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Evaluating the drivers of New Zealand's natural interest rate using an overlapping generations model

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Friday 7th March 2025

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Key Objectives

- Develop a small open economy overlapping-generations model to better understand the natural rate of interest in New Zealand.
 - Understand the probable **size** of various domestic & international drivers of the natural rate.
- Use a general equilibrium framework to analyse the overall importance of adjustment mechanisms that have complex feedback loops.
- Identify places where the “everyday intuition” of simple models is inadequate to describe real data.



Progress

Long-run Equilibrium *(this paper)*

- A decomposition of the relative importance of six different driving factors of the natural interest rate in the long run.
 - We estimate the long-run return to capital (or natural rate of interest) when driving factors persist indefinitely.
 - We calculate features of the corresponding long-run “natural economy” associated with different natural interest rates.
 - We focus on the level of capital.

Transition Paths *(ongoing work)*

- Calculate transition paths to the long-run natural economy.
- We assess capacity pressures along the transition path to relate the natural rate of interest to the neutral rate of interest.
- We explore the role of agent expectations in determining the transition path.
- A decomposition of the relative importance of different driving factors of the natural rate of interest in the short run.



Questions and Modelling Choices

**Small open economy
with international
capital flows**

**OLG converts
demographics
to savings**

What is the role of
the world natural
rate of interest?

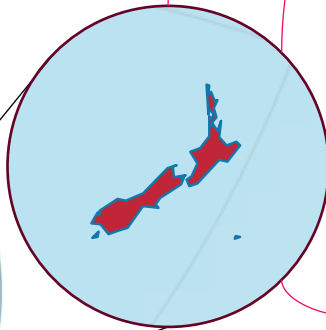
What are the role of
demographic changes?

Is changing old-age labour
force participation important?

What are the role of
government debt, taxes
and pensions?

What is the role of
labour productivity
and investment?

**Investment, savings and
interest rates
simultaneously determined**



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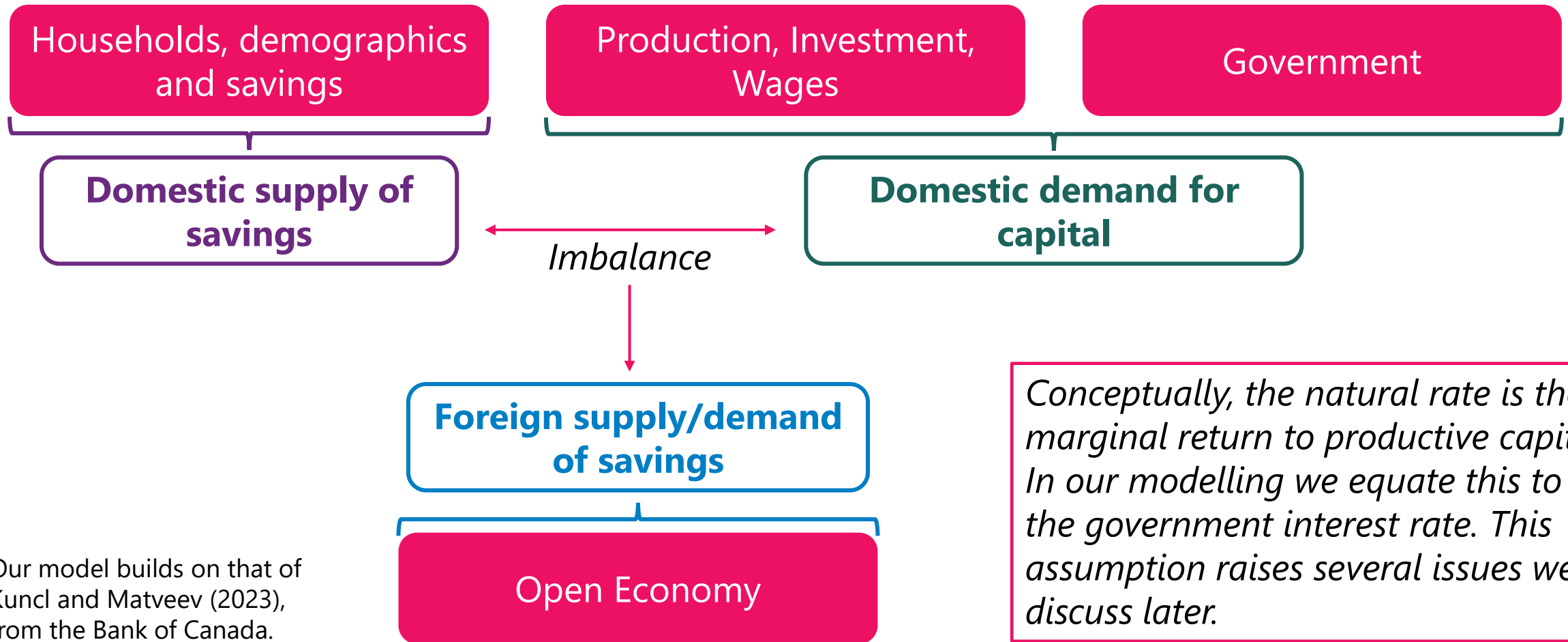


Key Findings

- We find most the important factors driving the natural rate of interest over recent decades, accounting for feedback loops, include domestic **labour productivity growth** and **population growth** and **the world natural rate**.
- We identify several areas where further understanding is needed, including:
 - *The impact of allowing for wedge between return to safe and risky capital.*
 - *The determinants of the New Zealand interest rate premium relative to world rates.*



1.1. The Model



Our model builds on that of Kuncil and Matveev (2023), from the Bank of Canada.

Conceptually, the natural rate is the marginal return to productive capital. In our modelling we equate this to the government interest rate. This assumption raises several issues we discuss later.



1.2. Households, Demographics and Savings

- Sixteen cohorts of households, representing ages 20-24, 25-29, and so on, up to 95-99.
- The demographic profile determined by “birth rates” and survival probabilities.
 - Birth rates of the first cohort captures net migration.
 - *We vary the **birth rate** and **survival probabilities** consistent with the New Zealand data to study the effects of population growth, and increasing longevity in the model, respectively.*
- Working-age households have inelastic labour supply; the participation rate of old-age households is set exogenously.
 - *We vary the **old-age participation rate** consistent with the New Zealand data to study the effects of rising old-age participation in the model.*
- Heterogeneity in household types, with differences in labour productivity and earnings.
- Optimal savings...
 - Assumes forward-looking consumption smoothing behaviour, with borrowing constraints
 - Anticipates government pension.
 - Anticipates receipt of bequests middle of life, and faces incentives to leave bequests at end of life.



1.3. Production, Investment and Wages

- A representative firm with a Cobb-Douglas production function.
- Perfectly competitive labour and capital markets.
- Labour-augmenting technological progress, varies at the labour productivity growth rate.
 - *We vary this growth rate consistent with the New Zealand data to study the effects of **labour productivity** in the model.*
- Capital stock adjusts in response to changes in the natural rate of interest
 - Determines firm investment demand.
- Wages adjust to changes in technology and the capital stock.
 - Influences household savings.



1.4. Government

- Raises taxes, via income, consumption and other taxes.
- Distributes pensions.
- Exogenous government-debt-to-GDP target, determining the government's capital demand.
 - *We vary this debt target consistent with the New Zealand data to study the effects of **government debt levels** in the model.*
- Other government spending adjusts endogenously to balance the government's budgetary targets.



