	(0.365)	(0.152)	(0.754)	(0.328)	(0.269)
L5D.afford	-0.139	0.0116	0.304	0.274*	-0.437	0.188	0.0721
	(0.149)	(0.0109)	(0.346)	(0.144)	(0.715)	(0.311)	(0.255)
LD.primerate	0.0874*	-0.00299	-0.0542	-0.110**	-0.00173	-0.0469	-0.105
	(0.0495)	(0.00360)	(0.115)	(0.0477)	(0.237)	(0.103)	(0.0847)
L2D.primerate	0.0544	-0.00649**	-0.000706	-0.0734*	0.204	-0.0659	-0.0220
	(0.0407)	(0.00297)	(0.0945)	(0.0393)	(0.195)	(0.0850)	(0.0698)
L3D.primerate	0.0308	-0.00584*	0.00528	-0.107***	0.0965	-0.0112	-0.0848
	(0.0409)	(0.00298)	(0.0950)	(0.0395)	(0.196)	(0.0855)	(0.0701)
L4D.primerate	0.0849**	-0.00733***	-0.0277	-0.0400	0.278	-0.0228	0.0252
	(0.0376)	(0.00274)	(0.0873)	(0.0363)	(0.180)	(0.0785)	(0.0644)
L5D.primerate	0.102***	-0.00454*	-0.116	-0.0364	0.256	-0.129*	-0.134**
	(0.0369)	(0.00269)	(0.0856)	(0.0356)	(0.177)	(0.0770)	(0.0632)
LD.uer	-0.00973	-0.00330	0.136	-0.172**	0.145	0.124	-0.0906
	(0.0758)	(0.00552)	(0.176)	(0.0731)	(0.363)	(0.158)	(0.130)
L2D.uer	0.0194	-0.00200	-0.0655	-0.0153	0.217	-0.0118	-0.0613
	(0.0725)	(0.00528)	(0.168)	(0.0699)	(0.347)	(0.151)	(0.124)
L3D.uer	0.0637	-0.00643	-0.00841	-0.0100	-0.124	-0.226*	0.249**
	(0.0645)	(0.00470)	(0.150)	(0.0622)	(0.309)	(0.135)	(0.111)
L4D.uer	-0.00961	0.00410	0.123	-0.0142	-0.377	-0.0471	-0.259**
	(0.0676)	(0.00492)	(0.157)	(0.0652)	(0.324)	(0.141)	(0.116)

	Equations						
Variables	D_dsr	D_lndispinc	D_lnnetsave	D_afford	D_primerate	D_uer	D_coreinf
L5D.uer	-0.0476	-0.000856	0.0855	-0.0778	-0.499	0.252*	-0.0338
	(0.0641)	(0.00467)	(0.149)	(0.0618)	(0.307)	(0.134)	(0.110)
LD.coreinf	-0.327***	0.00711	0.0745	0.0342	-1.206**	0.136	-0.693***
	(0.110)	(0.00798)	(0.254)	(0.106)	(0.525)	(0.229)	(0.188)
L2D.coreinf	-0.122	0.000487	-0.0732	0.165	-0.366	0.127	-0.527***
	(0.111)	(0.00808)	(0.258)	(0.107)	(0.532)	(0.232)	(0.190)
L3D.coreinf	-0.114	-0.00220	-0.311	0.0852	-0.496	0.106	-0.291*
	(0.0990)	(0.00721)	(0.230)	(0.0955)	(0.474)	(0.207)	(0.170)
L4D.coreinf	-0.0692	0.00413	-0.202	0.0474	-0.213	0.186	-0.399***
	(0.0869)	(0.00633)	(0.202)	(0.0838)	(0.416)	(0.181)	(0.149)
L5D.coreinf	-0.0156	-5.51e-05	-0.264*	-0.0189	-0.0653	0.248*	-0.148
	(0.0666)	(0.00485)	(0.154)	(0.0642)	(0.319)	(0.139)	(0.114)
Constant	0.00673	-0.000460	-0.0179	-0.0735***	-0.0216	-0.00597	-0.0462
	(0.0294)	(0.00214)	(0.0682)	(0.0283)	(0.141)	(0.0613)	(0.0503)
Observations	86	86	86	86	86	86	86

