

**BEFORE INDEPENDENT HEARING COMMISSIONERS
IN CHRISTCHURCH**

TE MAHERE Ā-ROHE I TŪTOHUA MŌ TE TĀONE O ŌTAUTAHI

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the hearing of submissions on Plan Change 14 (Housing and Business Choice) to the Christchurch District Plan

**STATEMENT OF PRIMARY EVIDENCE OF DR KIRDAN LEES ON BEHALF OF
CHRISTCHURCH CITY COUNCIL**

ECONOMIC DEMAND (COMMERCIAL AND INDUSTRIAL)

Dated: 11 August 2023

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EXECUTIVE SUMMARY

1. My name is **Kirdan Ross Lees**.
2. I am a Partner at Sense Partners, an economics and public policy consultancy based in Auckland and Wellington.
3. I have prepared this statement of evidence on behalf of Christchurch City Council (the **Council**) in respect of my peer review of the Council's business land demand model provided by Dr David Dyason from Lincoln University. I understand this model is used as an input to the evidence base on Plan Change 14 to the Christchurch District Plan (the **District Plan; PC14**).
4. The Council's business land demand model was used to assess the land demand and business capacity on a city-wide level to quantify land demand for the next 30 years. The results of this modelling are summarised in Table 4 of Dr Dyason's report as follows:¹

Table 4: Summary of results, up to 2051

	Demand (ha)	Supply (Vacancy, ha)		Total Supply (ha)	Gap (ha)
		Building	Land		
Retail	10.9	12.6	14.7	27.3	16.5
Office	14.7	9.2	9.9	19.2	4.5
Industrial	- 1.1	5.8	5.5	11.3	12.4
Warehousing	0.5	1.9	1.8	3.7	3.2
Short-stay	0.6			0.0	- 0.6
Total	25.6			61.5	35.9

5. Dr Dyason's report concludes that there is currently sufficient capacity to meet demand over the next 30 years.
6. I was engaged to undertake a peer review of the Council's business land demand model (**peer review**). That peer review concluded:
 - *“The modelling approach is sound and fit-for-purpose. It is robust but also pragmatic – it is relatively easy for the provider to communicate model inputs and outputs.*
 - *I would expect the approach [business land demand model] to meet the requirements of the Ministry of Housing and Urban Development on HBAs [Housing and Business Development Capacity Assessments] and Future Development Strategies.*

¹ 'Christchurch Central City: Land Demand Estimate and Business Capacity Assessment', April 2022, David Dyason – PC14 section 32 - Part 3 Appendix 5, <https://www.ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Plans/district-plan/Proposed-changes/2023/PC14/Section-32-Appendices-1/Technical-Report-Central-City-Land-Demand-Capacity-Report-VERSION-1.PDF>

- *While this note is a peer review rather than an audit of all the inputs to the model, I did not find obvious errors within the excel spreadsheet.”*
7. This evidence provides explains the modelling approach and the underlying assumptions that underpin the Council's business land demand model.
 8. In is my view, my conclusion in the peer review that the Council's business land demand model is sound and fit-for-purpose for informing the changes proposed under PC 14 remains valid.
 9. There were no submissions or further submissions raising concerns about the Council's business land demand model.

INTRODUCTION

10. My name is **Kirdan Ross Lees**. I am a Partner at Sense Partners, an economics and public policy consultancy based in Auckland and Wellington.
11. In June of 2022 I was engaged to undertake a peer review of the Council's business land demand model which was relied on to inform the proposed changes to the District Plan via PC14.
12. In preparing this evidence I have:
 - (a) Relied on my previous peer review of the Council's business land demand model; and
 - (b) Referred to guidance on business land demand provided by the Ministry for the Environment.²
13. I am authorised to provide this evidence on behalf of the Council.

QUALIFICATIONS AND EXPERIENCE

14. I hold a PhD in economics from the University of Melbourne. I am hold an honorary Senior Research Fellow (unpaid position) at the University of Canterbury.
15. I have nine years' experience leading policy and research teams at the Reserve Bank.

