Appendix A: Variable Descriptions and Statistics

The consumption variable used in this paper is Statistics Canada's real household final consumption expenditure (CANSIM Table 380 0067), adjusted to remove housing services. The latter is subtracted from real household consumption expenditure to get non-housing real consumption. This variable is available quarterly and is seasonally adjusted at annual rates. Where possible, variables were seasonally adjusted at annual rates. If unavailable, this paper controls for any omitted time-related factors by using quarterly and time dummies.

The DSR gap variables – mortgage and non-mortgage – come from CANSIM Table 380-0073. The total mortgage debt-service ratio is also available in this table. Note that the principal component is not in this table but can be calculated as a simple subtraction of the interest component from the total.

Household income also comes from CANSIM Table 380-0073. The present value of permanent disposable income uses this income variable to calculate the discounted sum of perfect-foresight forward-looking households 40 quarters (10 years) out in the future.

$$\ln\left(y_t^p\right) = \left(\sum_{s=1}^{k} \delta^{s-1} \ln\left(y_{t+s}\right)\right) / \left(\sum_{s=1}^{k} \delta^{s-1}\right)$$

This variable is weighted by current income as in Muellbauer et al. (2015) to get the following formula:

$$\ln\left(y_t^p \,/\, y_t\right) = \left(\sum_{s=1}^{k} \delta^{s-1} \ln\left(y_{t+s}\right)\right) / \left(\sum_{s=1}^{k} \delta^{s-1}\right) - lny_t$$

The discount rate used is 0.95, consistent with Muellbauer et al. (2015). To extrapolate past 2016Q3, this paper calculates a 0.2 percent growth rate used by these authors.

Housing assets come from CANSIM Table 378-0121, and to make housing assets real, this paper uses all-items inflation excluding the eight most volatile components from Table 326-0020, i.e. core inflation.

Unemployment comes from the labour-force survey, CANSIM Table 282-0087.

The loan-to-value ratio is a bounded variable taking on the policy rule in place at a particular point in time for first-time homebuyers. The timing of the changes comes from Kronick (2016a), based on public information.

Tables A1 and A2 contains descriptive and correlation statistics.

Table A1: Descriptive Statistics

	(1)				
	count	mean	sd	min	max
Consumption Growth	106	.6383809	.7870301	-2.923026	2.094553
DSR Gap Growth	106	-.0531132	.1357755	-.6300001	.3300004
DSR Gap Growth (NM)	106	-.0501887	.1966093	-.45	.7
Total DSR Growth	106	.0166038	.1838886	-.5499992	.4899998
Housing Wealth Growth	106	1.181267	.8512774	-1.719058	3.685609
Future Inc Growth	106	.0127051	.7547436	-2.199743	3.049113
Unemployment Rate Growth	106	-.0056604	.2985139	-.5999994	1.2
N	106				

Source: Author's calculations.

Table A2: Correlation Statistics

	(1)							
	Cons Growth	DSR Gap Growth	DSR Gap Growth (NM)	Total DSR Growth	Housing Wealth Growth	Future Inc Growth	Unemployment Rate Growth	LTV
Cons Growth	1							
DSR Gap Growth	-0.0636	1						
DSR Gap Growth (NM)	0.0245	0.284***	1					
Total DSR Growth	0.0316	0.447***	0.314***	1				
Housing Wealth Growth	0.403***	0.147	0.140	0.0965	1			
Future Inc Growth	-0.349***	-0.234**	-0.480***	0.0115	-0.355***	1		
Unemployment Rate Growth	-0.422***	0.0228	-0.204**	-0.373***	-0.268***	-0.333***	1	
LTV	0.331***	-0.0570	0.0885	0.121	0.340***	0.0950	-0.253***	1

* p < 0.10, ** p < 0.05, *** p < 0.01.

Source: Author's calculations.

