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Measuring the Effect of Negative Interest Rate on New Zealand Banks

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1. Introduction

Bernanke and Blinder (1988) derived the lending channel of monetary policy, which essentially predicted that low (policy) interest rate, e.g., the Federal Fund Rate, increases the bank supply of loans (i.e., increases credit). Bernanke and Blinder (1992) and Jimenze *et al.* (2012) are among others who provided empirical support for this theory. Goodfriend (2000), however, was the first to argue that negative policy interest rate is a possible solution to the Zero Lower Bound (i.e., the nominal interest rate reaches zero and monetary policy becomes ineffective in stimulating the economy.)

This paper attempts to measure the effects of negative interest rate on lending rates, deposits rate, and bank profit in New Zealand. Banks in New Zealand hold reserves in the Settlement Cash Account at the Reserve Bank (RBNZ). The lending channel hypothesis predicts that a negative interest on this account (i.e., negative OCR) encourages banks not to hold more reserves with the RBNZ, hence increase lending, and that would stimulate demand. A low and negative interest rate should also increase asset prices (e.g.iye

cost and boosts asset prices, increases credit flow, increases lending and bank profit. However, they speculated that although negative effects on bank profitability have not occurred, further significant decline in negative interest rate would "likely entail diminishing returns since the lending channel is crucially influenced by the bank's expected profitability."

Boungou (2019) used a very large panel data of 28 European countries and reported a strong negative impact of negative interest rate on bank net interest margins, which prompted banks to increase the non-interest margins. The effect on bank productivity depended on the bank-specific balance sheet characteristics. He found that banks tend to take less risk under a negative interest rate regime.

Arseneau (2016), similarly, analyzed the expected effect of a negative interest rate on U.S. banks. He argued that heterogeneity affects the results, whereby banks that provide liquidity to borrowers expect lower profitability because of the decline in interest-income. The opposite is true for banks that provide liquidity to depositors because they benefit from short-term funding cost.

The objective of this paper is to measure the effects of negative OCR on bank lending rate, deposit rate, and profit in New Zealand. We accomplish that by estimating the equilibrium lending rate and the deposit rate in New Zealand then making projections of the effect of a negative OCR in New Zealand on the *future* bank lending rate, deposit rate, and profit. We derive an equilibrium lending and deposit rates from a constrained profit maximization problem, and use an unrestricted VAR to summarize the dynamics of the equilibrium rates. Then, we solve the VAR model using dynamic and stochastic method, whereby the innovations are produced using bootstraps to produce baseline projections over the period from Sep 2020 to Dec 2024. Then, we follow the same methodology to make projections under a counterfactual scenario, whereby the OCR is negative. Similarly, we produce baseline projection and a projection under counterfactual scenario for the period from Jun 2020 to Dec 2024 under a negative OCR for, bank interest income, non-interest income, interest cost, and non-interest cost, which allow us to analyze bank profit under baseline and under negative OCR.

We found that both the equilibrium lending and deposit rates decline significantly when the OCR turns negative, and they both turn negative as the projection horizon increases. On average – over the projection horizon – however, the lending rate remained higher than the deposit rate. Also, net interest income increased. We project that a negative OCR increases bank profit relative to baseline by about 19 percent *on average* over the period Sep 2020 to Dec 2024, which is consistent with Bernanke and Blinder (1988). However, the trade-off is more uncertainty. Interest income and costs, and non-interest income, among all the components of profit (i.e., income from derivatives, trade, fees etc.) becomes more volatile when the OCR turns negative.

Next, we derive the equilibrium lending rate and the deposit rate from constrained profit maximization. In sections (3) and (4), we estimate the dynamic of the equilibrium lending and deposit rates using a VAR, and provide a dynamic stochastic baseline projection up to Dec 2024. Then we provide projections of the equilibrium lending and the deposit rates under scenarios of negative OCR. Section (5) is a similar analysis of the effect of the OCR on the bank profit. Section (6) is a conclusion.

2. Deriving the equilibrium lending and deposit rates

These equilibrium rates result from the interaction of supply and demand curves of loans and deposits. Let us assume a representative bank, which takes deposits from households, firms, and the government to make loans to firms and households. The interest paid on deposits is and the lending rate is . Banks receive interest on the deposits in the Settlement Cash account held at the RBNZ.

