The Base of Operations: Estimating New Zealand's productive capital stock of non-agricultural land

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Abstract

Productivity measures relate output with inputs to decompose the sources of GDP growth. The answer depends partly on the comprehensive coverage of both output and inputs; a model which fails to incorporate all inputs leads to estimates of productivity that conflate actual productivity change with whatever change there is in the missing component. Land is not used up in the production process like other inputs, but it is however, an essential input into any production function. A production process cannot take place without a physical location, whether that land is rented or owned.

How important is non-agricultural land in productivity, and how does its importance change over the course of a property market bubble? As part of the ongoing quality improvement of its official productivity measures, Statistics New Zealand has recently incorporated estimates of the productive capital stock of non-agricultural land. This paper details the methodology, considerations and results of that process, and its impact on the overall productivity series.

Productivity measures relate what an industry produces (its output) with what the industry uses in the process of production (inputs). In other words, such measures attempt to decompose the sources of economic growth by answering the question: What explains changes in the amount that an industry produces in relation to its inputs? The answer depends partly on the comprehensive coverage of both output and inputs. A model that does not incorporate all inputs underestimates capital input, and therefore total inputs. This in turn leads to estimates of productivity that conflate actual productivity change with whatever change there is in the missing component (as well as any model misspecification or statistical error).

Statistics NZ is working to improve the measurement of labour inputs by distinguishing more appropriately between different types of labour, and improve the measurement of capital by improving the specification of data inputs to the model underpinning capital services. While intermediate consumption, labour, and capital account for the majority of inputs across the economy, they do not form total inputs. Worse, for specific parts of the economy (eg agriculture) they may not form the majority. The missing input is land.

The System of National Accounts (SNA) excludes land from gross fixed capital formation because land is not a produced asset. The SNA includes land improvements and reclamation, but not land in its natural state. Productivity measures and the National Accounts are answering related, but different questions. The fundamental question of the value-added measure of GDP is: how much value was added in the transformation of inputs to outputs in production function of industry X? It is at its core output-focused – the net figure is generated by subtracting goods produced in other output functions. The aggregate of those functions provides a good net picture of everything produced in the economy. As a non-produced asset, land is not particularly relevant to the question answered by the value-added measure of National Accounts.

The core question of productivity, as noted above, is: what explains changes in the output of a production process in relation to its inputs? This is the relationship of all inputs of a production function to its output. Although land is not used up in the production process like other inputs, it is nonetheless an essential input into any production function. The baking of bread by a baker cannot take place without the purchase of flour from a miller, of an oven from an oven manufacturer, of a building within which to site the oven and provide shelter, and of land on which to site the building. The production process generally cannot take place without a physical location, whether that land is rented or owned.

Before 2009 only land in the agricultural and forestry industries was explicitly included in the capital inputs used in Statistics NZ productivity measurement.

The latest productivity release in March 2009 introduced four new capital assets: commercial land, industrial land, mining land, and other non-agricultural land.[1]

Statistics NZ deemed it important to include non-agricultural land for a number of reasons:

1. Without specifically including land, the impact of change in the volume of land within the industries covered by our official productivity measures is subsumed in the residual term multi-factor productivity

1 ‘Other non-agricultural land’ includes assembly/halls, Māori, religious, sporting and other/mixed. For confidentiality purposes, mining land has been included in ‘other non-agricultural land’ in this paper.

(MFP). This reduces the meaningful analysis of the contribution of capital services and labour input to MFP.

2. Land is a significant component of the capital asset portfolio of certain service industries. Therefore, it was important to incorporate land into our asset mix to calculate more accurate measures of capital and MFP measures for these industries[2.]

3. The effect of including non-agricultural land can be reasonably expected to vary across industries, which have different land ownership patterns. It is also common for land ownership patterns within an industry to vary over time. This is especially true when rates of land ownership chang over time – trends toward property sale and lease-back arrangements in some industries would show up as reduced value added.

4. As Diewert (2000) points out, in addition to the quantity of land in use by an industry changing over time, the price of land may change over time, causing shifts in user costs of capital. This is of particular interest because it is widely understood that New Zealand experienced a 'bubble' in the property market during the last decade, peaking in 2008.

This paper briefly describes how capital data is used in productivity analysis. It also details the methodology of compiling estimates of the productive capital stock (PKS) of non-agricultural land, and looks at the impact on the existing productivity series of adding non-agricultural land to the asset mix. The inclusion of non-agricultural land is expected to affect both the total flow of capital services and the relative weights of assorted assets between industries with different holdings non-agricultural land.

