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MEASURING THE EFFECT OF MORTGAGE DEBT SERVICE BURDEN ON PRIVATE CONSUMPTION

Key points:

- *Hong Kong household's mortgage debt has expanded amid the post-crisis low-interest rate environment. As Hong Kong dollar interest rates will eventually increase amid the US interest rate normalisation process, it is expected that the mortgage debt service burden on household will pick up going forward, posing headwinds to their consumption. As such, this paper examines the effect of higher mortgage debt service burden on private consumption.*

- *To better capture the effect of mortgage debt service burden on consumption, we follow the literature to construct a service burden indicator on the outstanding mortgage debt, given that existing timely indicators refer only to new mortgage debt. We find that the fluctuation of our constructed indicator is broadly consistent with the ratio derived from the Census and Statistics Department's quinquennial population census. This offers us confidence on the reliability of our indicator in tracking the aggregate mortgage service burden in Hong Kong.*

- *Using an empirical model, we find that higher mortgage debt service burden would drag private consumption, with a 1 percentage point increase in our indicator of outstanding mortgage debt service burden reducing household consumption by 0.76% in the long run. As such, the potential pickup in mortgage debt service burden would constitute a source of headwinds to private consumption going forward.*

- *As our empirical findings show that mortgage debt service burden can influence private consumption, this implies that macro-prudential measures, which help restrain mortgage debt service burden through dampening the growth of the aggregate household leverage on mortgages, may indirectly help alleviate the potential headwinds to private consumption in the event of interest rate hike.*

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I. INTRODUCTION

The ongoing interest rate normalisation in the U.S. is expected to raise Hong Kong dollar (HKD) interest rates eventually under the Linked Exchange Rate System. As shown in previous studies, rises in domestic interest rates would negatively affect Hong Kong's private consumption, and such effect would mainly operate through the housing wealth channel due to the importance of housing as an asset and its strong wealth effect on private consumption.[1]

With increase in household mortgage borrowing in recent years, however, there were concerns that interest rate rises in the current episode may further drag private consumption through aggravating the mortgage debt service burden. Indeed, recent studies for other economies have highlighted the negative effect of high debt service burden on private consumption, while an earlier study by the HKMA also points to the existence of such effect in Hong Kong in the past.[2] As such, this paper revisits the effect of mortgage debt service burden on Hong Kong's private consumption.

We first follow the literature to construct the outstanding mortgage debt service ratio (OMDSR), which is a quarterly indicator of the household's burden of servicing their outstanding mortgage debt. Differing from the existing timely indicators that refer only to new mortgage debt, the OMDSR covers the total outstanding mortgage debt which is more relevant to change in aggregate private consumption. We find that the broad trend of the OMDSR is consistent with the relevant ratio of the Census and Statistics Department (C&SD)'s quinquennial population census on the aggregate household mortgage debt service burden. This helps confirm the reliability of the OMDSR as a more timely indicator of aggregate housing mortgage debt burden in Hong Kong.

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[1] Lai and Lam (2002), Cutler (2005) and HKMA (2013) found significant impact of housing wealth on private consumption, while Peng, Cheung and Leung (2001) and HKMA (2016) showed that housing prices appeared to have stronger wealth impact on private consumption than equity prices.

[2] Based on micro-level studies by Johnson and Li (2000) and Dynan (2012), households in the US tend to have larger cut-back on their consumption spending in response to a rise in debt-service burden. Drehmann and Juselius (2012) illustrated that high debt service burden is associated with sizeable output loss in subsequent economic downturns, while Juselius and Drehmann (2015) found negative effect of debt service burden on the growth of private expenditure. In the case of Hong Kong, Lai and Lam (2002) found that debt service burden has a negative impact on private consumption.

Using an empirical model, we find that higher mortgage debt service burden would drag private consumption, with 1 percentage point rise in the OMDSR reducing each household's consumption by 0.76% in the long run. In terms of policy implications, as our empirical findings show that mortgage debt service burden can influence private consumption, this implies that macro-prudential measures, through dampening the growth of the aggregate household leverage on mortgages and thereby restraining mortgage debt service burden, may indirectly help alleviate the potential headwinds to private consumption in the event of interest rate hike.[3]

