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Measuring the Effect of Negative Interest Rate on New Zealand Banks

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Abstract

We derive an equilibrium lending and deposit rates from a constrained profit optimization model, and estimate them over the period from 1999 to 2020. Then, dynamic stochastic baseline projections of these equilibrium rates and bank profit, and their projections under a counterfactual scenario of a negative interest rate, were produced for the period 2020 to 2024. The model predicts that a negative Official Cash Rate (OCR) lowers the lending and deposit rates *on average* over the period Jun 2020 to Dec 2024; but the lending rate is higher than the deposit rate. It also increases the volatility of these rates relative to baseline projections. Negative OCR increases both incomes and costs; however, bank profit increases o*n average*, by about 19 percent relative to baseline projections over the period Sep 2020 to Dec 2024. However, that increase of bank profit is associated with more uncertainty.

Keywords: Lending rate, deposit rate, bank profit, negative interest rate
JEL Classification numbers: C15, C51, G21

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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. Razzak and Moosa, 2016) and reduce the cost of funds (e.g. reduce the interest rate on deposits). Together, these changes, depending on the relative magnitudes, affect bank income and profit.

Madaschi and Nuevo (2017) is a study of Sweden and Denmark banking systems. Both countries' banks have been operating under a negative interest rate for some time. They show that bank profit remained stable during the Great Recession period (the period that followed the Global Financial Crisis in 2007-2008). Banks in both countries have positive lending rates, but Sweden's banks have paid depositors negative rates while the Danish banks kept it at zero. For Sweden, the average repo rate from January 2018 to-date has been negative -0.35, the lending rate averaged 0.40, however, the deposit rate average has been -0.98. The deposit rate has been reduced well below the repo rate while the lending rate was positive. For Denmark, the average end-of-month policy rate since 2018 has been zero, the deposit rate is zero, and the lending rate is 0.05.

Jobst and Lin (2016) use a DSGE model to study the effect of negative interest rate in the EU area on bank profitability. They found that such monetary policy, which lowers bank funding 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 D_t from households, firms, and the government to make loans $L_t$to firms and households. The interest paid on deposits is $r_t^d$and the lending rate is r_t^l. Banks receive interest r_t^{ocr} on the deposits D_t^s in the Settlement Cash account held at the RBNZ. r_t^{ocr} is the OCR.[1] Banks can invest in bonds $B_t$or other financial products in the money and bond markets and obtain returns. We assume that the money and bond markets are one market for simplicity.

The representative bank maximizes profit, which is, total revenues less total cost. The profit function is:

$$\Pi_t = \{r_t^l L_t + r_t^{ocr} D_{t,}^s + r_t^b B_t + r_t^n NP_t - r_t^d D_t - c(.)\}. \qquad (1)$$

Π_t is bank profit. r_t^l is the lending rate. $L_t$is the quantity of loans of the bank. D_t^s is the Settlement Cash Balance at the RB, which is paid r_t^{ocr}, $r_t^b$is the interest rate on bonds. $B_t$the RB bonds held by the bank and $r_t^d$is the deposit rate paid by the bank and D_t is bank deposit. NP_t is the bank net position of the bank in the money and bond market, whereby banks invest in these markets, and $r_t^n$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:

$$NP_t = D_t - L_t - D_t^s - B_t. \tag{2}$$

We specify a simple quadratic cost function.

$$c_t = \frac{1}{2}(\alpha_1 D_t^2 + \alpha_2 L_t^2) . \tag{3}$$

The parameters $\alpha_1$and $\alpha_2$are positive marginal costs of deposits and loans. Substitute both (2) and (3) in (1)

The bank maximizes Π_t

$$\Pi_t = \underbrace{max}_{L_t, D_t^s, D_t, B_t} \left\{ r_t^l L_t + r_t^{ocr} D_{t,}^s + r_t^b B_t + r_t^n (D_t - L_t - D_t^s - B_t) - r_t^d D_t - \frac{1}{2}(\alpha_1 D_t^2 + \alpha_2 L_t^2) \right\},$$

(4)

subject to a constraint. The constraint is on the capital/asset ratio. We write this constraint as$\frac{K_t}{A_t} = \theta$. The assets, $A_t = L_t + x_t$, where $L_t$is loans and $x_t$is all the rest of the bank assets. For convenience, we rewrite the constraint $\lambda(L_t - \frac{\theta x_t - K_t}{\theta})$, where λ is the Lagrange multiplier.

Solve for the First Order Conditions (FOC).

FOC for $L_t \rightarrow$, $r_t^l - r_t^n - \alpha_2 L_t + \lambda = 0$, (5)

FOC for $D_t^s \rightarrow r_t^{ocr} - r_t^n = 0$ (6)

FOC for $D_t \rightarrow -r_t^d - \alpha_1 D_t + r_t^n = 0$ (7)

FOC for $B_t \rightarrow r_t^b - r_t^n = 0$ (8)

So from (6), the OCR, $r_t^{ocr}$is equal to the risk-free money market rate r_t^n.