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix E – Results from Stability Test Using Eigenvalues and Moduli

Eigenvalue	Modulus	Eigenvalue	Modulus
1	1	-.750564 - .4042876i	0.852523
1	1	-.2357726 + .8061365i	0.839908
1	1	-.2357726 - .8061365i	0.839908
1	1	.8284654 + .1158329i	0.836524
1	1	.8284654 - .1158329i	0.836524
1	1	.5733685 + .5905009i	0.823069
.7666291 + .5329683i	0.933689	.5733685 - .5905009i	0.823069
.7666291 - .5329683i	0.933689	-.4128299 + .6952706i	0.808597
-.8483256 + .2777777i	0.892646	-.4128299 - .6952706i	0.808597
-.8483256 - .2777777i	0.892646	.07769187 + .7661494i	0.770079
.4362806 + .7689785i	0.88412	.07769187 - .7661494i	0.770079
.4362806 - .7689785i	0.88412	-.2296613 + .7328136i	0.767958
-.6977831 + .5406485i	0.882724	-.2296613 - .7328136i	0.767958
-.6977831 - .5406485i	0.882724	.1473469 + .6920674i	0.707579
.8159291 + .3095368i	0.87267	.1473469 - .6920674i	0.707579
.8159291 - .3095368i	0.87267	-.6638089 + .1664311i	0.684355
-.5287044 + .6855335i	0.865728	-.6638089 - .1664311i	0.684355
-.5287044 - .6855335i	0.865728	-.3013911 + .1870639i	0.354725
.269306 + .8092256i	0.852861	-.3013911 - .1870639i	0.354725
.269306 - .8092256i	0.852861	.3491226 + .04684443i	0.352251
-.750564 + .4042876i	0.852523	.3491226 - .04684443i	0.352251

The VECM specification imposes 6 unit moduli.

Appendix F – Test for Gaussian Regression Residuals

Jarque-Bera test

Equation	Chi^2 **Statistic**	**P >** Chi^2
D_dsr	1.189	0.552
D_lndispinc	10.091	0.006
D_lnnetsave	1.205	0.547
D_afford	1.590	0.452
D_primerate	26.789	0.000
D_uer	0.088	0.957
D_coreinf	1.014	0.602
ALL	41.965	0.000