Π is bank profit. is the lending rate. is the quantity of loans of the bank. is the Settlement Cash Balance at the RB, which is paid , is the interest rate on bonds. the RB bonds held by the bank and is the deposit rate paid by the bank and is bank deposit. is the bank net position of the bank in the money and bond market, whereby banks invest in these markets, and is the market interest rate. $c(.)$ is the bank managing cost; it is strictly convex and twice continuously differentiable.

Assume that the net position of the bank is given by:

$$= - - - . \quad (2)$$

We specify a simple quadratic cost function.

$$= \frac{1}{2}(_1 ^2 + _2 ^2) . \quad (3)$$

The parameters $_1$ and $_2$ are positive marginal costs of deposits and loans. Substitute both (2) and (3) in (1)

The bank maximizes

$$= + _{,} + + (- - -) - - \frac{1}{2}(_1 ^2 + _2 ^2) ,$$

$$' \ ' \ '$$

(4)

subject to a constraint. The constraint is on the capital/asset ratio. We write this constraint as— = . The assets, = + , where is loans and is all the rest of the bank assets. For convenience, we rewrite the constraint (− ———), where is the Lagrange multiplier.

Solve for the First Order Conditions (FOC).

FOC for → , − − $_2$ + = 0, (5)

FOC for → − = 0 (6)

FOC for → − − $_1$ + = 0 (7)

FOC for → − = 0 (8)

Similarly, we could derive the equilibrium deposit rate as a positive function of and a negative function of aggregate saving.

From (7),

$$= \frac{-}{1}. \quad (16)$$

And we postulate that the supply of deposits is a positive function of aggregate savings and the deposits rate .

$$= + . \quad (17)$$

The equilibrium deposit rate is:

$$= \frac{(- 1)}{1+ 1}. \quad (18)$$

The deposit rate is positively correlated with the OCR, and negatively correlated with savings. The increase in savings is associated with lower deposit rate.

Next, we estimate the dynamics of the lending and deposit rates.

3. Estimating the dynamic of the equilibrium lending rate

We analyze the equilibrium lending rate over the sample from Mar 1999 to Jun 2020. Measurements and identifications of monetary policy shocks are highly controversial in the literature, see for example, Bernanke and Mihov (1998), Cochrane (1998), Baglino and Favero (1998), Rudebusch (1998), Christiano *et al.* (1999), Kuttner (2001), and Bernanke *et al.* (2005). Nonetheless, we only need to *summarize the dynamics* of OCR, lending rate, and a measure of household demand in order to make dynamic stochastic projections under a counterfactual

scenario of a negative OCR. Therefore, we use a standard VAR.[2] The VAR is given by the standard form

$$= \quad + \quad . \tag{19}$$

is (, ﷺ

2023 followed by periods of increasing rates. It steadily and slowly increases until it reaches 5.1 percent in Dec 2024.

3.2 Counterfactual projections of the lending rate under a negative OCR

The final step is to produce projections of the lending rate under a counterfactual scenario. We assume that the OCR was reduced in Mar 2020 to a negative 0.25 and it remained -0.25 in Jun 2020. We make no assumptions about the OCR after June 2020. Figure (4) displays the actual OCR and the negative OCR that we assumed for the counterfactual scenario. We re-estimate the VAR over the same sample from Mar 1999 to Jun 2020. The optimal number of lags is three. The residuals are serially uncorrelated.[8] Then the model is solved, and dynamic and stochastic projections for the period Sep 2020 to Dec 2024 are produced; the innovations were generated using 1000 Bootstraps.

Figure (5) plots the projections under this counterfactual negative OCR scenario and the standard error bands. The housing lending rate declines more under a negative OCR scenario relative to the baseline projections. Figure (6) plots the actual rate, the baseline projections, the projections under the counterfactual scenario and the deviations of the counterfactual projections from the baseline, which clearly shows that the lending rate falls significantly under the counterfactual scenario of a negative OCR.