From (5),

$$r_t^l = r_t^n + \alpha_2 L_t - \lambda. \tag{9}$$

We replace the risk-free market interest rate r_t^n with the OCR r_t^{ocr} and rewrite equation (9):

$$r_t^l = r_t^{ocr} + \alpha_2 L_t - \lambda \tag{10}$$

Therefore, the optimal supply of loans is:

$$L_t^s = \frac{r_t^l - r_t^{ocr} + \lambda}{\alpha_2} \tag{11}$$

We postulate the demand for loans to be negatively related to the lending rate and positively to demand.

$$L_t^d = \beta \tilde{y}_t - \gamma r_t^l , \tag{12}$$

Equate the supply and the demand and solve for the lending rate.

$$\frac{r_t^l - r_t^{ocr} + \lambda}{\alpha_2} = \beta \tilde{y}_t - \gamma r_t^l ; \tag{13}$$

$$r_t^l - r_t^{ocr} + \lambda = \alpha_2 \beta \tilde{y}_t - \alpha_2 \gamma r_t^l . \tag{14}$$

The optimal (equilibrium) lending rate is:

$$r_t^l = \frac{r_t^{ocr} + \alpha_2 \beta \tilde{y}_t - \lambda}{1 + \alpha_2 \gamma} . \tag{15}$$

Thus, $cov(r_t^l, r_t^{ocr}) > 0$ and $cov(r_t^l, y_t) > 0$, i.e., the lending rate is positively correlated with the OCR, and with income.

Similarly, we could derive the equilibrium deposit rate as a positive function of r_t^{ocr} and a negative function of aggregate saving.

From (7),

$$D_t^d = \frac{r_t^{ocr} - r_t^d}{\alpha_1}. \tag{16}$$

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

$$D_t^s = \phi S_t + \varphi r_t^d. \tag{17}$$

The equilibrium deposit rate is:

$$r_t^d = \frac{(r_t^{ocr} - \alpha_1 \phi S_t)}{1 + \alpha_1 \varphi}. \tag{18}$$

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

$$Y_t = BZ_t + \epsilon_t \ . \tag{19}$$

Y is $(r_t^{ocr}, \ \tilde{y}_t, \ r_t^l)$; ϵ is $(\epsilon_{1t}, \ \epsilon_{2t}, \ \epsilon_{3t})$ both are matrices of the endogenous variables are the innovations. The matrices $B = (A_1, \ A_2, \ A_3, constant)$ and $Z = (Z_{1t}, \ Z_{2t}, \ Z_{3t})$ are the matrix of coefficients and matrix of regressors respectively.

The RBNZ reports two lending rates; a business lending rate and a housing lending rate. Here we report our analysis of the housing lending rate r_t^l as a measure of the lending rate. Because we use the house lending rate instead of the business lending rate, it seems more appropriate to use household disposable income gap than the output gap to measure demand, $\tilde{y}_t$.[3]

Figure (1) plots the three variables of the VAR, the OCR, the disposable income gap, and the housing lending rate (we also plot the business lending rate to show how closely correlated it is to the housing lending rate). The VAR is estimated for New Zealand using quarterly data from March 1999 to Jun 2020.[4] The VAR includes a constant term. We fit three lags.[5] Figure (2) plots the *generalized* impulse response functions, Pesaran and Yongcheol (1998).[6] The standard errors of these impulse response functions are computed using a Monte Carlo with 1000 repetitions. The responses are consistent with the theory predicted by equation (15). The third row shows that the lending rate is highly positively responsive to the OCR and income.

3.1 Baseline projections of the lending rate

The next step is to produce a baseline dynamic stochastic projection of the lending rate for the period from Sep 2020 to Dec 2024. This end date is arbitrary. The model is solved and dynamic and stochastic projections are produced, whereby the innovations are generated using bootstrapping with 1000 iterations over the period Mar 1999 to June 2020.[7] Figure (3) plots the dynamics of the baseline projections. The projections show periods of slow decline until Mar

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 $cov(r_t^d, r_t^{ocr}) > 0$, and $cov(r_t^d, S_t) < 0$. 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 (2) reports the actual deposit rate, the mean dynamic stochastic baseline projection, and then the mean dynamic stochastic projections under the counterfactual scenario, followed by the deviations from the baseline. The projections of the deposit rate under the counterfactual scenario declined significantly, and turned negative in 2023 and 2024.

Table (3) compares the average baseline projections of the lending and deposit rates, and the mean of the projection scenarios. Under the baseline projection, the lending rate (4.05 percent) is 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 resulted in a sharp decline in bank profit in those two quarters. However, despite this downward spike, the overall trend of bank profit from 1999 to 2020 has been positive. The RBNZ reduced the OCR from 1 percent to 0.25 percent in Mar 2020 in response to COVID-19, and it is expected to make the OCR negative in Mar 2021 or even earlier.

Figure (11) plots the total interest income, total interest cost (or expense), and the net interest income. Note that interest income and expenses grew significantly over time and peaked in Dec 2008, during the GFC, then fell sharply in March 2009. They are also highly correlated. After Dec 2008, interest income fluctuated slightly, but remained almost unchanged while interest expense declined a little and the difference between interest income and expense (the net interest income) increased over time.

Table (5) compares the banking system outcomes for the period Mar 2009 – Dec 2009, i.e., the recession that followed the GFC with Mar 2020 – June 2020, i.e., the lockdown response to COVID-19. We show that the negative impact of the lockdown on bank profit has been very substantial compared with the effects of the recession in 2009. We report the average growth rates over the period Mar 2009 to Dec 2009 and over the first two quarters in 2020, March and June. The average growth rate of interest income fell sharply in the past two quarters compared to 2009, -11 percent compared with -6 percent. The interest cost average growth rate fell more during the pandemic compared with 2009; -17.7 percent compared with -9.4 percent. Net interest-income growth rate declined significantly. The average growth rate of non-interest income is -50.6 percent in 2020; it was +9.6 percent in 2009. These are clearly significant differences and the decline in the growth rate reflects the lockdown of the economy. Essentially, total operating bank income growth rate is -15.4 percent in 2020 compared with +12.6 percent in 2009. Bank profit before tax growth rate in 2020 is -13.7 percent; it was +37 percent in 2009. Bank profit went down significantly. Would bank profit recover if the OCR were negative?

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.