1.5. Open-Economy

- Current account reflecting the imbalance between domestic savings and domestic demand for capital. The accumulated current account determines the net foreign investment position.
- The net foreign investment position (NFP) determines the domestic interest rate premium to the world interest rate:

$$r_t = r_t^{world} + r_t^{premium}(NFP) \quad (9)$$

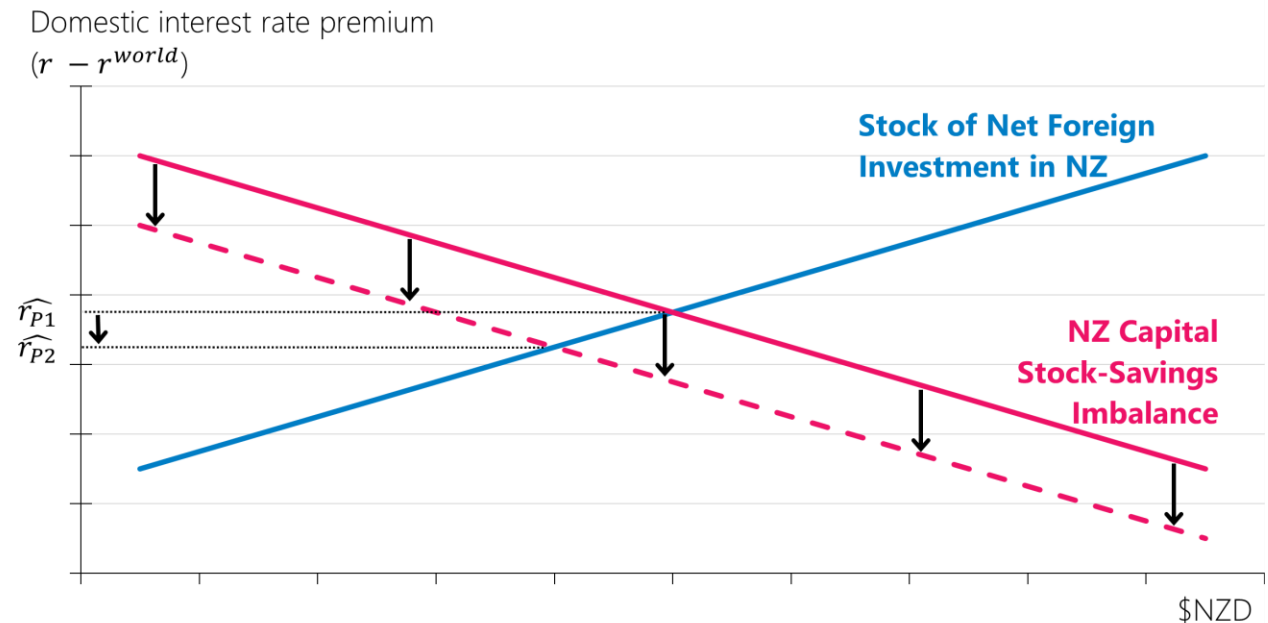
- The interest rate premium increases with external indebtedness (as the net foreign position becomes more negative).
- Equation (9) links domestic savings and investment to the gap between domestic and world interest rates.
- *We vary the r_t^{world} consistent with the data to study the effects of world natural rate of interest in the model.*



1.8. Model Intuition

- The equilibrium interest rate premium is such that **net foreign investment in New Zealand** offsets the **imbalance between the domestic capital stock and stock of savings**.
- Changes in the structural features of the domestic economy which change domestic capital demand or domestic savings **shift** the “**NZ Capital Stock-Savings Imbalance**” curve.

Equilibrium domestic interest rate premium



Note: This chart is drawn showing a positive interest rate premium and positive net foreign investment, as New Zealand has had a negative net foreign position for the last five decades. For data on the Net International Investment Position since June 2000, see the M7 collection, published on the Reserve Bank website. For earlier estimates, see Lane and Milesi-Ferretti (2007).

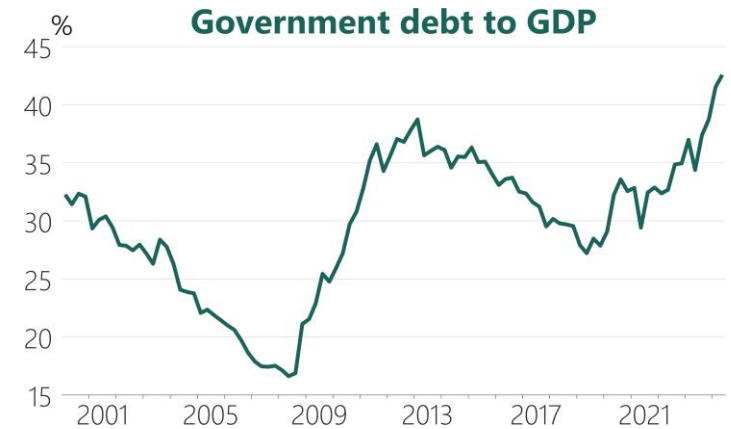
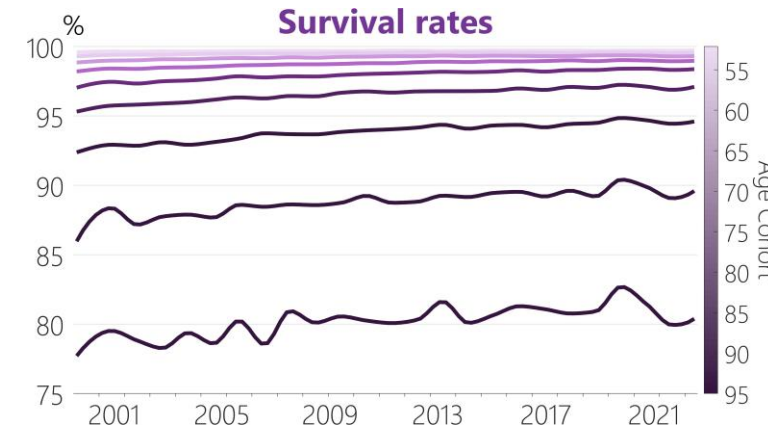
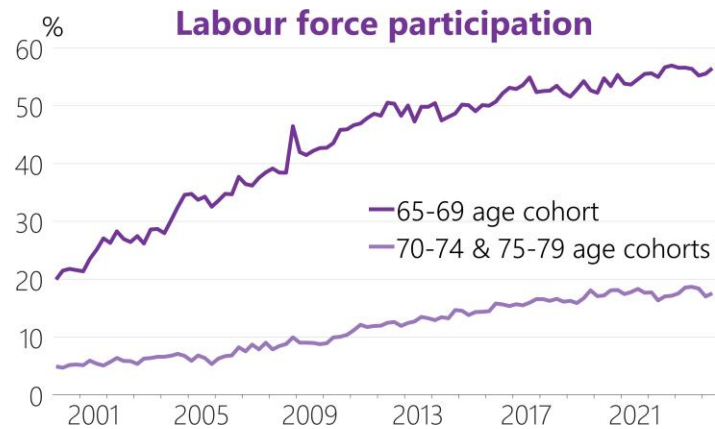
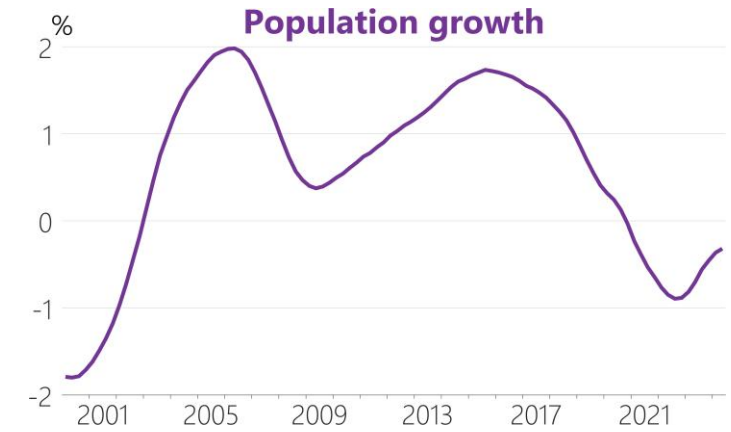
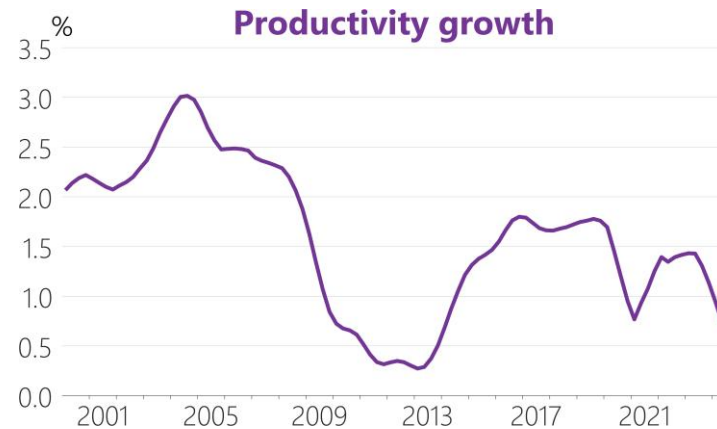
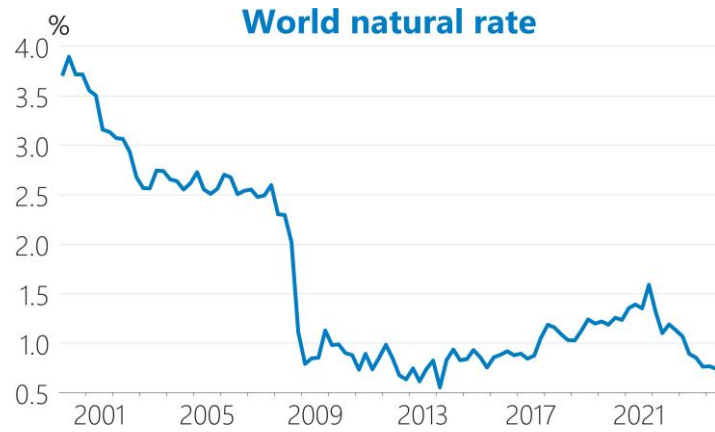