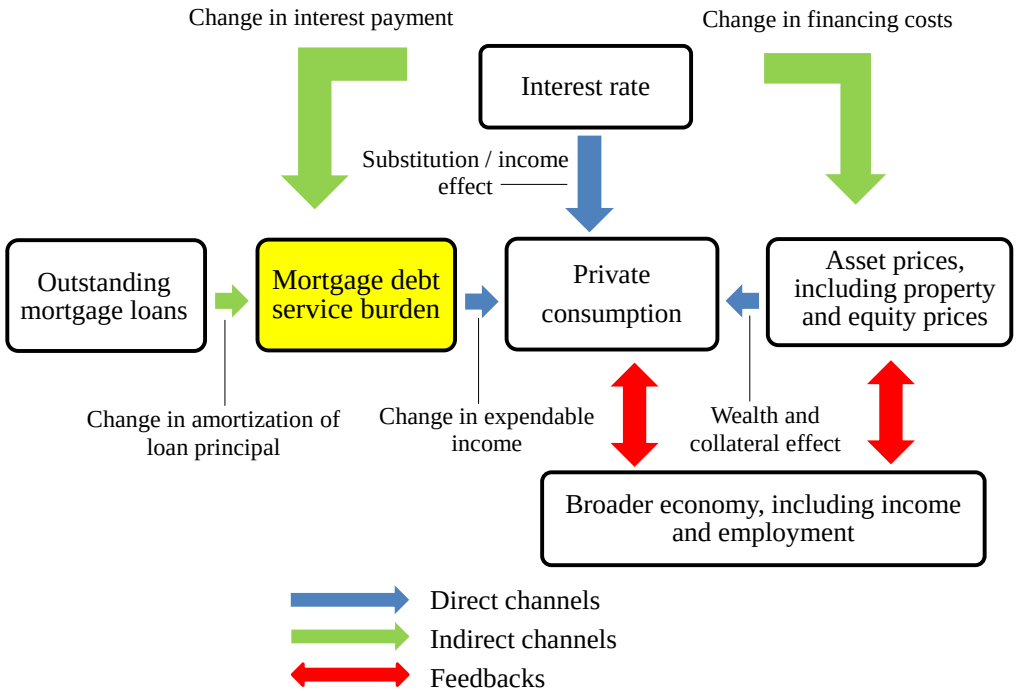
The rest of the paper is organised as follows. Section II outlines the methodology used to measure the mortgage debt service burden and compares the OMDSR with other relevant indicators. Section III estimates Hong Kong's consumption function including mortgage debt service burden as a determinant. Section IV discusses the implications of macro-prudential measures for mortgage debt service burden and private consumption. Section V concludes.

II. MEASURING THE MORTGAGE DEBT SERVICE BURDEN

Mortgage debt service burden refers to the mortgage debt service payment (i.e. interest payment plus amortization of loan principal) as a share of income. Chart 1 shows the transmission of an interest rate shock to private consumption, highlighting the role of mortgage debt service burden in the transmission process. Apart from the well-known substitution/income effect and wealth/collateral effects (through influencing asset prices), interest rate shocks, in the presence of a mortgage debt service burden, could also affect private consumption through changing mortgage interest payments and therefore households' expendable income (see Lai and Lam (2002) and Aron et al (2010)). Such impact is expected to increase with the size of the outstanding mortgage loans. Also, the amortization of loan principal changes along with the size of the outstanding mortgage loans, which can affect private consumption through households' expendable income.

[3] The HKMA has implemented eight rounds of macro-prudential measures since 2009 to strengthen banks' risk management on mortgage lending business. Wong et al (2014) and HKMA (2014) showed that these measures can restrain household leverage and mortgage loan growth in Hong Kong.

Chart 1: Determinants of private consumption



Source: HKMA staff estimates.

Previous studies by Lai and Lam (2002) and Kang (2016) have examined the impact of mortgage debt service burden on Hong Kong's private consumption. To do so, Lai and Lam (2002) construct an indicator based on the amortization of the *outstanding* mortgage loan, with an underlying assumption of fixing the loan maturity to a constant. Such assumption, however, is not consistent with the fact that the average tenor of the outstanding mortgage would vary over time, particularly given the lengthening of tenors of new mortgages in recent years. On the other hand, Kang (2016) uses the Centaline mortgage payment-to-income ratio to measure the mortgage debt service burden, but such ratio refers to the burden on *new* mortgage loans only.

To address the abovementioned issues of Lai and Lam (2002) and Kang (2016), we follow the methodology of Dynan et al. (2003), Drehmann and Juselius (2012) and BIS (2016) to measure the outstanding mortgage debt service ratio (OMDSR), using standard formula of fixed instalment loans:[4].

$$OMDSR_t = \frac{r_t}{(1-(1+r_t)^{-st})} \times \frac{D_t}{Y_t} \quad (1)$$

[4] Such methodology is based on an assumption that, for a given loan rate, debt interest and amortization costs on the aggregate debt are repaid in equal portions over the maturity of the loan. The justification for this assumption is that the differences between the repayment structures of individual loans will tend to cancel each other out in the aggregate

Where D_t denotes the outstanding amount of residential mortgage loans in the banking sector, and the data source is the HKMA. Y_t denotes the total income of owner-occupier households (proxied by multiplying the median income of owner-occupier households with the number of owner-occupier households), and the data source is the Census and Statistics Department (C&SD).[5] r_t and s_t denote respectively the average interest rate and the maturity of the outstanding mortgage loans. Data on these two series requires further elaboration below.