The baseline projection of bank profit shows declines then increases, but on average over the projection horizon, profit increases by 4.6 percent relative to actual profit (Mar 2009 to Jun 2020), from OR 1,463 million to OR 1,530. The projection under the counterfactual scenario of a negative 0.25 OCR increases to OR 1,816 million, which is 24 percent higher than actual on average. However, *on average over the projection horizon from Sep 2020 to Dec 2024*, the *deviations* of bank profit projections under the counterfactual scenario of a negative OCR of 0.25 from the baseline are +$286 million, a 19 percent increase. Most of the projected increase in bank profit under the counterfactual scenario of negative OCR comes from the projected increase in bank interest income; it increases by $784 million. Non-interest income projections also increase by $18 million. Costs also increase under the counterfactual scenario, but by less than the incomes. The interest cost increases by $445 million and the non-interest cost increases by $73 million. Impairments decline by $2 million. Therefore, total income projected to be $802 million and total costs $516 million. Figure (12) plots the actual profit, the baseline profit projections, and the projections under the negative OCR scenario.

Therefore, bank profit is projected to increase under a negative OCR. However, there is a trade-off for this increase in bank profit. The increase in profit is associated with more uncertainty. For the period from 2009 to 2020, where the average OCR was relatively low, Bank profit, non-interest income, non-interest income, and impairment became more uncertain.[12] For the projection period 2020 to 2024, interest income, non-interest income, and interest costs projections under the counterfactual scenario of a negative OCR are more volatile compared with the baseline projections.[13] So, while banks may benefit from higher income from interest and non-interest operations their incomes become more uncertain under a negative OCR.

6. Conclusions

We analyzed the lending and deposit rates and bank profit in New Zealand for the period from Mar 1999 to Jun 2020. An equilibrium lending and deposit rate was derived from a constrained profit maximization problem, and estimated using a VAR method. The model predicts that the official Reserve Bank interest rate, the OCR, which is the rate, paid nightly to the Settlement Cash Accounts at the Reserve Bank, is correlated positively with the lending, and deposit rates.

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 net interest income increases. Non-interest income component of bank profit, which is the income from derivatives, trading, fees, commissions etc also predicted to increase under negative OCR scenario, however, becomes more uncertain compared with the baseline projection. Therefore, there is a trade-off. Instability of bank income increases in the long run as OCR becomes more negative.

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Table (1)

Housing Lending Rate Projections

	Actual	Baseline	Counterfactual	Deviations
Jun-20	4.43			
Sep-20		3.71	3.35	-0.36
Dec-20		3.47	2.91	-0.56
Mar-21		3.31	2.56	-0.75
Jun-21		3.20	2.35	-0.85
Sep-21		3.22	2.21	-1.00
Dec-21		3.36	2.19	-1.17
Mar-22		3.61	2.23	-1.37
Jun-22		3.89	2.31	-1.58
Sep-22		4.14	2.38	-1.77
Dec-22		4.34	2.40	-1.93
Mar-23		4.48	2.41	-2.07
Jun-23		4.58	2.37	-2.21
Sep-23		4.67	2.30	-2.37
Dec-23		4.75	2.26	-2.49
Mar-24		4.84	2.21	-2.63
Jun-24		4.95	2.20	-2.75
Sep-24		5.05	2.19	-2.86
Dec-24		5.16	2.20	-2.96
Average		4.15	2.39	
STD		0.69	0.30	

Note: The counterfactual is the projections under the assumption that the OCR was negative -0.25 in Mar and June 2020.

Table (2)

Deposit Rate Projections

	Actual	Baseline	Counterfactual	Deviations from Baseline
2020	2.95	3.01	2.37	-0.64
2021		3.19	2.11	-1.09
2022		3.41	1.99	-1.42
2023		3.58	1.86	-1.72
2024		3.72	1.75	-1.97
Average		3.38	2.02	
STD		0.29	0.24	

Note: The counterfactual assumes the OCR to be -0.25 in 2020.

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	-Deposits	-Derivatives	-Fees and Commissions
-Debt securities	-Debt securities	-Trading	-Impairment
-Loans	-Borrowing	-Fees and commissions	-Individual provisions for losses on loans
.Floating mortgages	-Derivative interest	-Share of profit/loss of associates and joint ventures	-Collective loan loss provisions
.Fixed mortgages			-Debt right offs
.Business loans			-Recoveries
.Other loans			-Other
-Derivative interest			

*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: The average growth rate from Mar 2009 to Dec 20029 and the average growth rate of Mar and Jun 2020.

Table (6)

Descriptive statistics of bank profit components in three different periods

	Average 99-08	Correlation With OCR	Average 09-20	Correlation With OCR	Average Baseline 20-24	Average Counterfactual 20-24	Deviations From baseline
1. Interest Income	4,220	0.87	5,341	0.16	4,533	5,317	784
2.Non-interest Income	619	0.63	715	-0.18	839	857	18
3.Interest Cost	2,964	0.88	3,087	0.75	2,144	2,589	445
4.Non-interest Cost	880	0.60	1,320	-0.45	1,513	1,586	73
5.Impairment	74	0.11	185	-0.16	184	182	-2
6.Profit	920	0.73	1,463	-0.19	1,530	1,816	286

Notes: 1. Profit is 4+5-2-3-8; Net interest income is 4-2; Net non-interest income is 5-3.

2. The data are quarterly. The samples correspond to Mar 1999 to Dec 2008; Mar 2009 to Jun 2020; and Sep 2020 to Dec 2024.