2.1. Solution Method

- We parameterise the model to match the New Zealand economy between 2000 and 2005.
- We solve the long-run natural rate each quarter between 2000 and 2024, using the data for each of six drivers for that quarter.
- In each quarter, households assume the current value of each driver persists indefinitely.



2.2. Paths for natural rate drivers



Note: We do not plot the survival rate of the oldest cohort of households, aged 95-99 as this is fixed at 0.



2.3. Solution Method

The model is solved using VFI Toolkit (Kirkby, 2023)

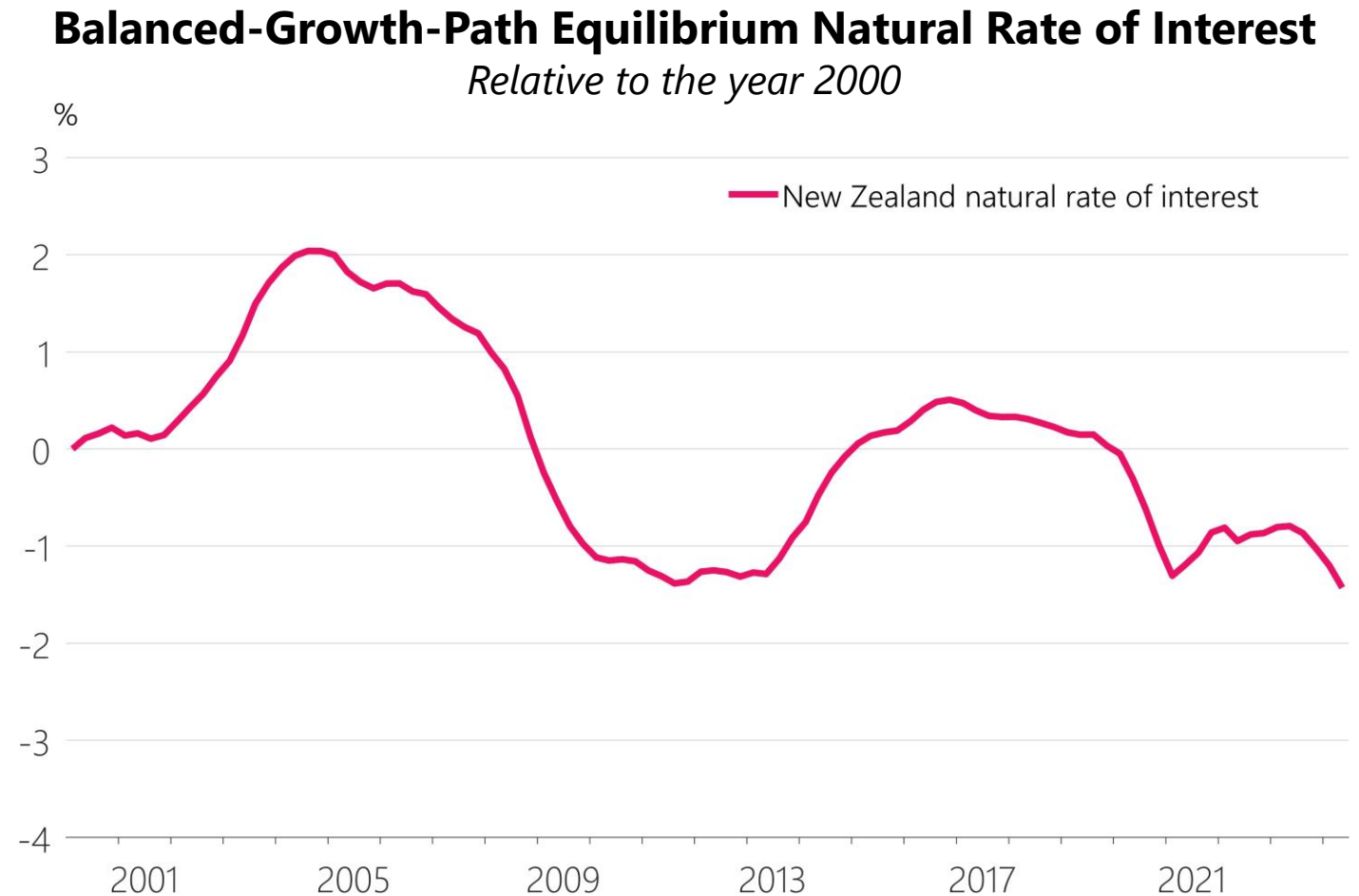
<https://www.vfitoolkit.com/>

The Toolkit is a Matlab toolbox, designed to easily solve value function iteration problems using parallel grid search algorithms, allowing a wide range of functions forms.