Data on r_t is obtained from the HKMA's Return of Interest Rate Risk Exposures, calculated as the average yield on banks' outstanding mortgage loans. With the time series of r_t starting from 2004, we backcast the series so as to aid our econometric analysis. In particular, we assume that prior to 2004, the average mortgage interest rate is priced with the Best Lending Rate (BLR) with a spread ($\overline{Spread_t}$) which assumes an exponential moving average (EMA) form:

$$r_t = BLR_t + \overline{Spread_t} \qquad (2)$$

$$\overline{Spread_t} = (1-\alpha)Spread_t + \alpha\,\overline{Spread}_{t-1} \quad (3)$$

where α is equal to 0.9 following Drehmann and Juselius (2012) and BIS (2016), and $Spread_t$ is the spread for new mortgage.[6] This assumption is based on the fact that the prevailing mortgage plans before 2004 mainly adopted floating mortgage rate pricing with reference to the BLR. Our sensitivity test in the Annex A shows that changing α does not affect much the pattern of the average mortgage interest rate.

The maturity of the outstanding mortgage loans, s_t, is estimated by using an EMA calculation:

$$s_t = \sum_{i=1}(1-\alpha)\alpha^{i-1}[tenor_{t-i+1} - (i-1)] \quad (4)$$

Where $tenor_{t-i+1}$ denotes the tenor of new mortgages recorded in the period t-i+1 (in monthly frequency), with i-1 months being subtracted from the tenor

[5] The median income of owner-occupier households is seasonally adjusted.

[6] Drehmann and Juselius (2012) and BIS (2016) directly estimate the average lending interest rates of outstanding loans using the exponential moving average formula, with α being equal to 0.9 and 0.8 for advanced and emerging economies respectively.

to proxy the remaining maturity of the mortgage loans approved in the past. The time series on the tenors of new mortgages start from June 1998 and are sourced from the HKMA residential mortgage survey (RMS). To extend the data backward from June 1998, we rely on two ad hoc HKMA surveys which provided estimates of the maturities of the outstanding mortgage loans as at end-September 1994 and end-September 1997.[7] These assumptions can take into account the recent lengthening of tenors of new mortgages in our estimation of the OMDSR. Our sensitivity test shows that changing α does not affect much the pattern of the maturity of the outstanding mortgage loans. See Annex A for details.

To assess whether the OMDSR can be a reliable measure of the mortgage debt service burden for the aggregate household sector, it would be useful to compare the OMDSR with other commonly-used indicators of debt service burden.

Chart 2 shows the estimated OMDSR over 1985 – 2016, together with the actual median mortgage payment and loan repayment-to-income ratio as estimated by the C&SD's quinquennial population census (the C&SD's ratio). As shown in the chart, both ratios trended down during early 2000s, consistent with the decline in aggregate household mortgage borrowings following the burst of the housing bubble in 1997 and the noticeable drop in mortgage interest rate during that period (Chart 3). Despite the sharp rise in property prices in the post-Global Financial Crisis (GFC) period, both ratios remained steady, as the aggregate household leverage on mortgages was constrained by the HKMA's macro-prudential measures on banks' mortgage loans (Chart 4), and the lengthened tenors of new mortgage loans brought down the actual amount of mortgage debt service (Chart 5).[8]

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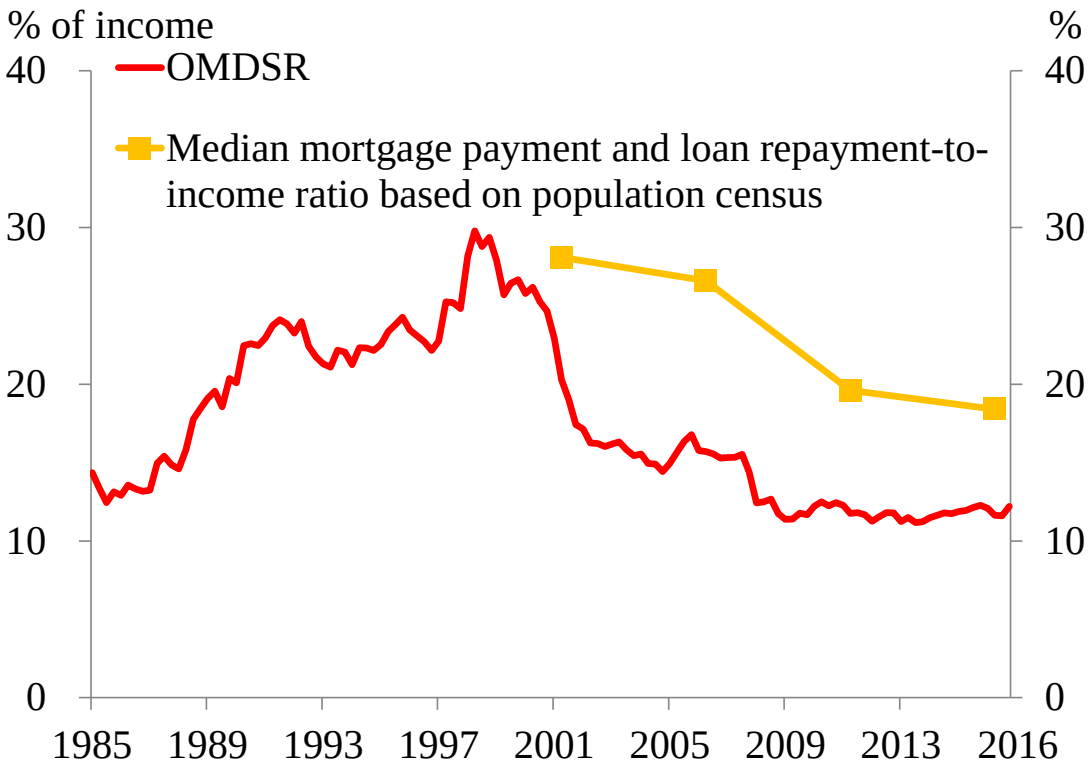
[7] See the HKMA Quarterly Bulletin article on "Mortgage Corporation Proposal" published in May 1996, and the HKMA press release on "Survey on Residential Mortgages in Hong Kong" published in February 1998. Based on these surveys, we set the maturity of the outstanding mortgage loans to 13.3 years before September 1994 and 16.8 years between September 1997 and May 1998 (i.e. the month prior to the start of the monthly HKMA RMS). Data in between October 1994 and August 1997 were filled by linear interpolation.