Table (1) reports data of the actual housing lending rate, the baseline projections, the projections under the counterfactual scenario, and the deviations from the baseline. Under the counterfactual scenario of a negative OCR, the lending rate declines steadily from 3.35 percent, in Sep 2020, to 2.20 percent, in Dec 2024. On average over the projection horizon, the average of the house lending rate under the counterfactual scenario of a negative OCR is 2.39 percent. The average baseline projection of the lending rate is 4.15 percent. In addition, note that the projections of the lending rate under the counterfactual scenario of a negative OCR are significantly less volatile than the baseline projection. The standard deviations are 0.30 and 0.69 for counterfactual projections and the baseline projections respectively. We examined the business lending rate and

the average of the business lending rate and the housing lending rate with the real GDP output gap. The results are qualitatively similar.[9]

4. Estimating the dynamic of the deposit rate

Equation (18) predicts that ϕ_{π}, $\phi_{y} > 0$, and ϕ_{π}, $\phi_{y} < 0$. Figure (7) plots the *annual* deposit rate, aggregate national savings, and the OCR. We use *annual* data from 2000 to 2019 because the RBNZ reports annual savings only and the data are available to 2019. We use national savings because the savers include not only households, but also businesses, and the government; all have savings. Figure (7) shows that the correlations are consistent with the model.

We estimate a VAR for the OCR, aggregate savings, and the deposit rate using *annual* data from 2000 to 2019. The Information Criteria identifies three lags.[10] Figure (8) displays the generalized impulse response functions. Most important is that the deposit rate responds positively to the OCR and negatively to aggregate savings as predicted by equation (18). Then, we solve the model and produce a dynamic stochastic baseline projection, where the innovations were generated using 1000 bootstraps exactly like what we did for the lending rate.

4.1 Counterfactual projections of the deposit rate under a negative OCR

We estimate the VAR under the counterfactual scenario using the same methods as before, whereby the OCR turned unexpectedly -0.25 in 2019 and remained negative in 2020. The model is solved from 2021 to 2024 and the innovations were generated by 1000 bootstrapping. Table

above the deposit rate (3.4 percent). Under the counterfactual scenario that the OCR is -0.25, the averages of both the lending rate and the deposit rate over the projection's horizon fall to 2.39 and 2.02 percent respectively. Figure (9) plots the deviations of the deposit rate projection under the counterfactual scenario from the baseline projection, which is a negative steady decline over time.

The results of the above analysis of the housing lending rate and the deposit rate under a negative OCR indicate that both rates would fall. Over the projection horizon from 2020 to 2024, the lending rate falls by about 1.65 percent and the deposit rate by about 1.38 percent. On average and over the period 2020 to 2024, the deposit rate is projected to be lower than the lending rate by about 0.25 percent. However, it is unclear what would be the effect on bank profit because profit depends on interest and non-interest incomes and costs such as derivatives, trade, fees and commissions among more. Negative OCR is a monetary policy response to anticipated economic slowdown, which has adverse effects on equities, assets, derivatives, fees and commissions, etc. Next, we examine the bank profit data.

5. Profit, the global financial crisis and the following recession

The RBNZ reports *quarterly* time series data on bank income, expenses, and profit from June 1991. Table (4) describes the data. The OCR affects interest and non-interest incomes and costs differently. Figure (10) plots bank profit (before tax); it had a negative spike during the Great Recession that followed the Global Financial Crisis (GFC) in June-September 2009. Bank profit declined sharply even though bank income was positive in these two quarters; it was most clearly, related to a significant spike in the operating cost, which increased significantly by 54 percent and 37 percent in June and in Sep quarters respectively. During that recession, the output gap fell significantly, -2 percent and -1.7 percent. The RBNZ slashed the OCR. It remained, relatively, low until 2020. The OCR dropped from an average of 6.25 percent to 2.35 percent over the sub-samples from 1999 to 2008, and 2009 to 2020 respectively. The drop is very clear in figure (1). The lending rate kept falling for more than two quarters before and after the recession; it fell by 1.8 percent and 0.37 percent in these two quarters. The deposit rate, however, fell significantly by 0.30 percent in 2009 and by 3.2 percent in 2010.