² See <https://environment.govt.nz/assets/Publications/Files/Guidance-on-Housing-and-Business-Development-Capacity-Assessments-HBAs-under-the-NPS-final.pdf>

16. I have published many articles related to applied macroeconomics and have acted as a referee for several journals.
17. I have twelve years' experience consulting on housing and urban economics issues.
18. I have conducted model reviews for many government agencies including New Zealand Treasury.
19. I have supplied business land demand forecasts to Greater Wellington Regional Council in 2022 and to Wellington City Council in 2017.
20. I understand the modelling approach and requirements under the HBAs and the National Policy Statement on Urban Development (**NPS-UD**).

CODE OF CONDUCT

21. While this is a Council hearing, I have read the Code of Conduct for Expert Witnesses (contained in the 2023 Practice Note) and agree to comply with it. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this statement of evidence are within my area of expertise. To my knowledge, I have not omitted material facts that might alter or detract from the opinions I express.

SCOPE OF EVIDENCE

22. My statement of evidence addresses the following matters:
 - (a) Council's business land demand model methodology.
 - (b) Council's business land demand model assumptions.
 - (c) Application of the Council's business land demand model to Christchurch City.
23. I address each of these points in my evidence below before making concluding points.

CONTEXT

24. Under the NPS-UD, an HBA must be carried out every three years.³

³ See Ministry for the Environment 2020 (<https://environment.govt.nz/assets/Publications/Files/Guidance-on-Housing-and-Business-Development-Capacity-Assessments-HBAs-under-the-NPS-final.pdf>)

25. The intent of an HBA is to first assess residential and business land demand and then compare demand to development capacity over 3-, 10- and 30-year timeframes.
26. A HBA also requires that councils assess the different types of demand for business land across sectors, sizes, and locations.

MODELLED DEMAND AND CAPACITY CONCLUSIONS

27. The Council's business land demand model provided by Dr David Dyason from Lincoln University concluded that there is currently sufficient capacity to meet demand over the next 30 years. The results of the modelling are summarised in Table 4 of Dr Dyason's report as follows:

Table 4: Summary of results, up to 2051

	Demand (ha)	Supply (Vacancy, ha)		Total Supply (ha)	Gap (ha)
		Building	Land		
Retail	10.9	12.6	14.7	27.3	16.5
Office	14.7	9.2	9.9	19.2	4.5
Industrial	- 1.1	5.8	5.5	11.3	12.4
Warehousing	0.5	1.9	1.8	3.7	3.2
Short-stay	0.6			0.0	- 0.6
Total	25.6			61.5	35.9

28. Dr Dyason's report concludes as follows:

"The total new demand for land for the Central City is estimated to be 25.6ha by 2051 while the existing supply from both vacant buildings and floors in buildings (29.6ha) and vacant land (32ha) amounts to 61.5 ha. This leaves additional capacity in the market of 35.9 ha.

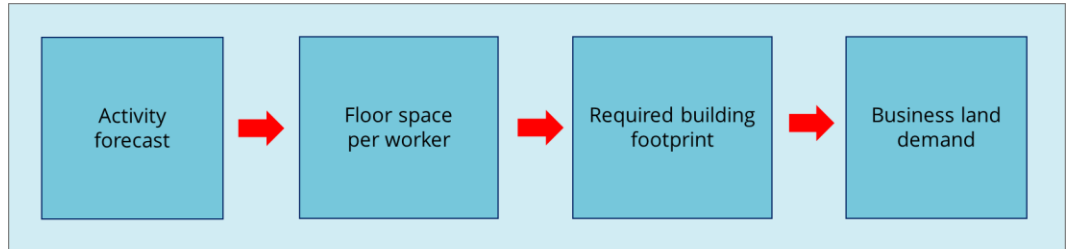
This result reveals that there is sufficient capacity in either vacant buildings or floors in buildings to capture new demand as well as sufficient vacant land. However, it is highly likely that the current vacancy level in buildings does not represent the highest and best use or ideal quality for tenants and could potentially remain vacant. In this case, the land vacancy represents a better indicator of capacity.