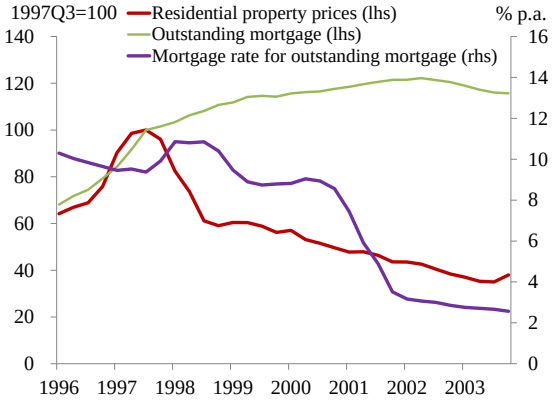
[8] The difference in the levels of the two indicators largely reflected different definitions, methodologies and assumptions used in the estimations. In particular, the C&SD's ratio refers only to those owner-occupiers with mortgage, while the OMDSR refers to all owner-occupiers (with or without mortgage debt) as the time series on the income of owner-occupiers with mortgage begin only in 2001, therefore inhibiting our econometric analysis. That said, restricting our definition of income to only those owner-occupiers with mortgage would not materially affect the shape of the OMDSR. Such OMDSR would be more volatile than the baseline OMDSR but still remains broadly subdued in recent years.

Chart 2: The OMDSR, and the median mortgage payment and loan repayment-to-income ratio



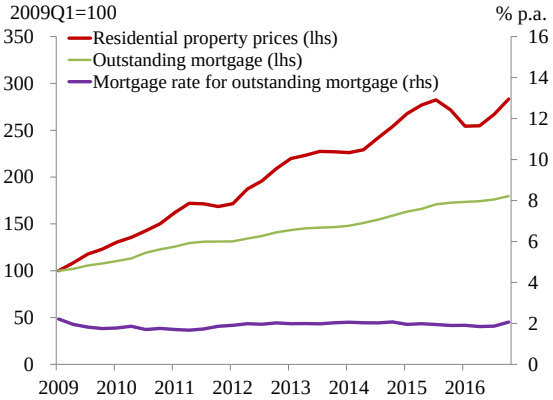
Sources: C&SD and HKMA staff estimates.

Chart 3: Housing prices, the outstanding mortgage loans, and mortgage interest rate (1996 – 2003)



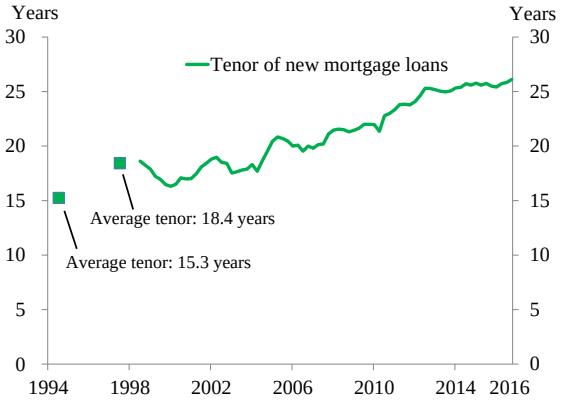
Sources: HKMA, R&VD, and HKMA staff estimates.

Chart 4: Housing prices, the outstanding mortgage loans, and mortgage interest rate (2009 – 2016)



Sources: HKMA, R&VD, and HKMA staff estimates.

Chart 5: Tenors of new mortgage loans



Note: For end-September 1994 and 1997, the average tenors refer to average contractual life of the outstanding mortgage loans as at the end of respective dates, obtained from the HKMA press release of "Survey on Residential Mortgages in Hong Kong" published in February 1998.

Source: HKMA.