Bank profit is mainly the sum of interest and non-interest incomes less interest and non-interest costs. The final effect of negative OCR on bank profit depends on the magnitudes of the various costs and incomes. During the 2009 recession, bank total cost increased (interest and non-interest costs) substantially while income (interest and non-interest income) remained unchanged, which

Table (6) reports descriptive statistics of bank profit components, in sample and the out-of-sample projections. In sample, we report statistics over two sub-samples, 1999 to 2008 and 2009 to 2020. The components of bank profit are (1) interest cost, (2) non-interest cost, (3) interest income, (4) non-interest income, (5) net interest income (income less cost), (6) net non-interest income (non-interest income less non-interest cost), impairment, and (7) profit (income less cost less impairment). Each column has two statistics, the average over the sample and the correlation of each of the profit components with the OCR. Note that banks were more profitable during the period from 2009 to 2020, when the OCR was relatively lower than the period from 1999 to 2008 when the OCR was high.

As the OCR declined significantly over time, bank profit increased. Lower OCR implied lower interest cost, and more lending (volume) – credit expansion as in Bernanke-Blinder (1988). More lending generated more income to banks; net interest income increased as a result. At the same time, lower OCR also led to higher asset prices. Non-interest income increased too but so did non-interest cost; however, the increase was not sufficient to offset the rise in income. Eventually profit increased from $920 million over the period 1999-2008 to 1,463 million over the period 2009 to 2020. The correlation coefficient of each of the profit components and OCR also changed over the two sub-samples; they become smaller. Four of these profit components' correlations with OCR changed signs over the two sub-samples.

The last three columns of table (6) report the descriptive statistics of the baseline projections and those of the projections under a counterfactual scenario of a negative 0.25 OCR. We produce the projections using these same methodology used earlier by fitting a VAR with six variables, OCR, and the components of profit, which are the interest income, non-interest income, interest cost, non-interest cost, and impairment. The sample is Mar 1999 to Jun 2020. We do not report the details but they are available on request.[11] The baseline projections are from Sep 2020 to Dec 2024. Then we re-estimate the VAR under a counterfactual scenario, whereby the OCR was negative 0.25 in Mar 2020 and June 2020. Then we made dynamic stochastic projections from Sep 2020 to Dec 2024 under this counterfactual scenario.

We tested a counterfactual scenario whereby the OCR is reduced to a negative 0.25 for two quarters. The projections of both, the lending rate and the deposit rate, over the period Sep 2020 to Dec 2024, declined on average. However, on average, the projected the lending rate is higher than the deposit rate.

Bank profit has five components; the interest and non-interest incomes, the interest and non-interest costs, and impairment residuals. There is a break in the OCR data. The average OCR from Mar 1999 to Dec 2008 was 6.25 percent. The OCR was reduced during the recession in June and September 2009 that followed the Global Financial Crisis. The average OCR for the period Mar 2009 to June 2020 is 2.24 percent. The components of bank profit also changed significantly after 2008, and the correlation with the OCR became relatively lower and changed signs. Bank profit increased steadily over the period of low OCR from 2009 to 2020. We also found that the OCR over the period from 2009 to 2020 to be less volatile than the period of high interest rate from 1999 to 2008, however, non-interest income, impairment, and bank profit were more volatile.

On average, a counterfactual scenario of negative 0.25 OCR predicts an increase in bank profit by $ 286 million, about 19 percent relative to baseline projections, because interest and non-interest incomes increase by $802 million and interest and non-interest costs and impairment increase by $516 million.

The growth rates of bank interest and non-interest incomes, costs, and profit during the period Mar to Jun 2020 are in a stark contrast to the growth rates during the period Mar to Dec 2009 after the GFC. Actual bank profit's growth rate was about 37.2 percent in 2009; so far in 2020, bank profit's growth rate is -13.7 percent. Most of the decline in bank profit is due to -50.6 percent growth rate of non-interest income. Non-interest income is investments, derivatives, trading, fees, and commissions, which have declined significantly due to the shutdown of the economy.