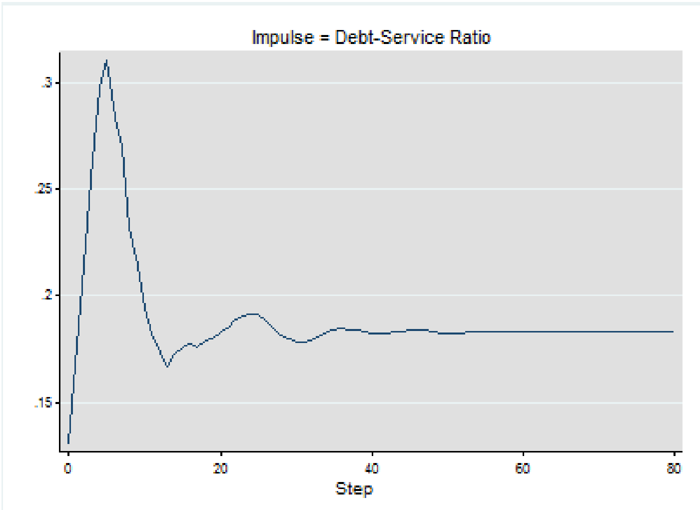
Skewness test

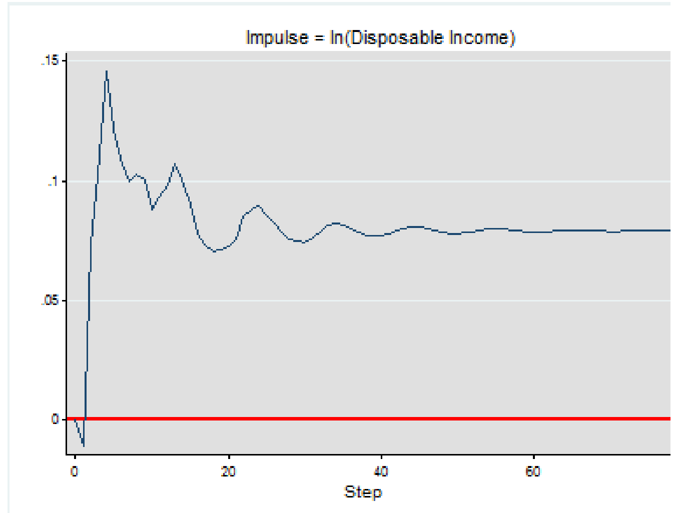
Equation	**Skewness**	Chi^2 **Statistic**	**P >** Chi^2
D_dsr	-0.287	1.178	0.278
D_lndispinc	-0.111	0.177	0.674
D_lnnetsave	0.127	0.231	0.631
D_afford	0.077	0.086	0.770
D_primerate	0.420	2.532	0.112
D_uer	0.077	0.085	0.771
D_coreinf	0.248	0.883	0.347
ALL		5.171	0.639

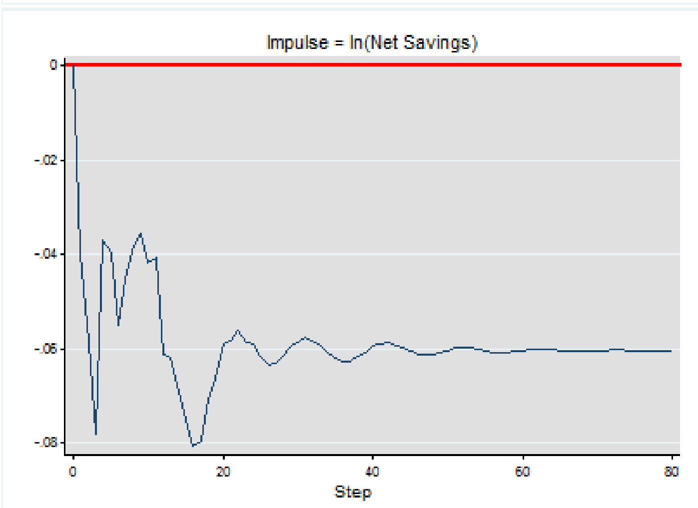
Kurtosis test

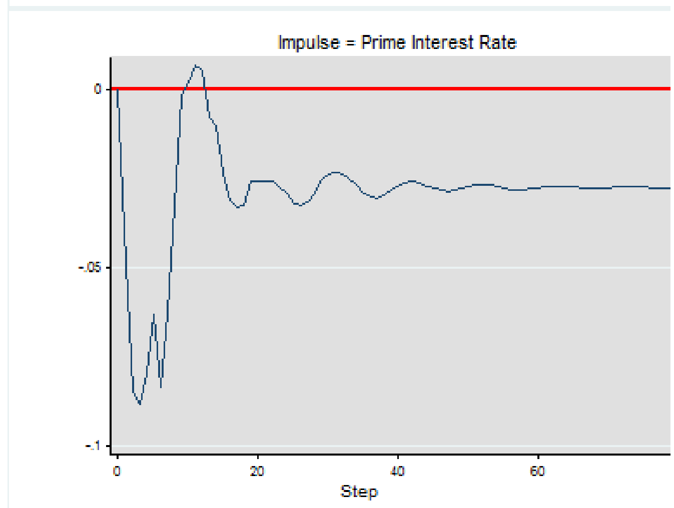
Equation	**Kurtosis**	Chi^2 **Statistic**	**P >** Chi^2
D_dsr	3.055	0.011	0.917
D_lndispinc	4.663	9.914	0.002
D_lnnetsave	3.521	0.974	0.324
D_afford	3.648	1.504	0.220
D_primerate	5.602	24.257	0.000
D_uer	3.032	0.004	0.952
D_coreinf	2.809	0.131	0.718
ALL		36.794	0.000