3.1. Results – Natural rate of interest

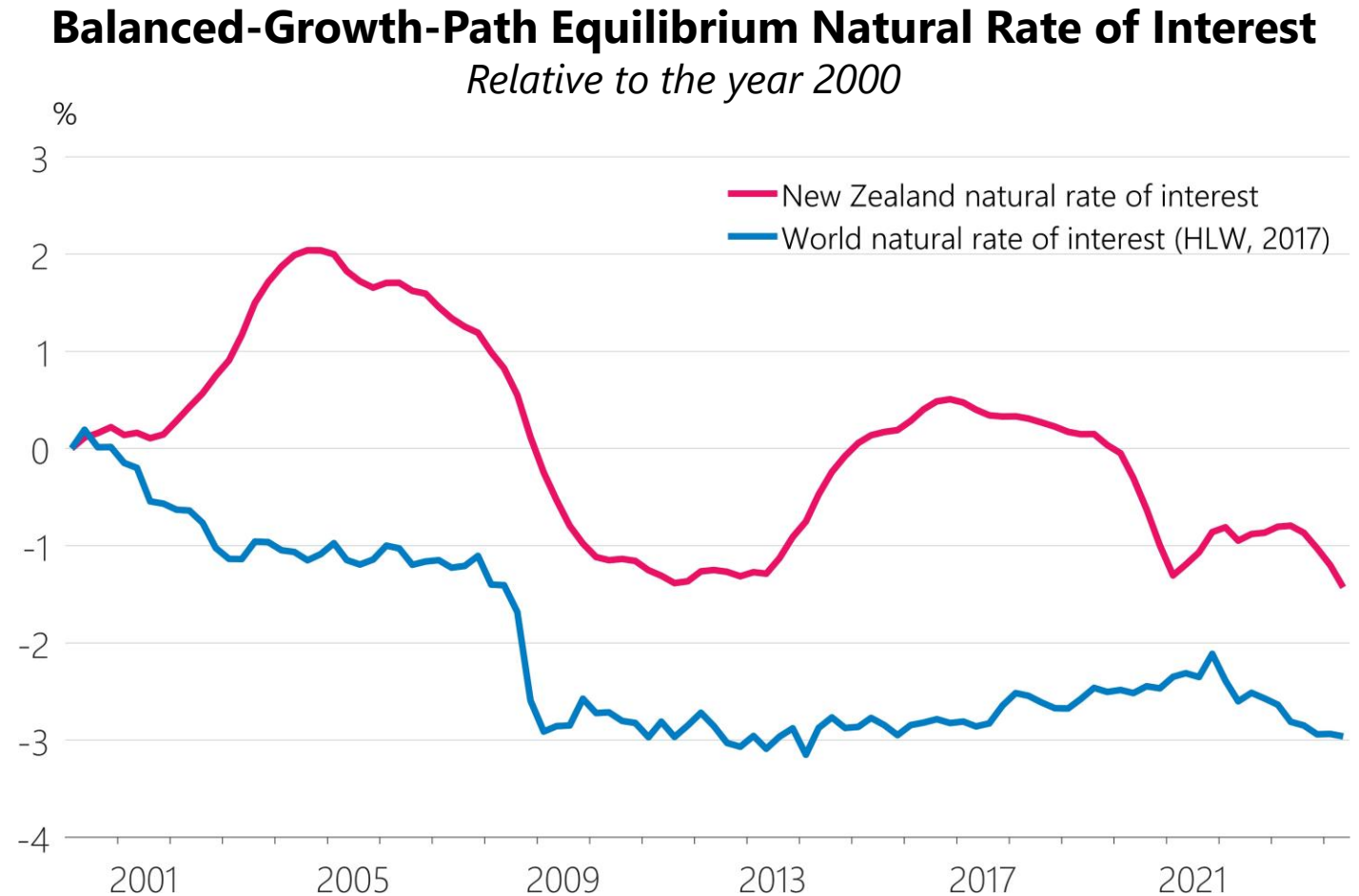
- We plot the equilibrium interest rate associated with the values the six drivers (shown earlier) in each quarter.





3.1. Results – Natural rate of interest

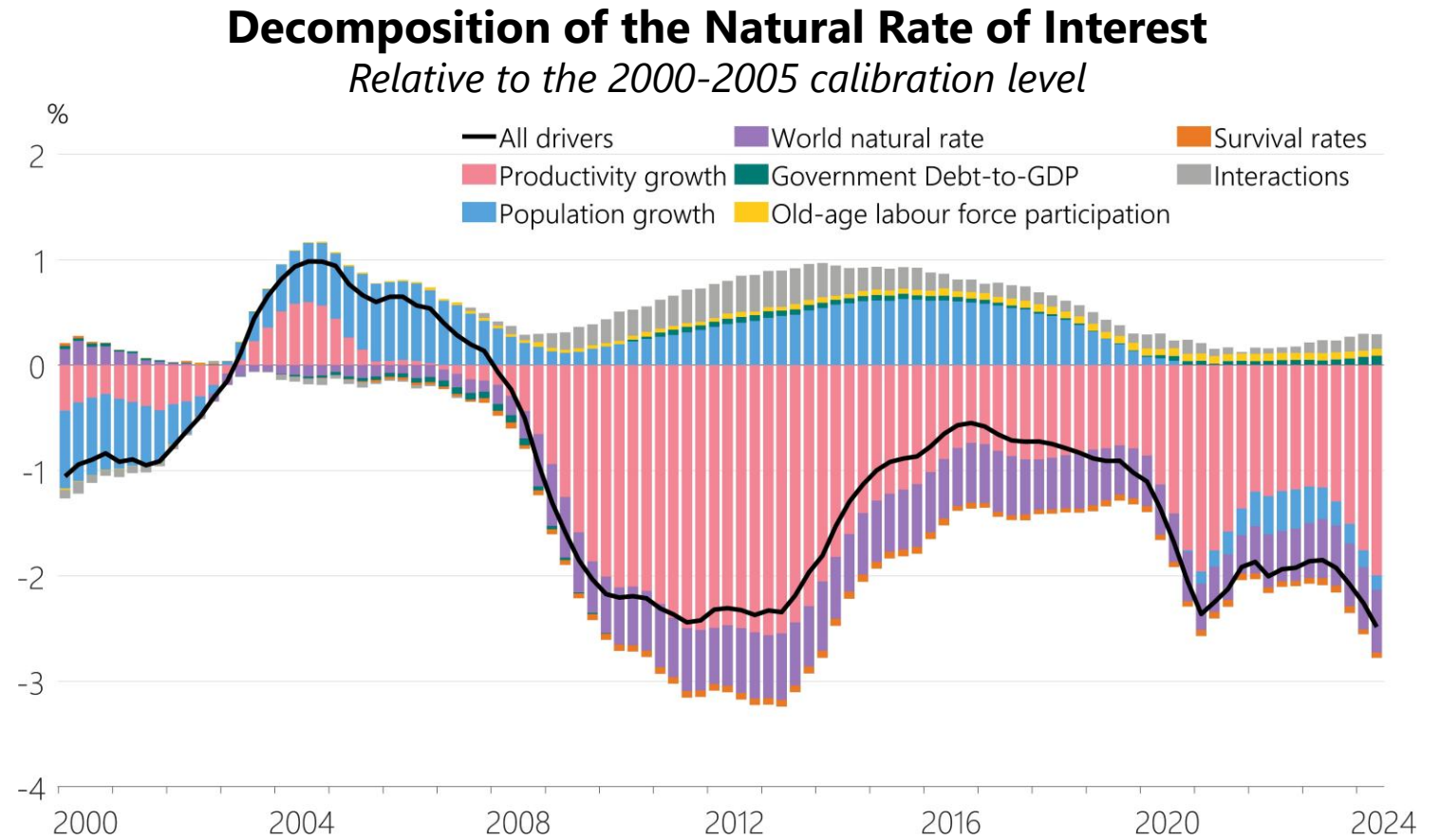
- We plot the equilibrium interest rate associated with the values the six drivers (shown earlier) in each quarter.
- If we also plot the world natural rate of interest (*HLW estimate*), we observe:
 - Some periods of co-movement (e.g., 2008)
 - Some periods of divergence (e.g., 2014)