3. Averages are in millions of NZ dollars.

4. Counterfactual is a scenario, whereby the OCR is -0.25 in Dec 2019 and Jun 2020.

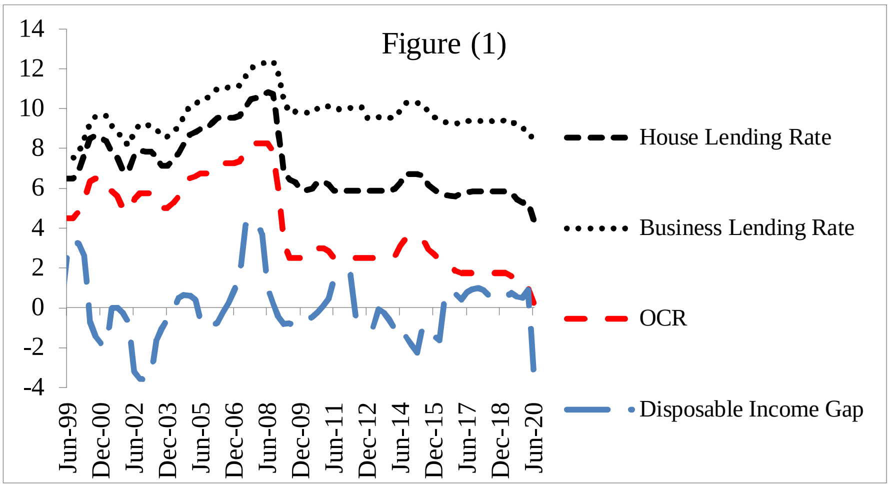
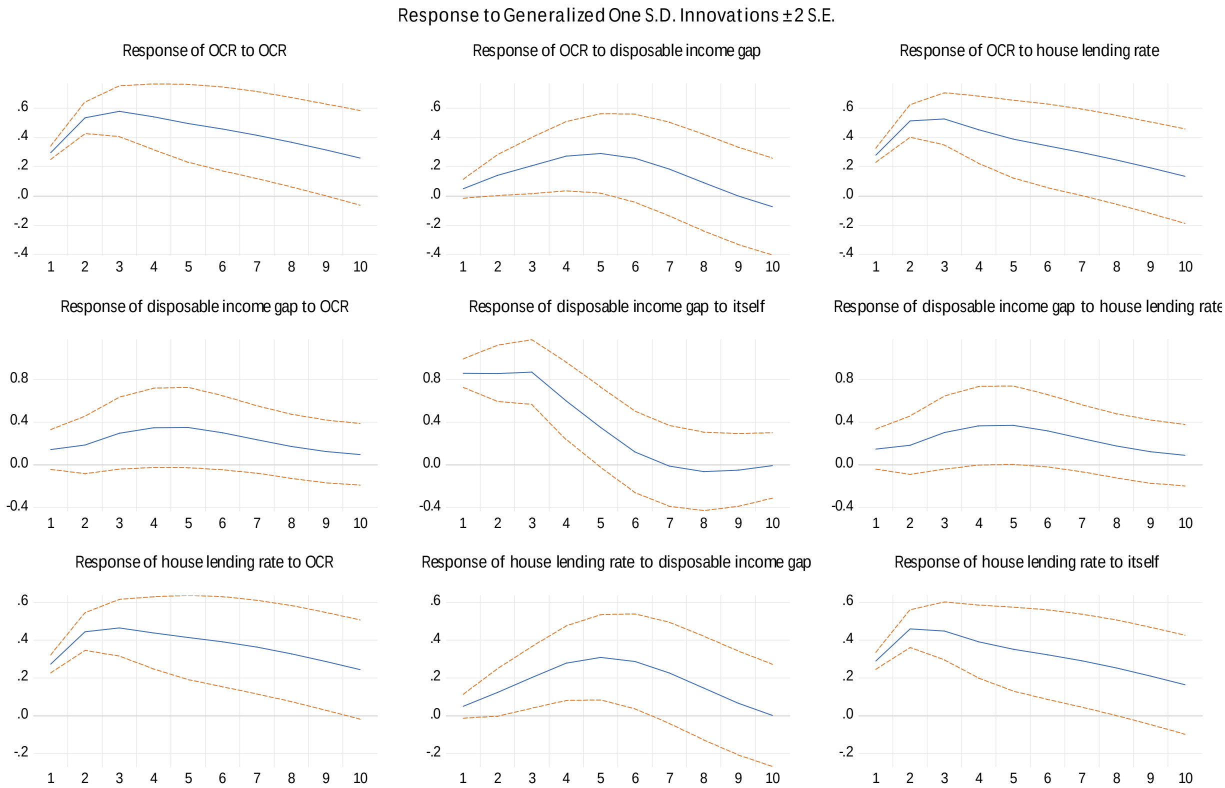


Figure (1)
House Lending Rate
Business Lending Rate
OCR
Disposable Income Gap
14
12
10
8
6
4
2
0
-2
-4
Jun-99
Dec-00
Jun-02
Dec-03
Jun-05
Dec-06
Jun-08
Dec-09
Jun-11
Dec-12
Jun-14
Dec-15
Jun-17
Dec-18
Jun-20

Figure (2)


Response to Generalized One S.D. Innovations ± 2 S.E.
Response of OCR to OCR
Response of OCR to disposable income gap
Response of OCR to house lending rate
Response of disposable income gap to OCR
Response of disposable income gap to itself
Response of disposable income gap to house lending rate
Response of house lending rate to OCR
Response of house lending rate to disposable income gap
Response of house lending rate to itself