In conclusion, the results reveal that the Central City has the space capacity, but the high rate of building vacancy suggests that the use of the land is not optimised resulting in efficiency losses."

MODEL METHODOLOGY

29. To forecast demand for business land, the Council's business land demand works through a four step process I describe in **Figure 1** below.

Figure 1: The CCC Business Land Demand model uses a four stage process



Source: Sense Partners (2018)

Step one: The activity forecast

30. In step one the model assesses future economic activity in terms of the number of full-time jobs across sectors.
31. The choice of sectors should capture the key drivers of the economy.
32. The sectors within the Council's business land demand are: retail, office, industrial, warehouse and logistics, accommodation, and other.
33. From a technical perspective, the total number of sectors is limited by the number of years of data on jobs within the region (about 20 years).
34. But in practice, opting for a large number of sectors results in a model that does not fit the data well.
35. In my opinion, the number and choice of sectors included in the Council's business land demand model is appropriate.
36. The addition of a warehouse and logistics sector is a judicious choice. After COVID-19, this sector has experienced an increase in economic activity.
37. Technically, a Vector-Autoregressive (**VAR**) model is used to project sector employment for Christchurch for the next thirty years.⁴ In my opinion, this is a sensible choice to capture the trends in the economy and forecast economic activity.

⁴ Sims 1980 and Stock and Watson 2001 show that Vector Autoregressions are a useful technique within the economic literature.

Step two: Floor space per worker

38. To translate economic activity to land demand, step two calculates floor space demand for most sectors and the aggregate Christchurch economy.
39. For example, new office workers added to the economy over the next 3-, 10- and 30-years are assumed to require 39 square metres of new floorspace per person. This generates a forecast for office floor space over the next 30-years.
40. A slightly different approach is used for retail. This approach assesses growth in floor space demand relative to spending growth.

Step three: Land is required to accommodate floor space

41. To translate floor space to demand for land, an assumption is required for the floor-to-area ratio, that is, the land needed to accommodate the floor space calculated in step two for each sector.
42. For example, within the model a floor-to-area ratio of 0.35 is assumed for the retail sector. This implies a little over 2.8 hectares of land is required to accommodate 10,000 square metres of demand for retail floorspace.

Step four: Total demand for business land

43. Demand for business land is then summed across each sector to provide an aggregate assessment of demand across Christchurch City.

ASSUMPTIONS

44. There are several assumptions that underpin the assessment of business land demand.
45. First, the Council's business land demand model assumes that the number of jobs in the economy is an appropriate indicator for forecasting demand for space. It may be the case that a firm's demand for land is best represented by a component of land demand that is fixed, and additional demand that is based on the number of people in the firm.
46. Second, the Council's business land demand model makes assumptions about floorspace required per worker. Improvements in technology that could reduce the space needed per worker (such as the uptake of digitisation in ports or working from home) will impact the total level of demand for business land.

47. Third, the Council's business land demand model assumes floor-to-area ratios for each sector. In practice we might expect some intensification in utilisation of land as demand increases. This could be addressed with scenarios to show aggregate impacts.
48. The Council's business land demand model also has a fixed number of sectors to represent the economy. Other options are possible. For example, a government sector might be needed to model the Wellington economy.
49. As a general point, the Council's business land demand model assumes that past trends and relationships across sectors are indicative of future trends and relationships across sectors. Large changes in the sectoral composition of the economy are not assumed in the modelling approach.