APPENDIX B: FORMAL REGRESSION TABLES

Table B1: Primary Results Summary

	(1)	(2)	(3)
	Cons Growth	**Cons Growth**	**Cons Growth**
DSR Gap Growth	-0.666 (-1.53)	-0.556 (-1.22)	-0.726 (-1.54)
DSR Gap Growth (NM)	-0.595* (-1.74)	-0.731** (-2.14)	
Total DSR Growth	0.381 (1.17)	0.290 (0.82)	0.223 (0.64)
Housing Wealth Growth	0.202** (2.13)	0.153 (1.59)	0.173* (1.71)
Future Inc Growth	-0.181 (-1.52)		-0.194 (-1.52)
Unemployment Rate Growth	-0.741*** (-3.01)	-0.663*** (-2.76)	-0.735*** (-2.69)
LTV	0.0314 (0.88)	0.0297 (0.81)	0.0287 (0.71)
Cointegration	-0.154*** (-2.95)	-0.103** (-2.46)	-0.107** (-2.22)
Current Inc Growth		0.301** (2.58)	
Constant	-2.635 (-0.77)	-2.566 (-0.74)	-2.312 (-0.60)
Observations	105	105	105
Durbin – Watson	2.184	2.245	2.052

t statistics in parentheses
Reject null of no autocorrelation if DW less than 1.284, and imply no autocorrelation if DW greater than 1.567
NM = non-mortgage
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Author's calculations.

Appendix C: Caveats

There are a couple of caveats to the results worth mentioning, in addition to the lack of regional and household-type data discussed earlier. First, not covered by interest rates and principal in the DSR discussion is discretionary lump-sum payments that reduce outstanding balances, or at renewal, if interest rates have fallen, households choosing to keep the higher principal payments to repay faster. In both cases, households would be smoothing out any non-housing effects from potential interest-rate changes. These decisions would then be endogenous to a household's consumption profile. This is admittedly a data concern, however some of the endogeneity issue can be resolved by lagging the debt-servicing variables, as this paper does. Dealing with endogeneity concerns in general by lagging is used in Albuquerque and Krustev (2015) with their debt variables, as well as other papers including Olney (1999).

Furthermore, presented as a purely interest-rate and house-price-variable story leaves out important features of decisions around debt, as well as the debt and asset sides of a household's balance sheet. For example, as found in Auclert (2016) in the analysis of U.S. and Italian data, the reactions to individuals' consumption from accommodative monetary policy depends on the net interest-rate exposure of that individual, i.e. the difference between maturing assets and liabilities at a particular moment in time, and on aggregate it depends on the cross-sectional covariance between this exposure and marginal propensities to consume, and intertemporal substitution. This type of modelling is beyond the scope of this paper but is of interest for future research.

APPENDIX D

Table D1: Sensitivity to Lags

	(1)	(2)	(3)
	Cons Growth	Cons Growth	Cons Growth
DSR Gap Growth	-0.666 (-1.53)	-1.051** (-2.11)	-0.365 (-0.86)
DSR Gap Growth (NM)	-0.595* (-1.74)	-0.539* (-1.77)	-0.0922 (-0.30)
Total DSR Growth	0.381 (1.17)	0.988*** (2.74)	-0.699* (-1.80)
Housing Wealth Growth	0.202** (2.13)	0.169* (1.70)	0.206* (1.97)
Future Inc Growth	-0.181 (-1.52)	-0.189 (-1.63)	-0.161 (-1.59)
Unemployment Rate Growth	-0.741*** (-3.01)	-0.555** (-2.23)	-0.596*** (-2.64)
LTV	0.0314 (0.88)	0.0247 (0.63)	0.0488 (1.12)
Cointegration	-0.154*** (-2.95)	-0.189*** (-3.46)	-0.221*** (-4.13)
Constant	-2.635 (-0.77)	-1.977 (-0.53)	-4.221 (-1.02)
Observations	105	104	103

t statistics in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: Author's calculations.

To test the main results, this paper performs a set of other robustness checks. Here, we highlight one: how sensitive were the results to changing the lags on all the DSR variables.[1] Specifically, this paper looks at the effect when instead of lagging both DSR gap variables and the total DSR variable by one lag (as shown in column 1 of Table D1), it is lagged by two and three lags (in columns 2 and 3 of Table D1 respectively).