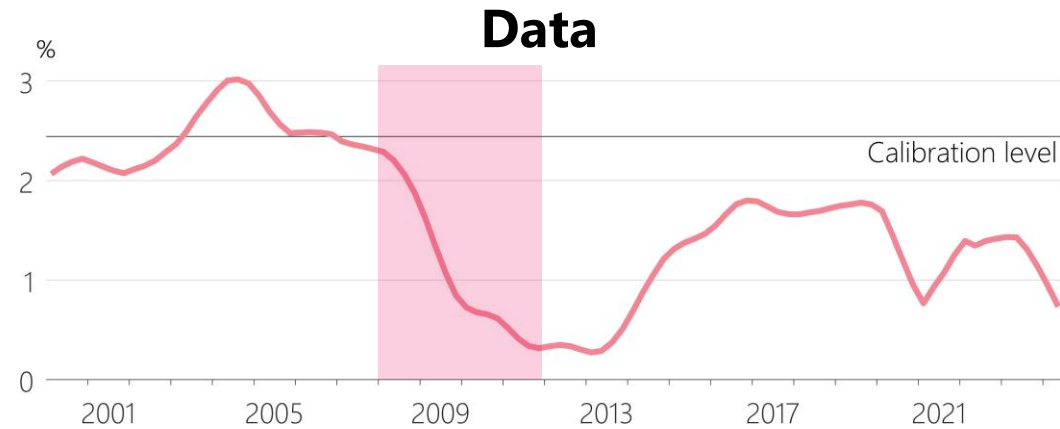
3.2. Results - Decomposition

- We decompose the drivers of natural rate by comparing the path where all six drivers are changing to counterfactual paths where only one of the drivers is changing at a time.
- We identify three key drivers over our analysis period: **productivity growth**, **population growth**, and the **world natural rate**.
- Other drivers seem quantitatively unimportant over this period.



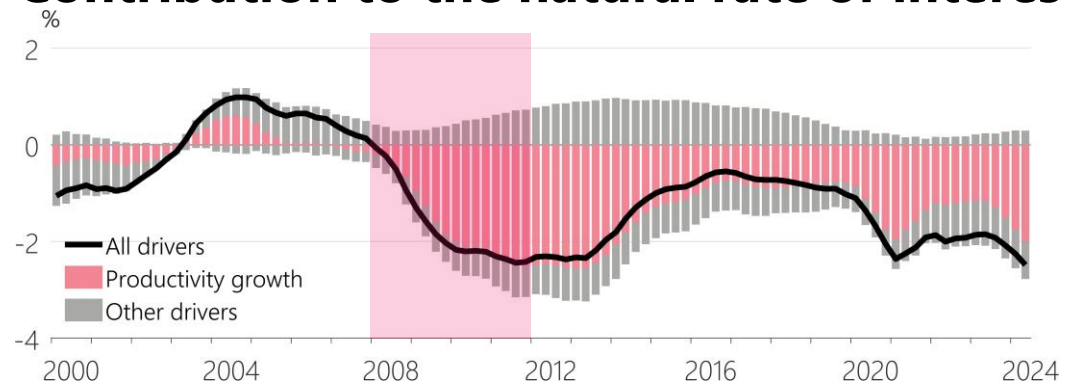


3.3. Results – Labour productivity growth

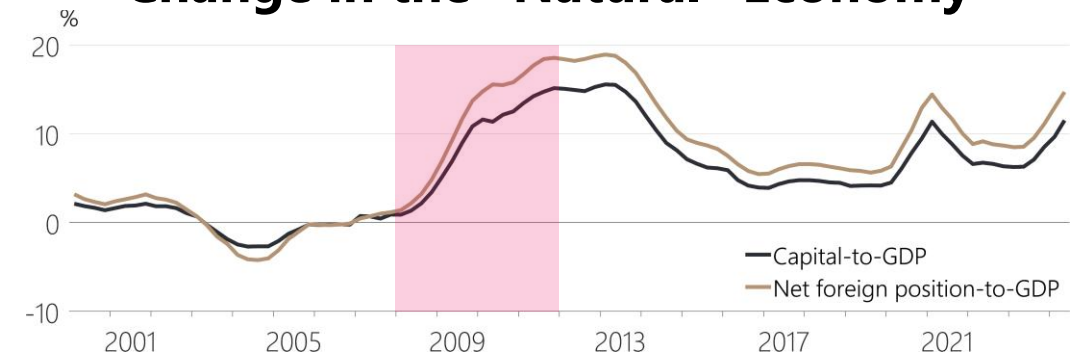


- Declining productivity growth has put material downward pressure on the natural rate since 2008.