We now compare the OMDSR with the banks' debt-servicing ratio, which is the actual debt repayment-to-income ratio for banks' *new* mortgage applicants.[9] As shown in Chart 6, the OMDSR was lower than the banks' debt-servicing ratio, partly reflecting the fact that the OMDSR covers mortgage repayments on "old" mortgages in addition to that on new mortgages. As "old" mortgages were made at a time when housing prices were lower, the mortgage repayment on these would accordingly be lower than that on new mortgages. As such, a debt service burden indicator on the outstanding mortgage (i.e. OMDSR), which covers both "old" and new mortgages, would be lower than an indicator on new mortgage applicants alone (i.e. banks' debt servicing ratio). Besides, the higher level of the banks' debt-servicing ratio also reflects the inclusion of non-mortgage loan repayment in calculating the banks' debt-servicing ratio in accordance with the HKMA's prudential requirements. Reflecting the prudential limits on the banks' debt servicing ratio, which should also help restrain the OMDSR, both the OMDSR and the banks' debt-servicing ratio were steady in the post-GFC period.[10]

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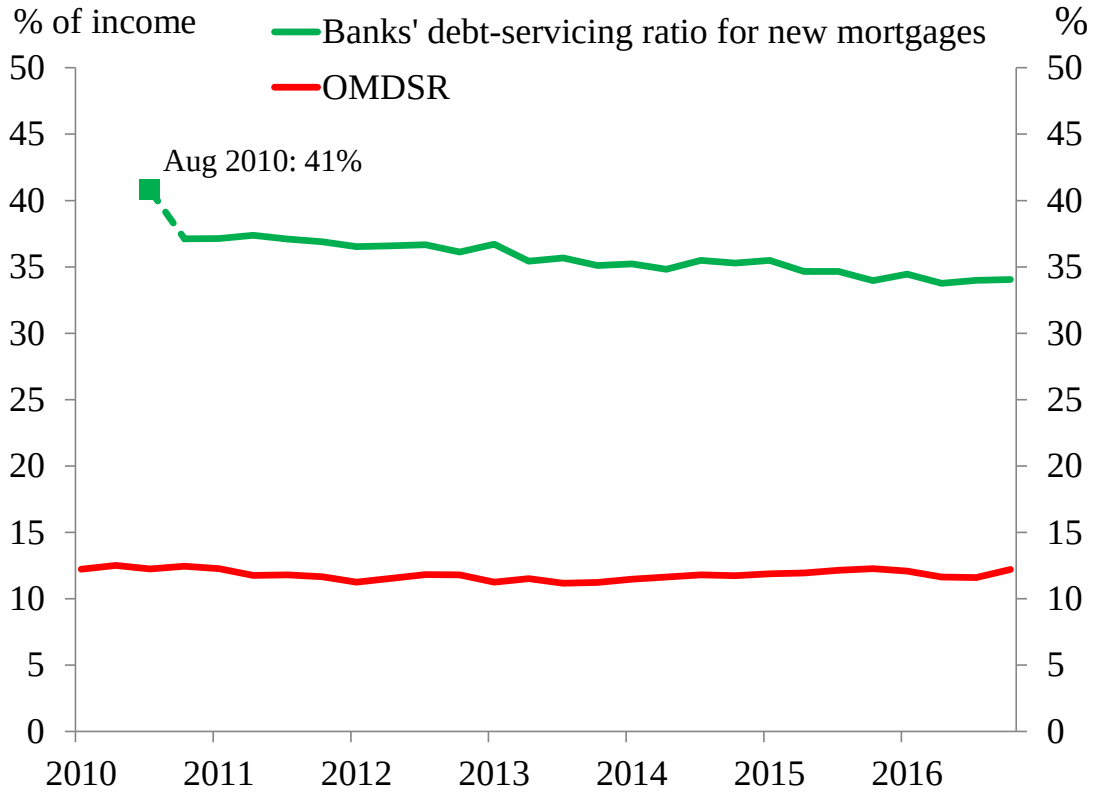
[9] The banks' debt-servicing ratio has been compiled by the HKMA on a monthly basis since August 2010. This ratio is subject to a maximum cap by the HKMA macro-prudential measures.

[10] One subtle difference is that the OMDSR tends to fluctuate less than the banks' debt-servicing ratio, as the OMDSR covers the aggregate mortgage repayments (i.e. including loans made in the past) and therefore would be less responsive to the change in new mortgage repayments.

Chart 6: The OMDSR and the banks' debt-servicing ratio for new mortgages



Note: The HKMA compiles the banks' debt-servicing ratio starting from August 2010. For the purpose of comparison, the monthly time series of banks' debt-servicing ratio is transformed into the quarterly average data.
Source: HKMA staff estimates.

Overall, the OMDSR is broadly in line with other commonly-used indicators of debt service burden, but it is more timely and refers to the burden on the total outstanding mortgage debt rather than new mortgage only. This offers us confidence in using the OMDSR to assess the influence of mortgage debt service burden on private consumption.