MODEL APPLICATION TO CHRISTCHURCH

50. The Council's business land demand model follows a standard approach that has also been used in the Greater Wellington Region to produce business land forecasts.
51. Sensibly, the Council's business land demand model has been tailored to the Christchurch economy with judicious choices about the most important sectors and the appropriate assumptions about floorspace per worker and floor-to-area ratios.
52. There is typically uncertainty associated with key assumptions that are required to approximate a rich and complex reality.
53. Usefully, the Council's business land demand model is sufficiently flexible to provide uncertainty bands around any business land forecast. Different assumptions can also be tested with a range of scenarios.
54. The model could be used to examine business land demand across the wider labour market that likely spans Waimakariri District Council and Selwyn District Council. This is an extension; it should not be inferred this is an omission – in my opinion, the Council's business land demand model is fit-for-purpose.
55. For the above reasons, in my opinion the Council's business land demand model is sufficiently robust to inform the changes proposed under PC14.

CONCLUSION

56. The Council's business land demand model follows a logical and pragmatic modelling approach to assess the future demand for business land across Christchurch City.
57. Like any economic model, there are a number of assumptions that underpin the estimates of future demand for business land.
58. However, the transparent modelling approach enables assumptions to be tested through scenarios where required.
59. In my opinion, the Council's business demand model is sufficiently robust and fit-for-purpose for informing the changes proposed under PC14.

Date: 11 August 2023

Dr Kirdan Lees

REFERENCES

- Ministry for the Environment 2020, "National Policy Statement on Urban Development 2020", Ministry for the Environment:
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Appendix A



SENSE PARTNERS

DATA LOGIC ACTION

Friday 10 June 2022

From: Kirdan Lees (Sense Partners)

To: Aimee Martin (Christchurch City Council)

Peer Review: Christchurch City Council Land demand model

Aimee,

Thank you for approaching Sense Partners to provide peer review on the Christchurch City Council land demand model provided by David Dyason. The accompanying note provides detailed comments. At high level, the following points are key:

- The modelling approach is sound and fit-for-purpose. It is robust but also pragmatic – it is relatively easy for the provider to communicate model inputs and outputs.
- I would expect the approach to meet the requirements of the Ministry of Housing and Urban Development on HBAs and Future Development Strategies.
- I am personally familiar with the approach that is essentially extremely similar to the method Sense Partners used to provide forecasts for industrial land for a group of councils in the Wellington region in 2018.
- While this note is a peer review rather than an audit of all the inputs to the model, I did not find obvious errors within the excel spreadsheet.
- There are some minor comments and suggestions that could be explored to provide additional surety on the model outputs and expected demand, but these are second order. The council should have confidence in the output from the model.

I have two recommendations:

1. There is evidence to suggest that Christchurch City Council, Selwyn District Council and Waimakariri District Council operate as one effective labour market area. One modelling approach worth exploring is to identify the land demand needs across the entire labour market area, rather than for Christchurch City Council alone. With land demand identified at a high level through employee demand, this demand can be allocated to each council by estimating very simple share models. Such an approach would capture the real-world decisions firms make to locate or relocate across the region.
2. Modelling industrial land demand across the shared urban area would also have the benefit of providing industrial land demand forecasts for Selwyn District Council and Waimakariri District Council at low cost, lowering costs for councils.

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Peer review: Christchurch City Council land demand model

Report to Christchurch City Council
Friday 10 June 2022



Context

I have been asked by Christchurch City Council to provide peer review comments on the Christchurch City Council land demand model. I have been provided with the spreadsheet that contains the calculations within the model and a draft report that outlines the technical details of the model.

The comments span:

- (i) General comments
- (ii) Specific comments
- (iii) Recommendations

Although I have looked through the model and found no obvious errors, my comments are peer review comments and should not be construed as a full audit of the model.



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General Comments

Transparency of approach

It is refreshing to review a model with a high degree of transparency of approach. Sufficient model transparency should be required so a numerically competent analyst can replicate the forecast process. A transparent approach requires noting key assumptions, analytical methods, how to input data and the operation of source code.

This has been provided by the spreadsheet and model documentation supplied.