Contribution to the natural rate of interest

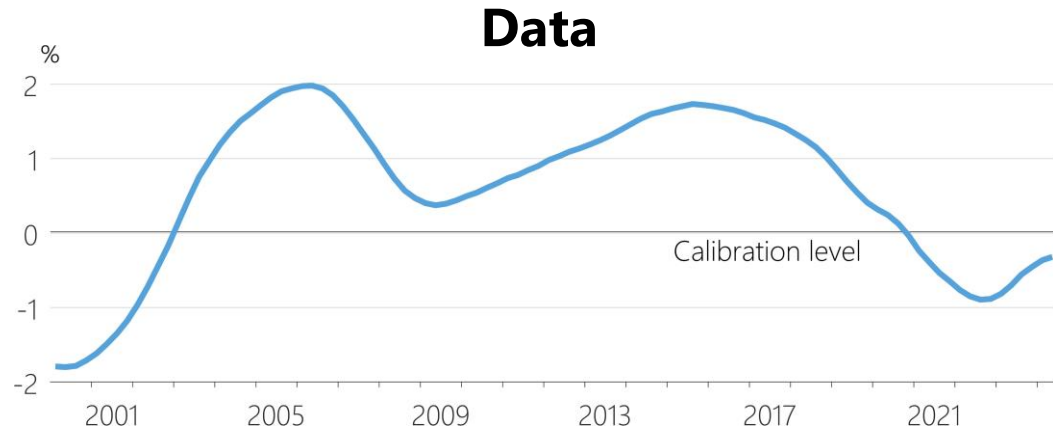


Change in the “Natural” Economy



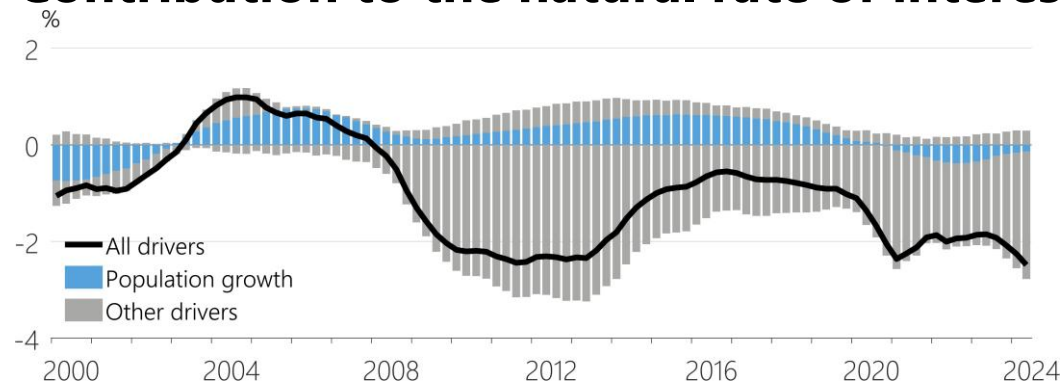


3.4. Results – Population growth

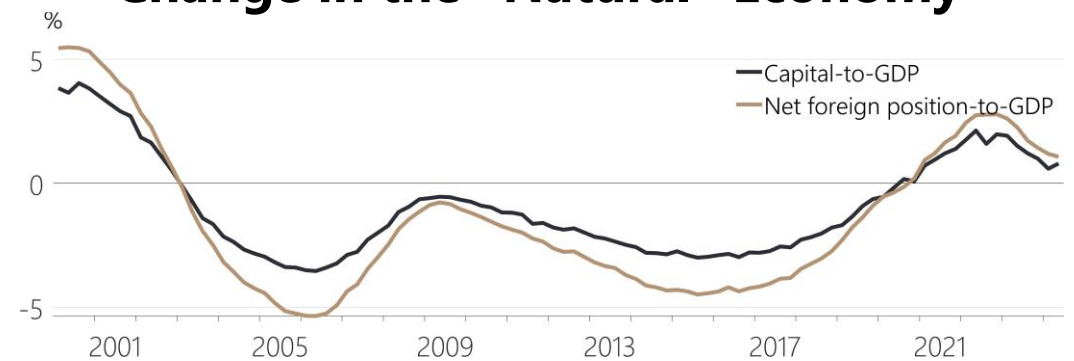


- Higher population growth put moderate upward pressure on the natural rate between 2004 and 2020.

Contribution to the natural rate of interest



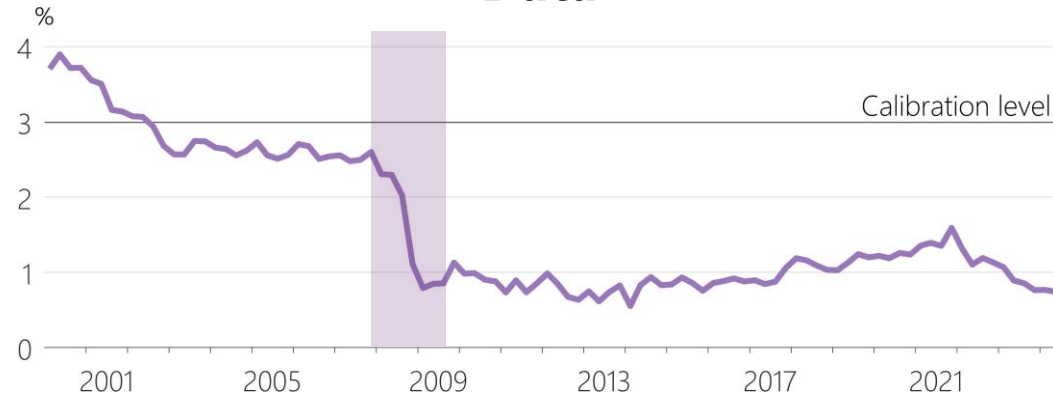
Change in the “Natural” Economy





3.5. Results – World natural rate

Data

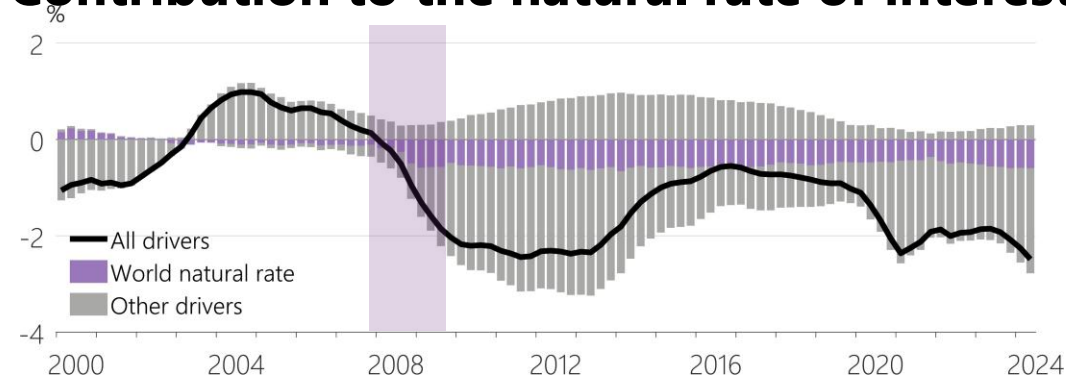


- A lower world natural rate has put moderate downward pressure on the natural rate since 2003.

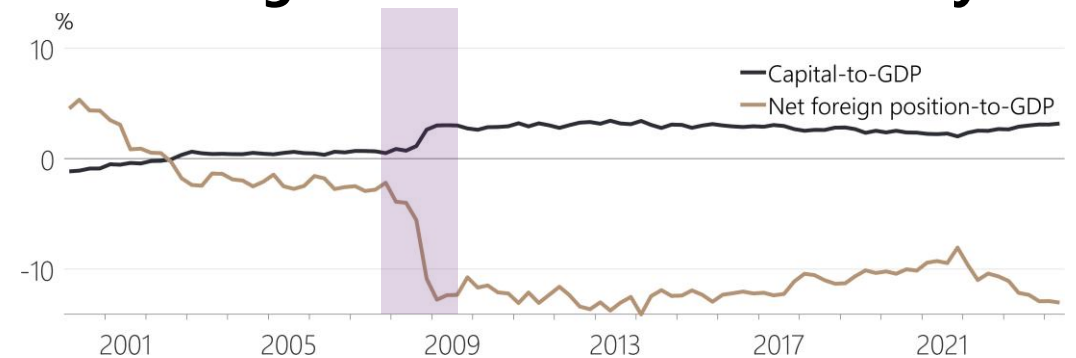
$$r_t^{world} + r_t^{premium(NFP)} = r_t$$