III. EMPIRICAL ANALYSIS

To assess the impact of mortgage debt service burden on Hong Kong's private consumption, we follow Lai and Lam (2002) and Kang (2016) in using error correction model, where the long-run relationship between private consumption and its determinants is expressed as an error correction term in the short run equation. In accordance with theory and empirical evidences, we include real income, real housing and financial

wealth, real interest rate, as well as OMDSR as the long-run determinants of real private consumption.[11]

Real private consumption is expressed as per household unit. Real income, real housing wealth, and real financial wealth are measured respectively by the real median household income, real residential property prices and the real Hang Seng Index, with nominal terms being translating into real terms through deflating by the Composite Consumer Price Index (CCPI). Real interest rate is constructed as the 3-month Hong Kong Interbank Offered Rate (HIBOR) minus CCPI inflation. Except for the real interest rate and the OMDSR, all variables are expressed in logarithmic values. Augmented Dickey-Fuller tests confirm that all variables have a unit-root.

We estimate the long-run co-integrating equation using quarterly data from 1985 Q1 to 2016 Q4, and table 1 shows the estimation results using the Fully Modified Ordinary Least Square.[12] All coefficients have the correct signs, with real income, real housing prices, and real equity prices having positive and statistically significant impact on real private consumption, while the OMDSR has negative and statistically significant impact. In particular, 1 percentage point rise in the OMDSR would reduce private consumption by 0.76% in the long run, affirming the fact that indebtedness could further render consumption vulnerable to interest rate rises. On the other hand, the coefficient of real interest rate is positive but not statistically significant, which may reflect the offsetting income and substitution effects. As such, we drop the real interest rate from the long-run equation, and column (2) of Table 1 shows that doing so would not affect much the size of other coefficients and the test statistics.

[11] The specification of our error correction model is different from those in Lai and Lam (2002) taking into account the more recent economic and financial environments.

[12] Engle and Granger (1987) test statistics reject the null hypothesis that the series are not co-integrated at the 1% significance level.

Table 1: Estimated results of the co-integrating equations

Specification of the long-run co-integrating equation:

$$\log(PCEH_t) = \beta_0 + \beta_1 \log(RMI_t) + \beta_2 \log(RPROP_t) + \beta_3 \log(RHSI_t) + \beta_4\, RHIBOR3M_t + \beta_5\, OMDSR_t + \varepsilon_t \quad (5)$$

Variables

$PCEH_t$:	Real private consumption expenditure per household
RMI_t :	Real median household income (deflated by CCPI)
$RPROP_t$:	Real housing prices (deflated by CCPI)
$RHSI_t$:	Hang Seng Index in real terms (deflated by CCPI)
$RHIBOR3M_t$:	3-month HIBOR minus CCPI inflation
$OMDSR_t$:	Outstanding mortgage debt service ratio

Long-run coefficients	(1)	(2)
Dependent variable: LOG(PCEH)		
Constant	0.53 *	0.53 *
	(0.28)	(0.28)
LOG(RMI)	0.63 ***	0.63 ***
	(0.08)	(0.08)
LOG(RPROP)	0.28 ***	0.28 ***
	(0.02)	(0.01)
LOG(RHSI)	0.03 *	0.03 **
	(0.02)	(0.02)
RHIBOR3M	0.03	
	(0.14)	
OMDSR	-0.76 ***	-0.76 ***
	(0.10)	(0.09)
Adjusted R^2	0.98	0.98
SE of regression	0.0297	0.0295
Long-run variance	0.0018	0.0018
Engle-Granger tau-statistic (p-value)	0.0025	0.0010
Engle-Granger z-statistic (p-value)	0.0000	0.0000

Notes: Figures in ( ) are standard errors.
*, **, ***: Statistical significance at the level of 10%, 5% and 1% respectively.

We then construct a short-run equation with the growth of real private consumption per household as the dependent variable. The short-run determinants include the error-correction term (i.e. the residual of the long-run equation), changes in real median household income, real housing prices, real equity prices and the OMDSR. Table 2 shows that the error-correction term is negative and statistically significant, indicating that 14% of the deviation from the long-run equilibrium level would be offset in the next

quarter. As for short-run determinants, all the short-run determinants have the expected signs and are statistically significant except the OMDSR.[13]

Table 2: Estimated results of the short-run equation

Specification of the short-run equation:

$$\Delta\log(PCEH_t) = \gamma_0 + \alpha\varepsilon_{t-1} + \gamma_1\Delta\log(RMI_t) + \gamma_2\Delta\log(RPROP_t) + \gamma_3\Delta\log(RHSI_t) + \gamma_4\,\Delta OMDSR_t + \mu_t \quad (6)$$

Where

$$\varepsilon_t = \log(PCEH_t) - [\beta_0 + \beta_1\log(RMI_t) + \beta_2\log(RPROP_t) + \beta_3\log(RHSI_t) + \beta_5\,OMDSR_t]$$

based on equation (5)

Short-run coefficients	
Dependent variable: ΔLOG(PCEH)	
Constant	0.00 ***
	(0.00)
Error-correction term	-0.14 **
	(0.05)
ΔLOG(RMI)	0.14 ***
	(0.05)
ΔLOG(RPROP)	0.11 ***
	(0.03)
ΔLOG(RHSI)	0.05 ***
	(0.01)
ΔOMDSR	-0.20 (1)
	(0.15)
Adjusted R^2	0.36
SE of regression	0.0137

Notes: Figures in ( ) are standard errors, calculated using the Newey-West method.
*, **, ***: Statistical significance at the level of 10%, 5% and 1% respectively.
(1) p-value = 0.1911

Overall, our estimations show that the OMDSR can influence the long-run equilibrium level of real private consumption, while not appearing to have significant impact on the growth of real private consumption in the short run.