Clear and accurate documentation is critical and can help minimise key person risk. Without providing a rating or score of the documentation provided, the documentation meets many of the elements we would look for, including:

- A reference to an archived model package
- High-level description of changes relative to previous models
- A concise model description including forecast generation and critical assumptions
- Mathematical model specification
- Comprehensive model and variable definitions
- Model estimation procedures

Model documentation is critical to help mitigate key person risk so it's good to see a reasonably well documented model for review.⁵

Chris Gray makes the point:

“Without the ability to understand where the numbers are coming from or how they were developed, people will resist being held accountable.”⁶

General model hygiene

But model documentation is only one aspect of many facets of process that fall under the rubric of model hygiene. These include, is the model spreadsheet:

- logical and well-structured?
- readable and easily-understood?
- regularly reviewed?

I am pleased to note the spreadsheet is logical and well structured and easy to understand.

⁵ We set out a more detailed checklist of the model documentation in the Appendix that could be used to monitor documentation standards on an ongoing basis.

⁶ See Gray 2013.

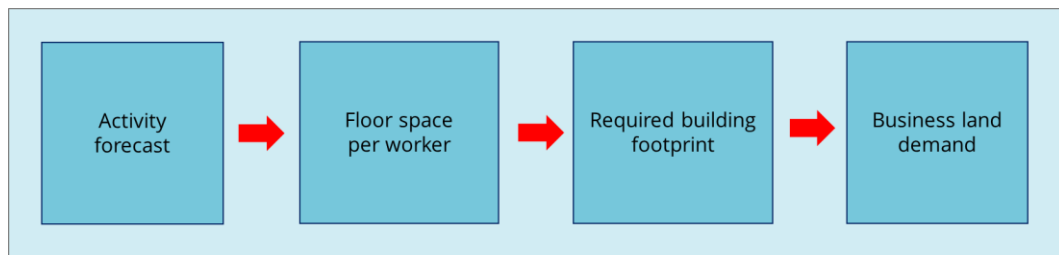


Overview of model approach

The model is really two models. The first model is a business growth model that predicts future activity in terms of number of employees. Then a second model or second set of models is used to translate activity into demand for different land types.

This set up is very similar to the approach Sense Partners used to estimate industrial land demand for a group of Wellington councils. Essentially, there are four key steps across the two models we show in **Figure 1**. Effectively, the business activity model provides the activity forecast. Then the second model provides floor space per worker with building footprints and ultimately business land demand.

Figure 2: The model mostly works through a simple four stage process



Source: Sense Partners 2018

Estimating future activity

The Christchurch land demand model uses annual employment data from Statistics New Zealand's business demography dataset. The job data can be split by sector and by local council. Jobs are then put in the forecasting demand model to estimate future activity.

The model used is a Vector-Autoregression or VAR model, a standard workhorse model in macroeconomics that has been used in many contexts over several decades.⁷

One of the decisions that needs to be made when using VAR models is the number of variables or individual sectors to model. Too many sectors and we run out of data to identify how each sector relates to each other sector. Too few sectors and we lose the ability to say very much about differences in sectoral dynamics and future land demand needs by sector.

The Christchurch land demand model uses a judicious choice of aiming to model 6 sectors – retail, office, industrial, warehouse and logistics, accommodation, and a catch-all “other” group. This set-up helps captures the major groups and demand for land by sector.