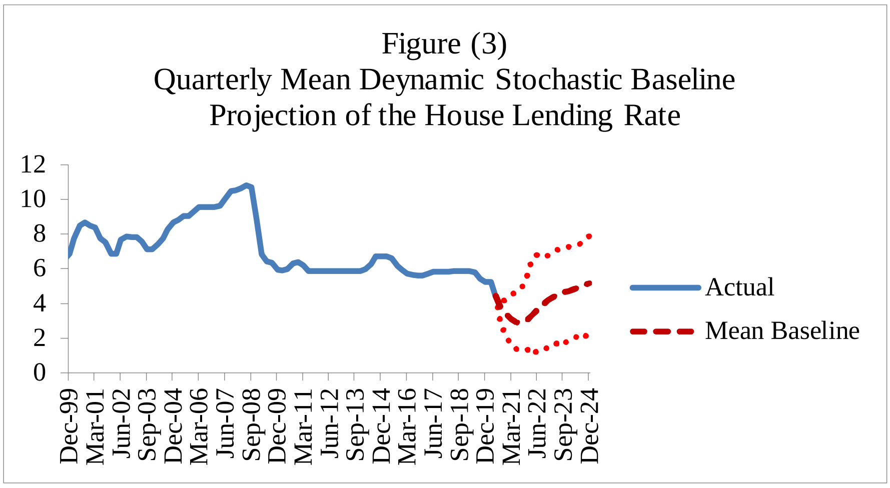


Figure (3)
Quarterly Mean Deynamic Stochastic Baseline
Projection of the House Lending Rate
12
10
8
6
4
2
0
Dec-99
Mar-01
Jun-02
Sep-03
Dec-04
Mar-06
Jun-07
Sep-08
Dec-09
Mar-11
Jun-12
Sep-13
Dec-14
Mar-16
Jun-17
Sep-18
Dec-19
Mar-21
Jun-22
Sep-23
Dec-24
Actual
Mean Baseline

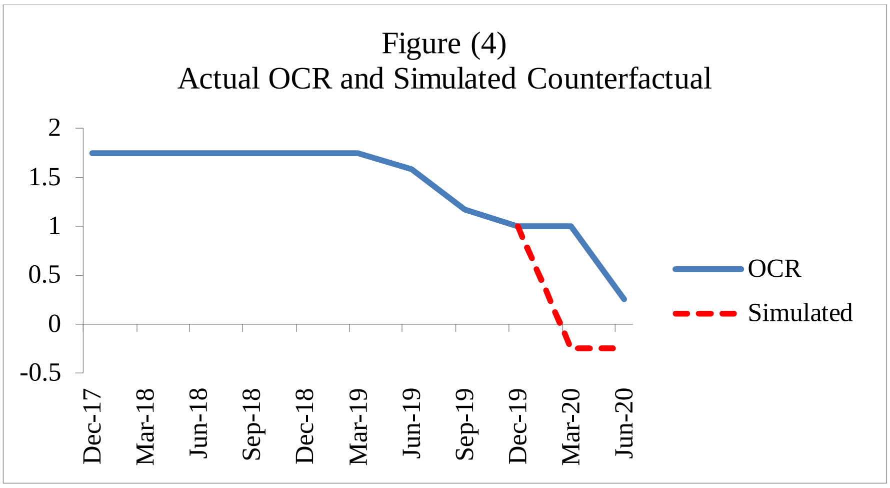


Figure (4)
Actual OCR and Simulated Counterfactual
2
1.5
1
0.5
0
-0.5
Dec-17
Mar-18
Jun-18
Sep-18
Dec-18
Mar-19
Jun-19
Sep-19
Dec-19
Mar-20
Jun-20
OCR
Simulated

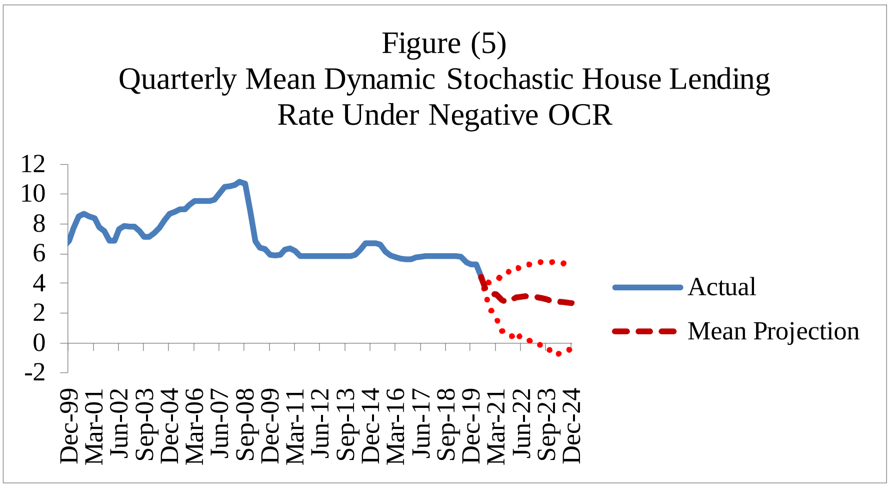


Figure (5)
Quarterly Mean Dynamic Stochastic House Lending
Rate Under Negative OCR
12
10
8
6
4
2
0
-2
Dec-99
Mar-01
Jun-02
Sep-03
Dec-04
Mar-06
Jun-07
Sep-08
Dec-09
Mar-11
Jun-12
Sep-13
Dec-14
Mar-16
Jun-17
Sep-18
Dec-19
Mar-21
Jun-22
Sep-23
Dec-24
Actual
Mean Projection