New Zealand Banks benefit from *looser* monetary policy and benefit more from negative OCR because lending activity increases significantly with the lending rate higher than deposit rate, and

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Table (1)

Housing Lending Rate Projections

Table (3)

The Average Lending and Deposit Projections over the Period 2020-2024

Baseline Projection		Counterfactual under negative OCR	
Lending Rate	Deposit Rate	Lending Rate	Deposit Rate
4.05	3.4	2.39	2.02

Table (4)

Bank Profit (A – B + C) – D*			
Total Income A – B + C			Non-interest cost
Net Interest Income A – B			
A	B	C	D
Interest Income	Interest Cost	Non-interest Income	Operating Cost
-Cash and deposits -Debt securities -Loans .Floating mortgages .Fixed mortgages .Business loans .Other loans -Derivative interest	-Deposits -Debt securities -Borrowing -Derivative interest	-Derivatives -Trading -Fees and commissions -Share of profit/loss of associates and joint ventures	-Fees and Commissions -Impairment -Individual provisions for losses on loans -Collective loan loss provisions -Debt right offs -Recoveries -Other

*The cost also includes “impairment.”

Table (5)

Average Growth Rates

	Interest income	Interest cost	Net interest income	Non interest income	Total operating income	Operating cost	Profit
2009	-6.16	-9.38	0.82	9.59	12.64	12.92	37.16
2020	-11.07	-17.77	-5.50	-50.57	-15.42	-5.60	-13.72

Note:

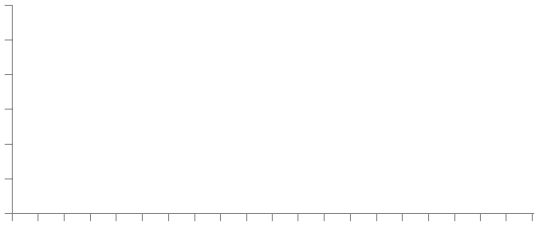
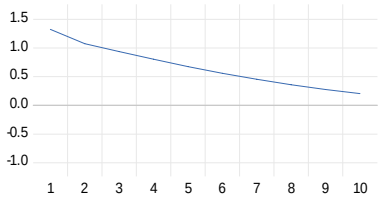


Figure (8)



Data Appendix

Variables	Definition	Source	Table	Frequency	
Housing Lending Rate	Floating first mortgage new customer housing rate	RBNZ	hb3	Quarterly	Average of monthly data
Business Lending Rate	SME new overdraft rate	RBNZ	hb3		
Average Lending Rate	Average of the above two rates				
OCR		RBNZ	hb2	Quarterly	Average of monthly data
Deposit Rate	The 6-month term deposit	RBNZ	hb3	Quarterly	
Real Disposable Income	Seasonally adjusted	Stats NZ		Quarterly	
Bank Profit Data		RBNZ	hs21	Quarterly	

[1]**ENDNOTES**

[1] In order to discourage banks from accumulating balances, the bank pays OCR less 100 bps on the settlement cash above a certain limit. This limit is reviewed monthly based on the bank's size and payment's business.

[2] Estimating an SVAR does not alter the results, therefore, we do not report the result. The results are available on request. The observed residuals have a covariance matrix $\sum(\ ')$. The structural VAR model is $=$, where is a matrix of unobserved shocks, which we want to identify. This matrix has an identity covariance matrix $\sum(\ ') =$. Different methods can be used to identify shocks, but the orthogonality of the shocks implies that the identifying restrictions on and are of the form $\sum\ ' = \ '$. Since the matrices on both sides of the equality sign are symmetrical, we have $(\ + 1)/2$ restrictions on the $2^{\ 2}$ unknown elements in and . To identify and , additional $2^{\ 2} - (\ + 1)/2$ identifying restrictions are needed. We use short-run restrictions on . These restrictions imply that the OCR is unaffected by the lending rate and disposable income and it is a function of its own past, disposable income is a function of its own past values and the OCR past values, and the lending rate depends on its own lags, disposable income lags, and OCR lags.

[3] We also used the business lending rate and then the average of the business and the housing lending rates, and the real GDP output gap instead of disposable income gap. The results are qualitatively similar, but the statistics differ