[13] Using estimates of the OMDSR based on different α would not make much difference to our estimated results. See Annex A for details.

IV. POLICY IMPLICATIONS

Our findings in this paper suggest that the HKMA's macro-prudential measures, while aiming to strengthen banks' resilience, can alleviate the impact of interest rate hike on private consumption via the debt service burden channel. Through restraining the growth of the aggregate household leverage on mortgages[14], the macro-prudential measures would reduce the aggregate amount of mortgage repayment (including amortization of loan principals and interest payments), compared to the situation where no such measure were in place. This would restrain the mortgage debt service burden particularly in the event of an interest rate hike, helping alleviate the consequent impact on private consumption.

To illustrate, Table 3 shows the estimated impact of 200 basis points increase in the mortgage rate on the OMDSR and private consumption per household, under different counterfactual scenarios with higher outstanding mortgage loans. Based on the current level of the outstanding mortgage loans, a mortgage rate hike of 200 basis points would increase the OMDSR by 3.0 percentage points from 12.2% to 15.2%. If the outstanding mortgage loans were 40% larger than the current level (last row of Table 3), the OMDSR would rise from 12.2% to 17.1% in the absence of any rate hike (Column A), and increase further by 4.2 percentage points to 21.3% in the event of a 200-basis-point rise in the mortgage rate. As such, higher outstanding mortgage loans would not only raise the OMDSR, but also make it more susceptible to the impact of mortgage rate hike.

Table 3: Numerical illustration of counterfactual scenarios

Had the outstanding mortgage loans been higher than the current level by (%)	**The outstanding mortgage debt service ratio (OMDSR) (%)**		**Increase in OMDSR (ppt)**	**Decrease in real private consumption per household (%)**
	No rate hike	200-bp rate hike		
	(A)	**(B)**	**(C) = (B) - (A)**	**(D) = (C) × β_5**
0 (Current)	**12.2**	**15.2**	**3.0**	**-2.3**
10	13.4	16.7	3.3	-2.5
20	14.6	18.2	3.6	-2.7
30	15.9	19.8	3.9	-3.0
40	17.1	21.3	4.2	-3.2

[14] See Wong et al. (2014) and HKMA (2014).

In either case, the rise in the OMDSR as a result of the mortgage rate hike would dampen consumption spending, and the decline would be sharper if the outstanding mortgage loans were higher. Based on its estimated long-run elasticity with respect to the OMDSR [15], real consumption spending per household would drop by 3.2% if the outstanding mortgage loans were 40% higher, compared with a relatively smaller decline of 2.3% if the outstanding mortgage loans stay at the current level (Table 3).

V. CONCLUDING REMARKS

In light of the potential pickup in the mortgage debt service burden amid the U.S. interest rate normalisation process, this paper examines the influence of such burden on private consumption in Hong Kong. In doing so, we follow the literature to construct the OMDSR to track households' debt service burden on the outstanding mortgage debt. We find that the fluctuation of the OMDSR is broadly consistent with the relevant results of the C&SD's quinquennial population census, and this offers us confidence on the reliability of the OMDSR in measuring the aggregate mortgage debt service burden in Hong Kong.

Results of our econometric analysis confirm that higher mortgage debt service burden would drag private consumption, with 1 percentage point rise in the OMDSR estimated to reduce household consumption by 0.76% in the long run. As such, higher mortgage debt service burden can constitute another source of headwinds to the outlook for private consumption. In this regard, through dampening the growth of the aggregate household leverage on mortgages, macro-prudential measures implemented by the HKMA have restrained households' mortgage debt service burden. As our empirical findings show that mortgage debt service burden can influence private consumption, this implies that macro-prudential measures may indirectly help alleviate the potential drag on private consumption in the event of interest rate hike.

[15] For simplicity, we hold other variables constant in this illustration.

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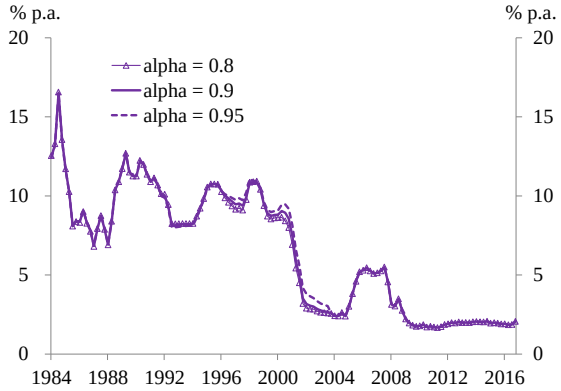
ANNEX A: THE SENSITIVITY OF THE OMDSR TO DIFFERENT VALUES OF α