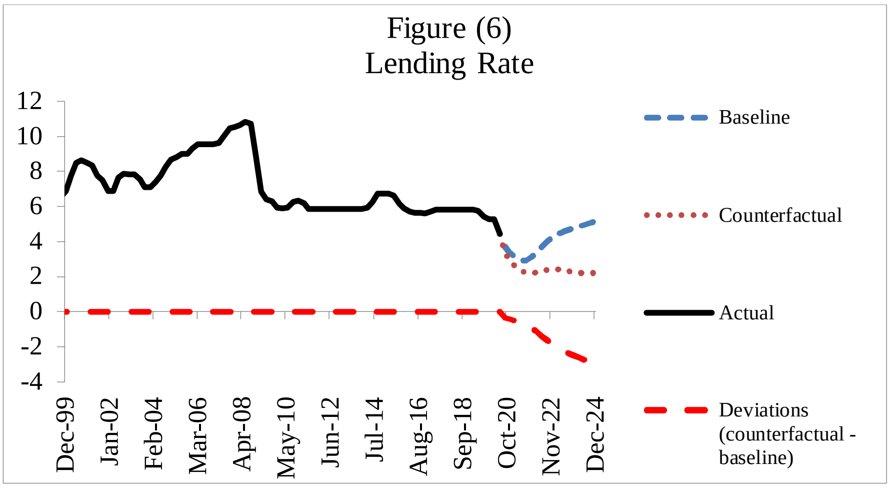


Figure (6)
Lending Rate
Baseline
Counterfactual
Actual
Deviations (counterfactual - baseline)
12
10
8
6
4
2
0
-2
-4
Dec-99
Jan-02
Feb-04
Mar-06
Apr-08
May-10
Jun-12
Jul-14
Aug-16
Sep-18
Oct-20
Nov-22
Dec-24

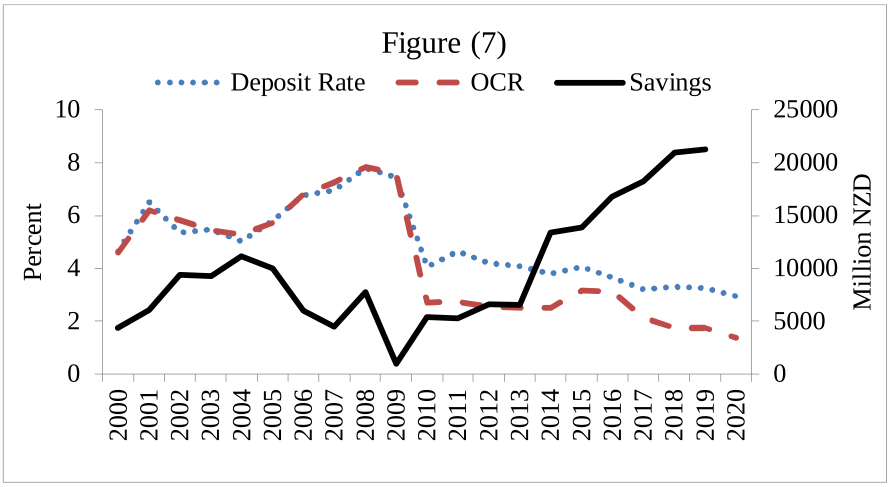


Figure (7)
Deposit Rate
OCR
Savings
Percent
Million NZD
10
8
6
4
2
0
25000
20000
15000
10000
5000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

Figure (8)

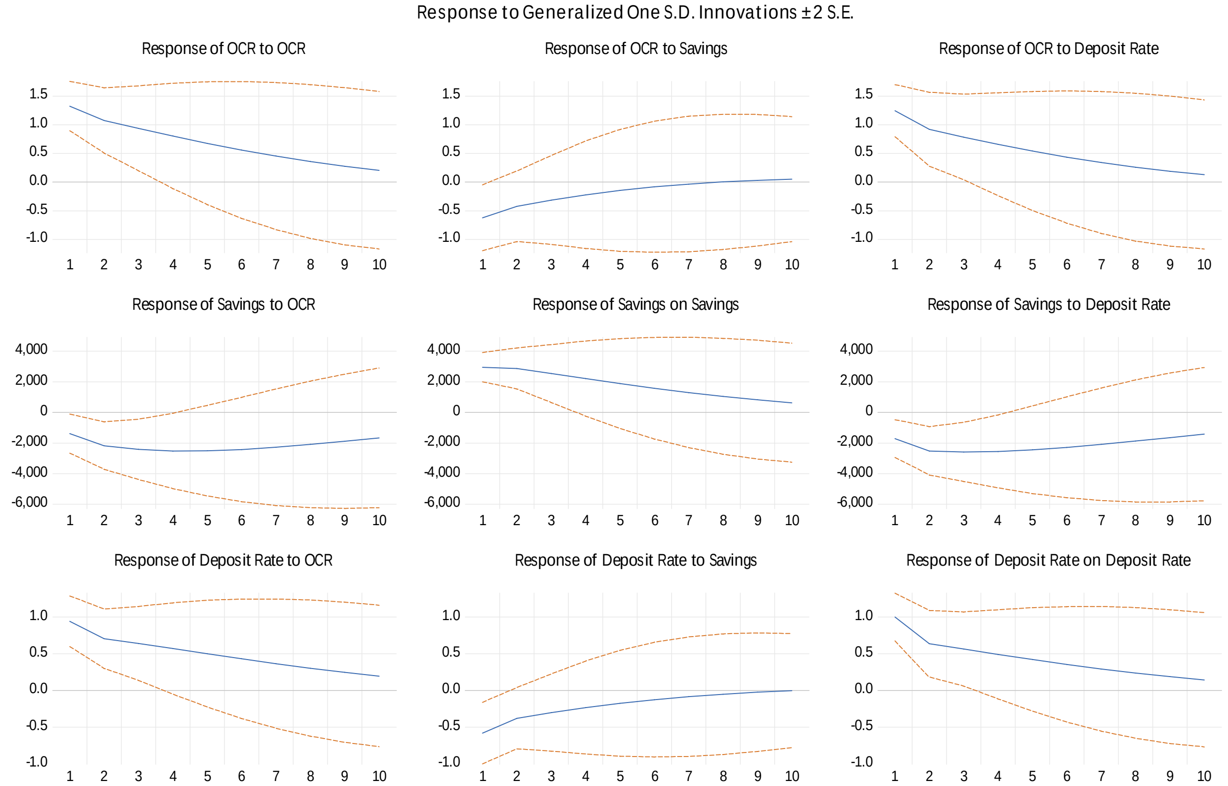
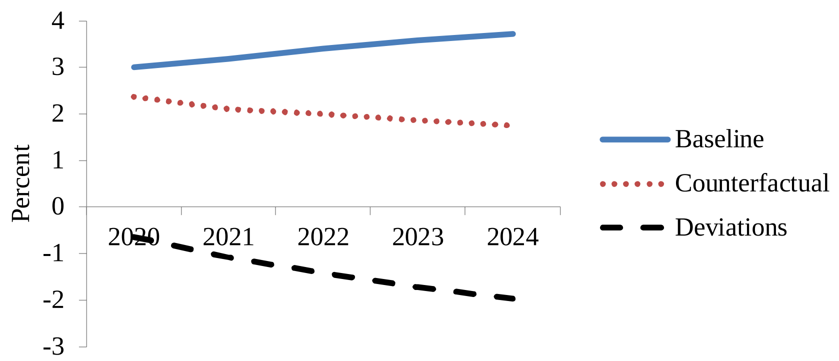