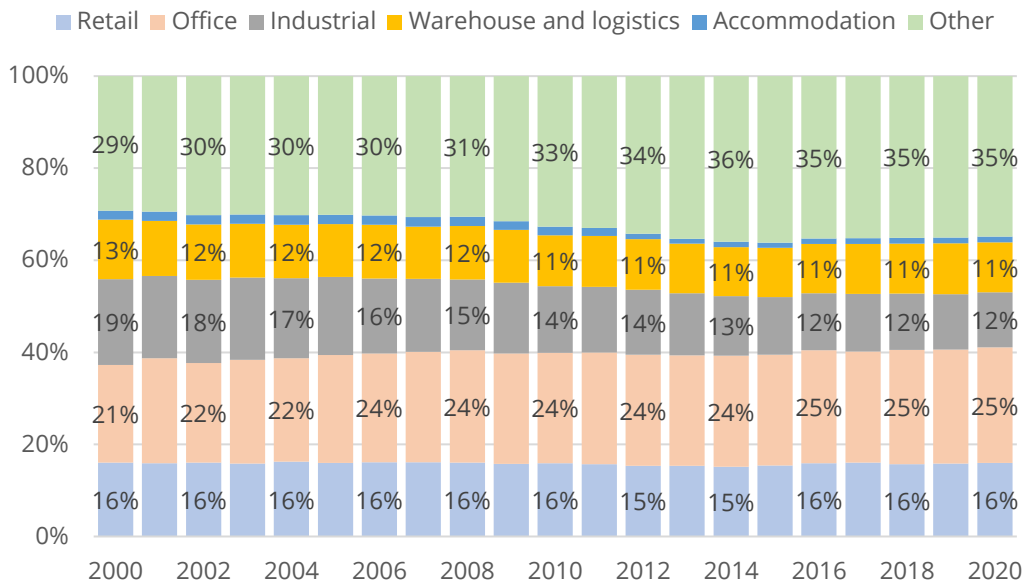
Figure 3 shows the change in the relative size of each sector over time. Retail increases the share of jobs over time and office workers are also increasing. This is part of a general shift across the economy towards services employment and away from goods manufacturing, that has been occurring over decades. Usefully, the model separates out warehousing and logistics – the movement of goods has been increasing over time. Source: Statistics New Zealand

Figure 4 shows the increase in warehousing and logistics employment relative to the declines in industrial employment.

⁷ See for example Sims 1980, Blanchard and Quah 1989 and Stock and Watson, 2001.

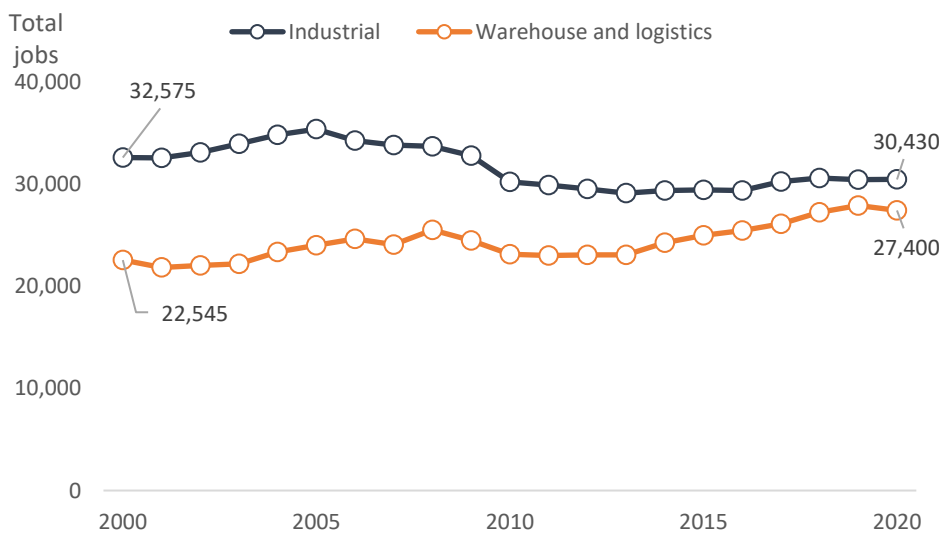


Figure 3: Each sector shows changes in demand over time



Source: Statistics New Zealand

Figure 4 Warehousing and logistics employment is increasing relative to industrial jobs
Population forecast comparison Statistics New Zealand vs Long-term Plan: **Tasman**



Source: Statistics New Zealand

The choice of sectors is appropriate, although the “Other” category now forms a large share of all jobs – 35 percent. It may prove possible to align some of the service jobs within “Other”, into some of the additional sector categories, including retail and office.