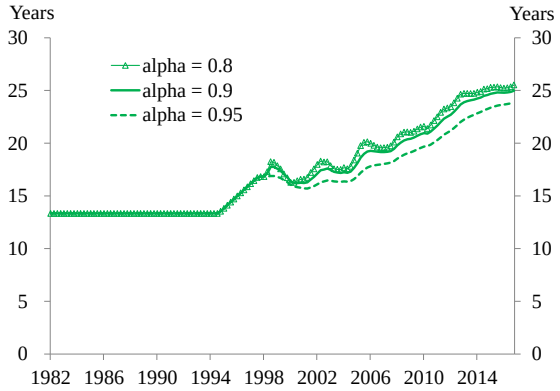
We consider two alternative cases of α = 0.8 (i.e. larger weight on new loans, being adopted for emerging economies in Drehmann and Juselius (2012)) and α = 0.95 (i.e. smaller weight on new loans) in approximating the average interest rate and the maturity of the outstanding mortgage loans. Overall, changing α does not affect much the movement and the level of the average mortgage interest rate and the maturity of the outstanding mortgage loans (Chart A1 and Chart A2).

Chart A1: Average interest rate of the outstanding mortgage loans with different α



Source: HKMA staff estimates.

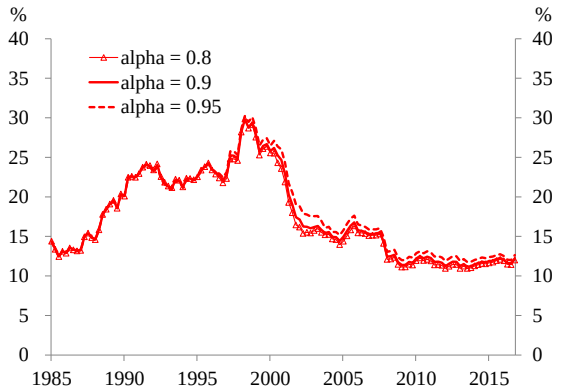
Chart A2: Maturity of the outstanding mortgage loans with different α



Source: HKMA staff estimates.

With the average interest rate and the maturity of the outstanding mortgage loans remaining roughly similar, changing α also does not affect much the movement and the level of the OMDSR (Chart A3).

Chart A3: The OMDSR with different α



Source: HKMA staff estimates.

Furthermore, Tables A1 and A2 show that estimating the long-run and the short-run equations using OMDSRs with α = 0.8 and 0.95 would not affect much the sign, magnitude, and statistical significance of the coefficients.

Table A1: Estimated results of the co-integrating equations (different α)

	alpha = 0.8		alpha = 0.95	
Long-run coefficients	(1)	(2)	(3)	(4)
Dependent variable: ΔLOG(PCEH)				
Constant	0.58 **	0.58 **	0.46 (a)	0.47 (b)
	(0.28)	(0.28)	(0.29)	(0.29)
LOG(RMI)	0.61 ***	0.62 ***	0.65 ***	0.65 ***
	(0.08)	(0.08)	(0.08)	(0.08)
LOG(RPROP)	0.28 ***	0.28 ***	0.28 ***	0.27 ***
	(0.02)	(0.01)	(0.02)	(0.02)
LOG(RHSI)	0.03 *	0.03 **	0.03 *	0.04 **
	(0.02)	(0.02)	(0.02)	(0.02)
RHIBOR3M	0.00		0.07	
	(0.14)		(0.14)	
OMDSR	-0.75 ***	-0.76 ***	-0.77 ***	-0.76 ***
	(0.10)	(0.09)	(0.11)	(0.10)
Adjusted R^2	0.98	0.98	0.98	0.98
SE of regression	0.0299	0.0297	0.0301	0.0300
Long-run variance	0.0018	0.0018	0.0018	0.0018
Engle-Granger tau-statistic (p-value)	0.0021	0.0007	0.0037	0.0019
Engle-Granger z-statistic (p-value)	0.0000	0.0000	0.0000	0.0000

Notes: Figures in ( ) are standard errors.
*, **, ***: Statistical significance at the level of 10%, 5% and 1% respectively.
(a) p-value = 0.1109, (b) p-value = 0.1019

Table A2: Estimated results of the short-run equations (different α)

	alpha = 0.8	alpha = 0.95
Short-run coefficients	(1)	(2)
Dependent variable: ΔLOG(PCEH)		
Constant	0.00 ***	0.00 ***
	(0.00)	(0.00)
Error-correction term	-0.13 **	-0.14 ***
	(0.05)	(0.05)
ΔLOG(RMI)	0.14 ***	0.14 ***
	(0.05)	(0.05)
ΔLOG(RPROP)	0.11 ***	0.11 ***
	(0.03)	(0.03)
ΔLOG(RHSI)	0.05 ***	0.05 ***
	(0.01)	(0.01)
ΔOMDSR	-0.19 (a)	-0.21 (b)
	(0.15)	(0.15)
Adjusted R^2	0.36	0.36
SE of regression	0.0137	0.0137

Notes: Figures in ( ) are standard errors, calculated using the Newey-West method.
*, **, ***: Statistical significance at the level of 10%, 5% and 1% respectively.
(a) p-value = 0.2177, (b) p-value = 0.1601