Figure (9)
Deposit Rate Projections



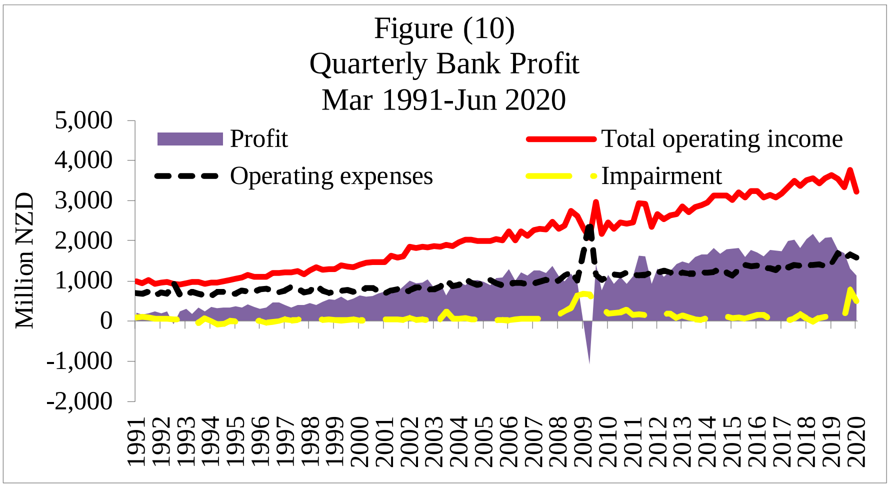


Figure (10)
Quarterly Bank Profit
Mar 1991-Jun 2020
Profit
Total operating income
Operating expenses
Impairment
Million NZD
5,000
4,000
3,000
2,000
1,000
0
-1,000
-2,000
1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

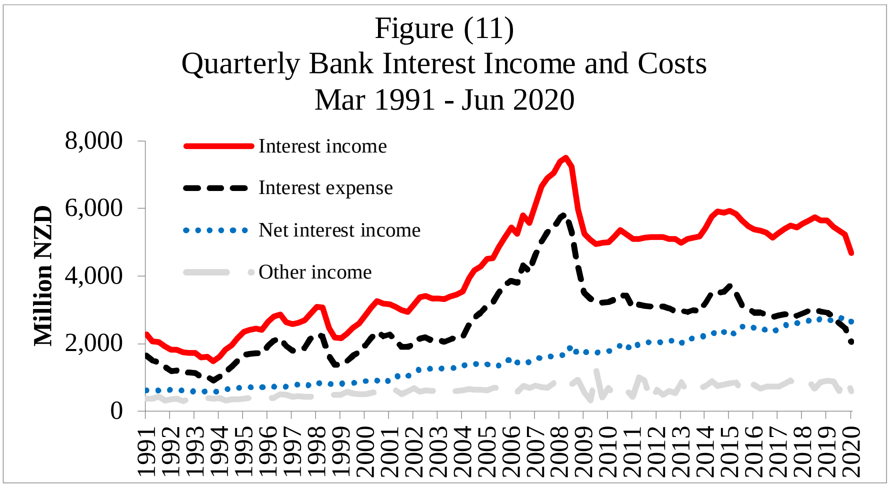


Figure (11)
Quarterly Bank Interest Income and Costs
Mar 1991 - Jun 2020
Interest income
Interest expense
Net interest income
Other income
Million NZD
8,000
6,000
4,000
2,000
0
1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