The land demand models

The land demand model produces forecasts of land demand for the market within each sector. The retail model is interesting since it usefully allows for consumption – and hence



demand for floor area – to be driven by population growth. This approach has been used in other settings and is a relatively standard approach.

For each sector, demand for floor space is translated into land demand through the floor-to-area ratio. This is a critical parameter. As I understand it, this parameter is not estimated but sourced from the population of sites for each sector in Christchurch, removing the need for estimation. One risk is that the floor-to-area ratio changes, possibly increasing over time as demand for land in general increases. Monitoring movement in the floor-to-area ratio could be done every three years as part of the Future Development Strategy process.

With regard to the office land demand model, the results rest heavily on the assumption for floor space per worker. An estimate of 39 square metres is used which might be considered towards the upper end of what might be expected for the Wellington market – even with a broad interpretation of the number of workers for each square metre. I don't know the relevant rate for Christchurch in detail, but it would be worth checking against current norms given the changing environment with respect to the number of people working from home.

The land demand models include a short-stay accommodation model which adds some detail to the forecasts. The profile of the accommodation employment forecast looks very low. This is likely because the accommodation sector was the hardest hit after the earthquakes with lower employment than other sectors. Recent years have shown reasonably growth. It would be sensible to test the robustness of the demand for land forecasts to a forecast profile for the accommodation sector that is flat rather than falling over the forecast horizon.

One of the benefits of the work to date is splitting out warehousing and logistics from industrial activity. However, solid communication is required to make sure how the forecasts are put together is well understood. Many will think that the industrial land demand from the model will include logistics and warehousing. It will be important to be clear about what comprises the industrial activity forecast.

Additional model details

A modest amount of additional summary statistics about the VAR model would be useful. This would naturally include the selection technique for the number of lags in the VAR model (one lag may well be enough with annual data) and some tests for normality of the residuals. Some discussion of whether the model is estimated in levels, growth rates or using the share of total jobs would be helpful.

Testing model performance

Structural models – like the model used to predict land demand by sector – make clear the different drivers of outputs. This offers advantages for black box models.

Since relationships are grounded in well-known historical patterns, theories or identities (that could decompose future expenditure into price and volume effects) richer stories can be conveyed rather than using a statistical model alone.

So, we could simply conduct tests of the extent to which the model provides intuitive stories that resonate with users. These tests include assessing:



- the extent to which the model is well understood; and
- if the model intuitively describes outcomes.

Alternative information sources can also be used as a cross-check on the model outputs. For example, one of the key performance indicators we use is out-of-sample forecasting precision. This could be used to test if the VAR model of economic activity does a good job of predicting future employment by sector. Since some variables are inherently more difficult to forecast than others, we need to compare forecast performance against sensible competitors. Future work might usefully report on the out-of-sample forecast performance of the activity model.