2008: -1.5 + 1 = -0.5

Contribution to the natural rate of interest



Change in the "Natural" Economy

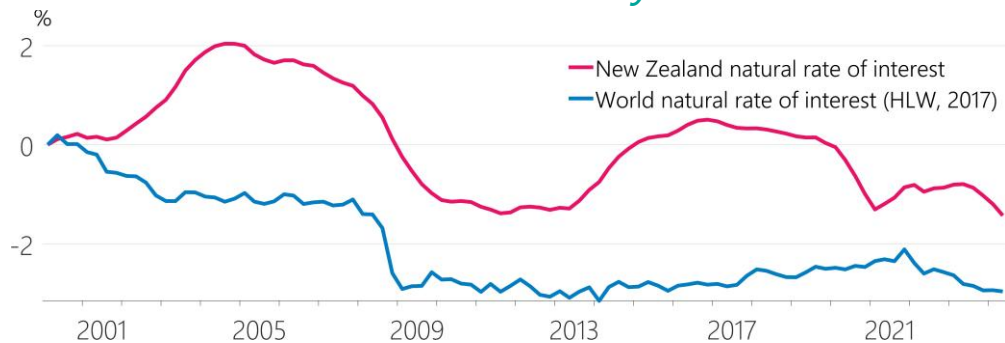




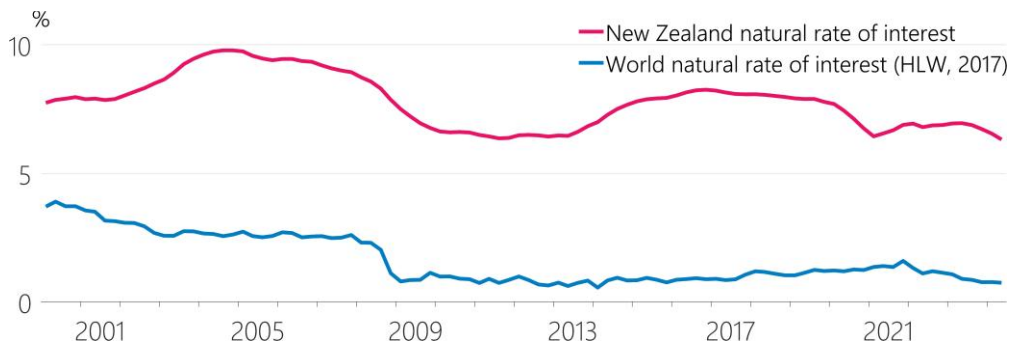
4.1. Open Questions: Return to capital

Natural Rates of Interest

Plotted relative to the year 2000



Plotted in levels



- Equating the natural rate of interest to the marginal return to capital makes it difficult to reconcile the **data** on:
 - the capital-to-GDP ratio
 - the Cobb-Douglas elasticity of output w.r.t capital

..and the **endogenous (model)** level of the natural rate of interest, with level estimates for the related neutral interest rate for New Zealand.

- This emphasises the need to allow for a wedge between the return to safe and risky assets to get *realistic level estimates* of the natural rate, with most evidence suggesting safe returns have declined much faster than risky returns over recent decades.¹

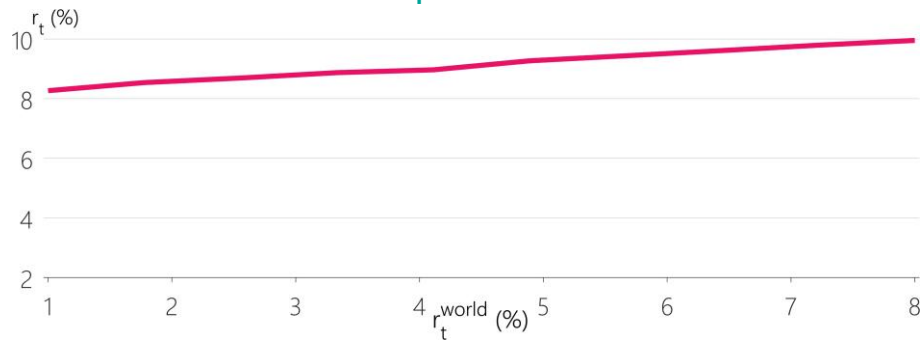
1. See, for instance, the reviews by Caballero et al., 2017, Holston et al., 2017, or Obstfeld, 2023.



4.2. Open Questions: International premium

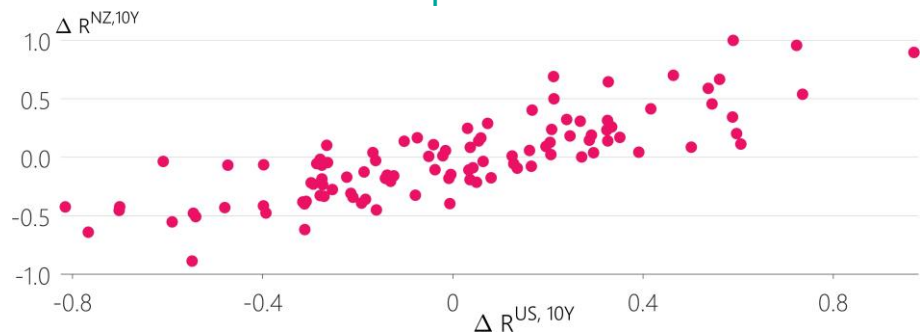
Model sensitivity to world interest rates

slope ≈ 0.3



Quarterly change in 10-year bonds

slope ≈ 1



- The model sensitivity to world interest rates differs from co-movement in 10-year government bond rate data. However, a simple comparison of these slopes may be misleading:
 - Similar fluctuations in underlying trends in the two countries driving the 10-year rates.
 - Similar changes in safe asset premiums on government interest rates in both countries.
 - The model shows the long-run effect of drivers, including offsetting effects from changes in the slow-moving capital stock and net foreign position. The quarterly data may not capture these long-run relationships.
- However, we are unsure what a realistic passthrough is. There is also no evidence on whether the premium mainly depends on the net foreign position, or other factors (such as, the debt servicing costs on the net foreign position).

1. See, for instance, the reviews by Caballero et al., 2017, Holston et al., 2017, or Obstfeld, 2023.



5. Conclusion

- The most important factors driving the natural rate of interest over recent decades, accounting for feedback loops, domestic **labour productivity growth** and **population growth** and **the world natural rate**.
 - *Old-age labour force participation, survival rates, government debt-to-GDP* seem quantitatively unimportant.
- These results suggest the most likely causes of a reversal in the fall in the New Zealand natural rate of interest would be an increase in the world natural rate of interest, or an increase in labour productivity growth in New Zealand.
- Important areas where further understanding is needed:
 - *The impact of allowing for wedge between return to safe and risky capital.*
 - *The determinants of the New Zealand interest rate premium relative to world rates.*



6. References

Lane, P. R., & Milesi-Ferretti, G. M. (2007). The external wealth of nations mark ii: Revised and extended estimates of foreign assets and liabilities, 1970–2004. *Journal of International Economics*, 73(2), 223-250.

Caballero, R., Farhi, E., & Gourinchas, P. (2017). The safe assets shortage conundrum. *Journal of Economic Perspectives*, 31(3), 29-46.

Holston, K., Laubach, T., & Williams, J. C. (2017). Measuring the natural rate of interest: International trends and determinants. *Journal of International Economics*, 108, S59-S75.

Obstfeld, M. (2023, December). Natural and Neutral Real Interest Rates: Past and Future [NBER Working Papers]. (31949).

Kirkby, R. (2023). VFI Toolkit. `vfitoolkit/VFIToolkit-matlab: v2.2 (v2.2.0)`.

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Appendix

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4.3. Open Questions: Long-run equilibrium

- Our focus on long-run equilibrium means households assume the current value of each driver continues to persist indefinitely.
- Following a change in a given driver, the implied changes in household savings behaviour, the natural economy and natural rate of interest are likely to be larger than if households only considered a change to be temporary.
- Future work could address this by solving for repeated transition paths rather than a long-run equilibrium balanced growth path.
- This would allow analysis what would happen **today** following a change in a driver, rather than solving for what would *eventually happen* if this change persisted.



A.1. Transition Paths

- In our model, households expect current conditions to last forever, and we solve for what would eventually happen if they continued to expect this.
- Transition paths involve households having expectations about the future.
 - These expectations can be perfect foresight, where households know everything that will happen in the future, or imperfect foresight, where households make forecasts of the future and update their expectations over time.
- We solve for transition paths using a recursive simulation method following Cesa-Bianchi et al. (2022).