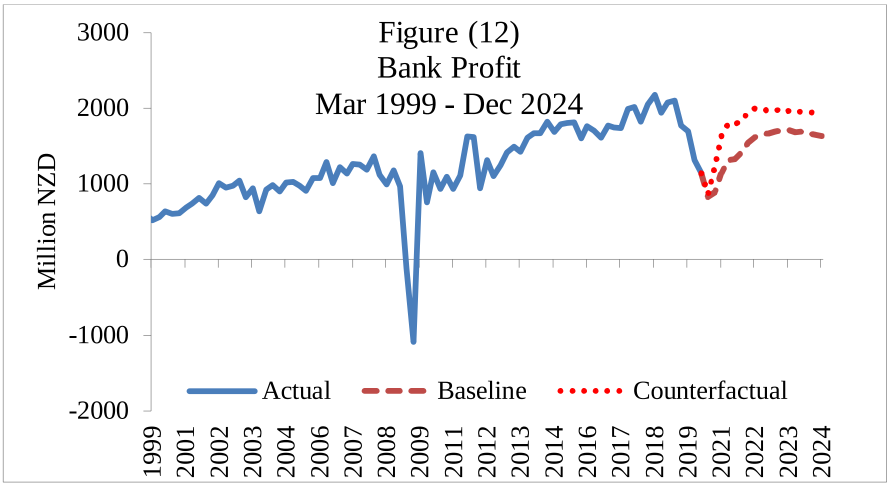


Figure (12)
Bank Profit
Mar 1999 - Dec 2024
Million NZD
3000
2000
1000
0
-1000
-2000
Actual
Baseline
Counterfactual
1999 2001 2002 2003 2004 2006 2007 2008 2009 2011 2012 2013 2014 2016 2017 2018 2019 2021 2022 2023 2024

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 e_t have a covariance matrix $\sum(ee')$. The structural VAR model is $Ae_t = Bu_t$, where u_t is a matrix of unobserved shocks, which we want to identify. This matrix has an identity covariance matrix $\sum(uu') = I$. Different methods can be used to identify shocks, but the orthogonality of the shocks implies that the identifying restrictions on A and B are of the form $A\sum A' = BB'$. Since the matrices on both sides of the equality sign are symmetrical, we have $k(k+1)/2$ restrictions on the $2k^2$ unknown elements in A and B. To identify A and B, additional $2k^2 - (k+1)/2$ identifying restrictions are needed. We use short-run restrictions on B. 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

slightly. We do not report these results but they are available on request. The HP filter is used to de-trend the real disposable income.

[4] The standard Dickey-Fuller test for unit root is a weak test against stationary alternative, however, we adjust the test for a break in the data, especially during the Global Financial Crisis, and we could easily reject the null hypothesis of a unit root in interest rates. For the disposable income gap is stationary by design.

[5] The VAR satisfies the stability conditions with all roots are inside the unit circle. The *joint* Wald statistic for lag-exclusion test has p-values of 0.0000, 0.0001, and 0.0211 for lags 1 to 3. The AIC, SC, and HQ Information Criteria to determine the lag structure suggested three lags. The residuals are tested for serial correlation using the LM test. The null hypothesis that the residuals are serially uncorrelated at lag 1, 2, and 3 cannot be rejected. The P values are 0.0771, 0.0611, and 0.2939 respectively. When testing the null hypothesis of no serial correlation at lag 1 to 3, the P values of the Edgeworth expansion corrected likelihood ratio statistic are 0.0771, 0.2162, and 0.0501 respectively. The F statistics in equations (1 to 3) are highly statistically significant.

[6] The order of the variables does not seem to matter. We tested that and found that the impulse response functions to be the same.

[7] Dynamic Stochastic solution of the model has been used before in the literature to deal with the Lucas critique. When solving, we use an approximated Jacobian to linearize the model. Then the approximation is updated each iteration by comparing the residuals, which result from the new trial value of the endogenous variables with the residuals of the linear equation. The method is not significantly different from Newton, but it runs faster. We generate the innovations to the stochastic equations by drawing a set of random shocks from a standard normal distribution each period. To match the variance-covariance system, we scale these draws by multiplying the vector by its standard deviation because the covariance matrix is diagonal.

[8] We do not report the statistics to save space, but they are available on request.

[9] We do not report the results to save space, but they are available on request.

[10] The VAR satisfies the stability condition. The Fstatistics for equations 1, 2, and 3 are 10.72619, 18.08870, and 8.171596. The LM test of the residuals has a P value of 0.5231. The null hypothesis of no serial correlation cannot be rejected. The residuals are multivariate normal in equations 2 and 3, but not in equation (1) of the OCR.

[11] The VAR has two lags according to the same Information Criteria we used earlier. The residuals are white noise and serially uncorrelated as indicated by the LM test. The P-values for lags 1, 2, and 3 were 0.1146, 0.4724, and 0.8103 respectively. The F tests for all equations were significantly different from zero.

[12] We test the hypothesis that variance for the sub-sample 2009-2020 is equal to the variance for the sub-sample 1999-2008 using the statistic $F_{40,45} = {S_1^2}/{S_2^2}$, where$S_1^2$is the sample variance over the period 2009-2020, where the OCR was declining, and S_2^2 is the sample variance over the period 1999-2008 where the OCR was relatively higher. These ratios (P-value) are: interest income 0.03615 (1), non-interest income 5.07 (0.0000), interest cost 0.07 (1), non-interest cost 3.6 (0.0000), impairment 6.8 (0.0000), and profit 6.0 (0.0000). The hypothesis that the variances are equal across the two samples is rejected except in the cases of interest income and interest cost.

[13] We test the hypothesis that variance under the counterfactual scenario is equal to the variance under the baseline, against the alternative that it is larger by computing the statistic $F = {S_1^2}/{S_2^2}$, where$S_1^2$is the sample variance of each component under the counterfactual scenario of negative OCR, and S_2^2 is the sample variance under baseline. The F stats (P values) are: 3.0 (0.01118), 2.8 (0.0174), 2.2 (0.0523), 0.65 (0.8101), 0.50 (0.9193), and 1.13 (0.3946) for interest income, non-interest income, interest cost, non-interest cost, impairment, and profit respectively. There is evidence of increased volatility under the counterfactual scenario of negative OCR, especially in interest income, non-interest income, and interest cost.