Specific Comments

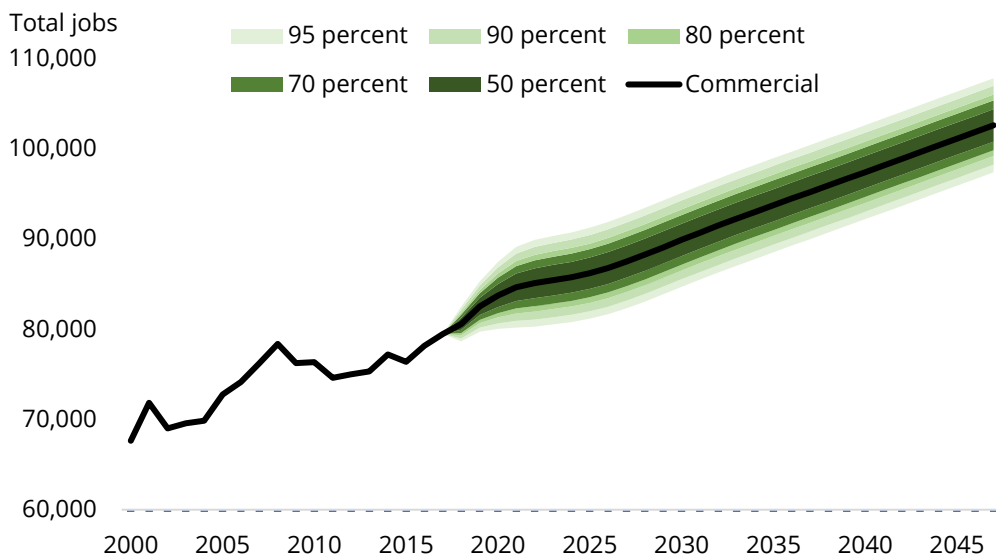
Scenario analysis

One benefit of the model is the clarity and transparency of the set-up. This makes it relatively easy to conduct “what-if” scenario analysis. This might, for instance, test specific assumptions around the growth of retail, or the propensity of sectors to be affected in different ways by a switch to allow more people to work from home.

Testing uncertainty

The model can also be used to show uncertainty. The VAR forecasts provided by the model are not in set in stone. A range of outcomes are possible. For example, Figure 5 presents an example of the uncertainty bands from forecasts of commercial employment in the Wellington region. This uncertainty can be carried over to land demand forecasts.

Figure 5: Future reports could leverage existing model estimates to show uncertainty
Wellington Region, Employees by industry, 2000-2047, Commercial



Source: Sense Partners 2018

Uncertainty bounds can also be used to place reasonable limits on scenario analysis that might be undertaken. Augmenting the model-based forecasts with scenarios can be



particularly valuable when there are well-known events or policies likely to shape future employment, but not yet realised in the jobs data.

Specific recommendations

Other work suggests that the Greater Christchurch region acts as a single labour market. Using the commuting data from the 2018 census shows strong connections between Selwyn District, Waimakariri District and Christchurch City.⁸

This means that firms operating within the Greater Christchurch region connect to workers right across the shared urban area. Future work might usefully use the same framework to build a Greater Christchurch land demand model. For little additional cost, the model could also produce land demand forecasts for Waimakariri District and Selwyn District.

Figure 6 Christchurch, Selwyn and Waimakariri are a single labour market area
Colours shows labour market areas, black borders denote local council boundaries



⁸ At least for 2018, there are insufficient commutes between Banks Peninsula and the other suburbs within the other territory authorities.



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Wellington City Council 2019, "Housing and Business Development Capacity Assessment" Wellington City Council, November.



Appendix

Our model documentation checklist is a summary of the US Energy Information Administration (2015) model documentation checklist.

Our checklist suggests:

1. A reference to the appropriate archive package.
2. A high-level description of changes from the previous archived version.
3. Model overview: A concise description of the model, its purposes and uses, how it generates forecasts, critical assumptions, and a discussion of any significant departures from accepted theory or practice.
4. Process flow diagram (optional): A flowchart showing the sequencing of the data inputs, calculations (processes), and outputs of the model.
5. Mathematical specifications: The equations representing the computations performed in the model. The relevant equations include those used to transform input data and parameters into model data and parameters, as well as equations that characterize the solutions of algorithms.
6. Variable and parameter definitions: The following should be included for all variables and parameters used in the documentation:
 - a. Clear definitions, including data sources for the input variables and parameters.
 - b. Units of measurement.
 - c. Whether each variable is an input, output, or only used in intermediate calculations. In many cases, this will be clear from the text of the documentation.
 - d. Whether data elements are direct inputs to the model or only used in preliminary calculations, e.g., to estimate fixed parameters for input to the model. If data were transformed or manipulated prior to use, an explanation should be provided.
7. Model estimation procedures: The methods and data sources used to estimate parameters and other quantities in the model should be identified.⁹

⁹ Enough information about the estimation techniques should be given to allow an expert to exactly reproduce the estimation results. This includes a precise citation of data sources, the data series used, and an exact description of which portions of the data series are used in each calculation. Relative to the US Energy Information Administration (2015) checklist, we drop existence and uniqueness of solutions and score sensitivity analysis elsewhere.