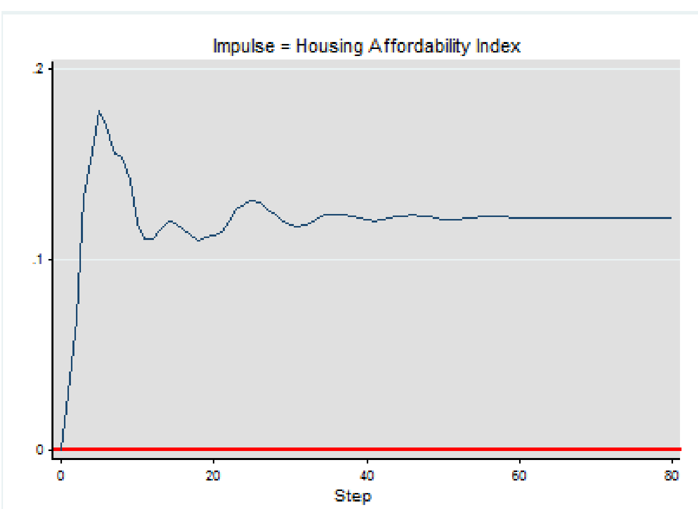
Appendix G – Orthogonalized Impulse Response Functions

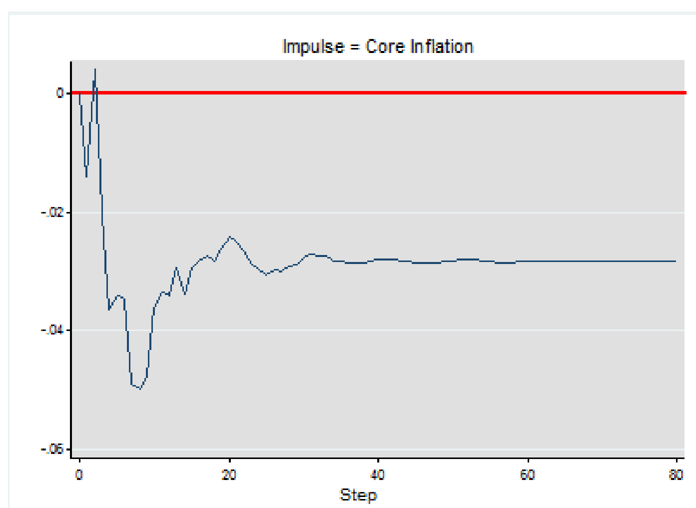


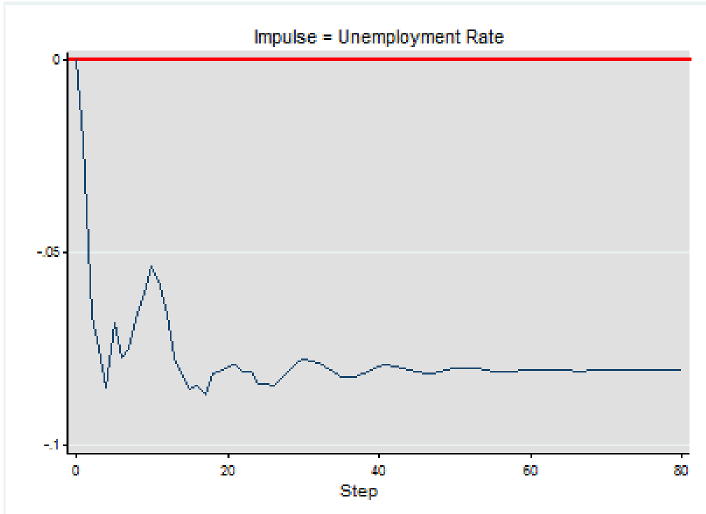











Impulse = Unemployment Rate
0
-.05
-.1
0
20
40
60
80
Step