On the bulk of variables, including this paper's variable of interest (the DSR mortgage gap variable), the results and implications remain essentially the same – although there is some significance at two lags. Therefore, it continues to be the case that households have not increased precautionary savings from the riskier housing environment, and perhaps have even increased non-housing spending.

1 Other robustness checks include the sensitivity of the results to using full consumption including housing services, checking the results where we look at year on year quarterly changes as in Albuquerque and Krustev (2015), and the impact on the results of using a different credit constraint, specifically the credit constraint index (CCI) generated in Muellbauer et al. (2015). The main results do not change. Results available upon request.

Table D2: Sensitivity using only lags of Total DSR

	(1)	(2)	(3)
	Cons Growth	Cons Growth	Cons Growth
DSR Gap Growth	-0.666 (-1.53)	-0.427 (-1.01)	-0.277 (-0.64)
DSR Gap Growth (NM)	-0.595* (-1.74)	-0.831** (-2.24)	-0.303 (-0.90)
Total DSR Growth	0.381 (1.17)	0.920** (2.55)	-0.786** (-2.08)
Housing Wealth Growth	0.202** (2.13)	0.198** (2.02)	0.246** (2.39)
Future Inc Growth	-0.181 (-1.52)	-0.160 (-1.40)	-0.204** (-2.04)
Unemployment Rate Growth	-0.741*** (-3.01)	-0.791*** (-3.03)	-0.662*** (-2.73)
LTV	0.0314 (0.88)	0.0287 (0.71)	0.0406 (0.98)
Cointegration	-0.154*** (-2.95)	-0.147*** (-3.03)	-0.153*** (-3.33)
Constant	-2.635 (-0.77)	-2.384 (-0.62)	-3.499 (-0.89)
Observations	105	104	103

t statistics in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: Author's calculations.

Where we do see a big change with these results is on the total DSR variable. When we increase the lags to two, we see a big increase in consumption should debt-servicing costs increase. However, at three lags, the results completely flip and consumption falls when these costs rise. What might be causing these results? One potential explanation is that in an environment where the bulk of mortgages have five-year fixed mortgage rates, consumer behaviour is not necessarily forced to immediately adjust. Perhaps households react with two lags to the increased debt servicing costs by increasing consumption, while their particular mortgage rate has not increased, then adjust to these higher servicing costs by lowering consumption at three lags. This would be consistent with the idea of consumption-smoothing behaviour.

Also interesting is how we see the speed of adjustment coefficient get closer to the expected range.[2] This would suggest that some of the misspecification is from the lags on the DSR variables.

Given the consistency of the DSR gap variables to additional lags, this paper reruns the main

2 A coefficient of -0.221 implies approximately 10 quarters for 90 percent of the shock to consumption to dissipate.

regression and adjusts the lags of only the total DSR variable to see whether the consumption-smoothing behaviour holds (Table D2).

The story remains pretty consistent as in the primary specification, with the DSR mortgage-gap variable having a negative and insignificant coefficient, the DSR gap variable on non-mortgage debt being negative as well but with mixed significance. These results continue to show a lack of precautionary savings by Canadian households. The housing-wealth variable continues to be significant, suggesting that households have consumed out of this wealth.

The total DSR variable continues to have the same switching signs across lags that we saw earlier, suggesting some form of consumption smoothing.

The speed of adjustment term does return to its slower pace, implying that the lags of the DSR gap variables matter for specification not the lag of the total DSR. Specifically, as results not presented show, it is the lags of the non-mortgage DSR gap variable that drives the speed of adjustment term closer to the expected range.[3]

Overall, it appears that the robustness checks confirm that to the extent we have an environment where total debt-servicing costs have been flat but we have shifted to greater-principal, lower-interest-rate debt dynamics that have increased risk, households have not compensated by lowering non-housing consumption. Additionally, they have spent out of increases to housing wealth.

3 Full results available on request.