A.2. Transition Paths

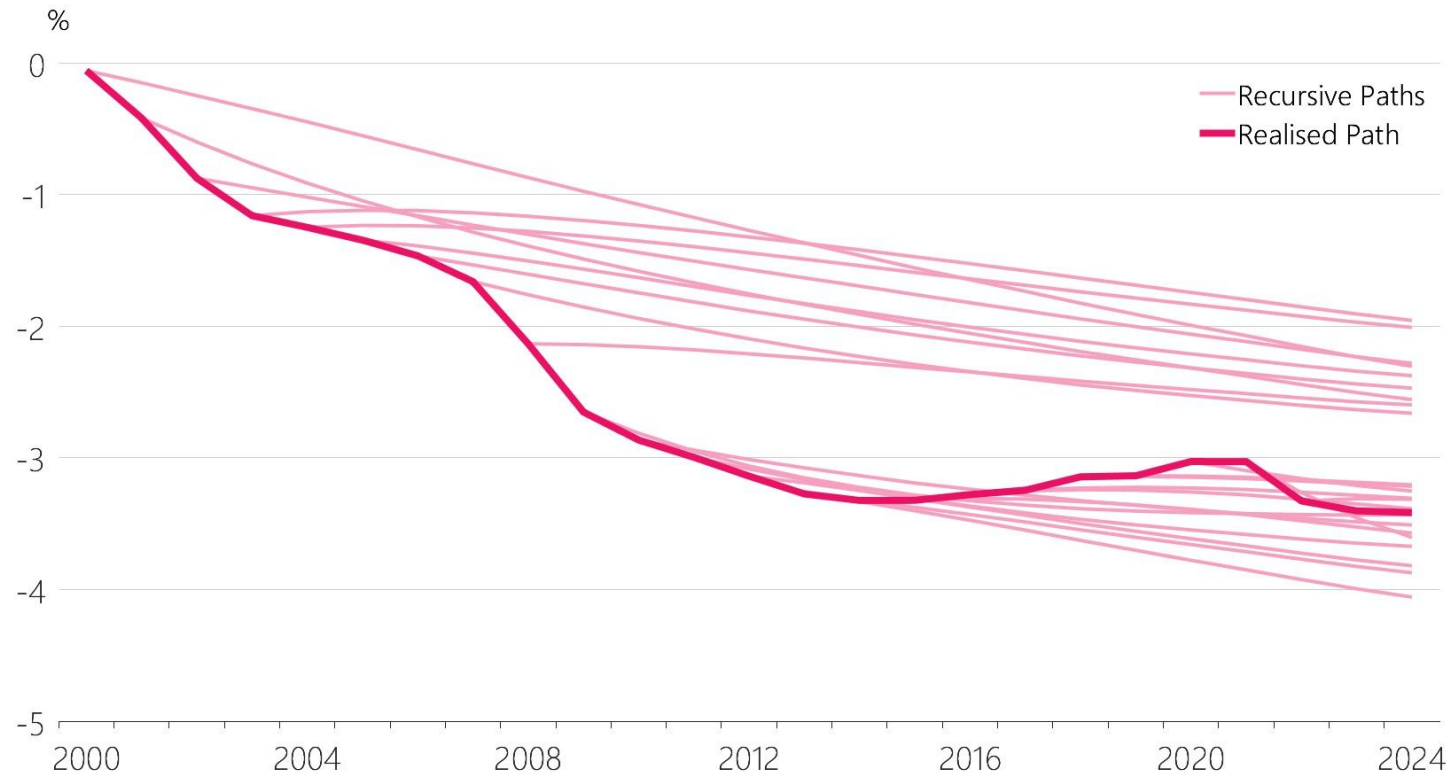
1. Set the initial conditions to correspond to the New Zealand economy in the first year of our analysis period (the year 2000).
2. In $t = 0$, households form expectations over the future path of the structural drivers for periods $t = 1, 2, \dots, N_T$, where N_T represents the length of the transition path we wish to solve.
3. We solve the transition path from the initial conditions to the stationary general equilibrium associated with households' forecasts for the structural drivers.
4. We step forward to $t = 1$, at which point households observe another year of data and update their forecasts. We use the solution for the first year of the $t = 1$ transition path as the initial conditions, and households' updated forecasts to solve for the next transition path.
5. We repeat this process for each year in our analysis period (2000-2023), with households gradually updating their forecasts for the drivers, using the first year of the transition path in period t as the initial conditions for the economy in period $t + 1$.



A.3. Transition Paths – Preliminary Results

The Natural Rate of Interest (Transition Paths)

Relative to the 2000 calibration level

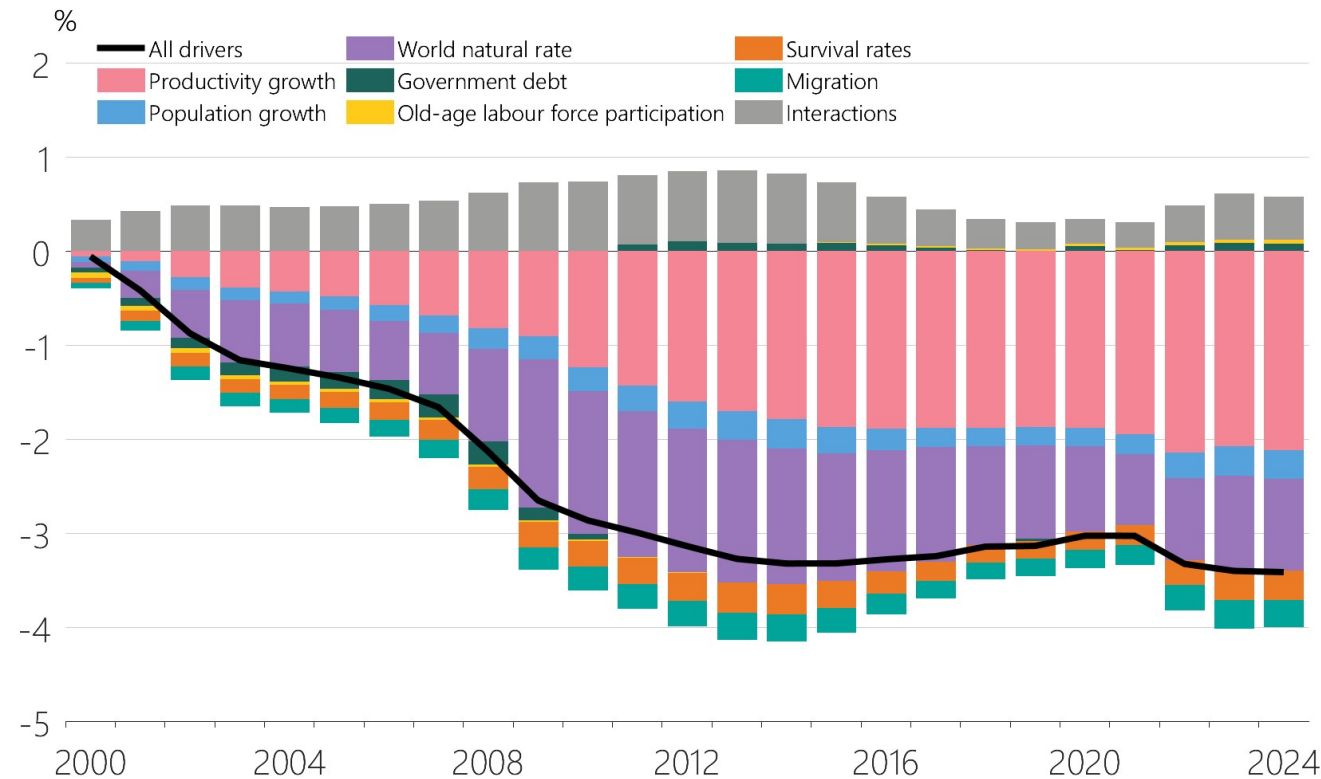


Note: These results are preliminary, and are subject to change.



A.4. Transition Paths – Preliminary Results

Decomposition of the Natural Rate of Interest (Transition Paths)
Relative to the 2000 calibration level



Note: These results are preliminary, and are subject to change.