Methodology

Three components were required to calculate the PKS of non-agricultural land in a way that could be included in the existing productivity measures:

1. volume estimate for each land type, in hectares
2. price indexes specific to land type (commercial, industrial, mining, other)
3. estimates of land allocation to industry, by type.

Quotable Value (QV) collates data on the area and rateable value of properties valued for tax purposes by all territorial authorities (TAs) in NZ. Land parcels are allocated into 12 categories and 77 sub-categories (see appendix). This data is high quality, readily available back to 1991 and already in use by Statistics NZ.

The rateable value on properties has two components:

1. capital value – land value + improvements, that is, buildings excluding chattels, plant, machinery, and equipment

2 Capital services are calculated at the industry level, with individual assets weighted by the derived user cost of capital. Industries are aggregated to the total measured sector for publication (see Statistics New Zealand's *Productivity Statistics: Sources and Methods* for more detail). Statistics NZ is currently investigating the possibility of publishing industry-level productivity.

2. land value – sum of the owner's estate or interest in the land, if unencumbered by any mortgage or other charge, might be expected to realise at the time of valuation if (a) offered for sale on such reasonable terms and conditions as a bona fide seller might be expected to impose; and (b) no improvements have been made to the land (Ratings Valuation Act 1998).

QV data provides volume estimates and price by land type, meaning that it supplies the required components to construct land price indexes for various types. For our purposes, the major drawback of this data was that it is not available back to the beginning of the productivity series in 1978. Although the dataset begins in 1991, the rolling three-year valuation cycle was not consistent across TAs until the mid-1990s. Various alternative sources were investigated and determined unfit for our purposes because of inconsistent volume measures, lack of availability by land type, and different systems of aggregation. For these reasons of quality, the decision was made to introduce non-agricultural land from 1996 only[3].

Land volumes and values were both sourced from the QV dataset. The six variables available for each combination of year, TA and category are:

1. total count
2. count of assessments missing area information
3. count of assessments missing value information
4. total land area in hectares
5. total sum of land value
6. sum of land value of assessments not missing area information.

All TAs must revalue at least once every three years[4], but they do so on different schedules. To create a smooth series, values for non-valuation years have been imputed by bringing forward the most recent year. In cases where there was no prior value (ie the beginning of the series), the earliest data was carried back to the beginning of the series.

Missing land areas were imputed at an individual TA-category level (eg 26IH, or heavy industrial land in Kawerau) using the following method:

1. total value was divided by total area to yield average value per ha
2. land value of assessments not missing area was subtracted from total land value, yielding the value of assessments missing area
3. value of assessments missing area was divided by the average value per ha derived in step 1, yielding missing area based on the assumption of average value/ha
4. missing area was added to total area, yielding adjusted total area.

Where value per ha could not be calculated for a given period (ie number of assessments was >0 but no value information was available), value per ha was brought forward from the prior period.

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3 The base year for the national accounts, as well as the year from which industries LC and QA are included in the measured sector for productivity, is 1996. This makes 1996 a natural breakpoint for bringing in developments that can't reasonably be backdated to the beginning of the series.

4 Before 1995 there was a five-year interval in some areas.

The summed adjusted volume was used as the land volume series, and the total current price value per year was used as the current price value series. These were in turn used to calculate annual land volume expressed in constant 1996 dollars, or productive capital stock, and land price indexes (base 1996=1000). The price indexes are used in the calculation of user costs, which in turn feeds into asset weights.

The resulting adjusted volume and value series were examined for implausible data in the following areas:

1. value per ha: magnitude and year-on-year percentage change
2. imputation: volume imputed
3. volume changes: magnitude and year-on-year percentage change.

Suspect values were discussed with QV. Anomalous values and volumes that could not be justified were replaced by means of straight line interpolation.

The process detailed above has resulted in four new assets being specified: commercial land, industrial land, mining land, and other non-agricultural land. The next challenge was to allocate these four assets to the industries presented in the Statistics NZ productivity estimates, shown in table 1.

Table 1
Measured sector covered by Statistics New Zealand Productivity Estimates

ANZSIC division	Industry aggregates used in productivity estimates
A Agriculture, forestry and fishing	AA, Agriculture AB, Forestry AC, Fishing
B Mining	BA, Mining
C Manufacturing	CA, Food, beverage and tobacco CB, Textile and apparel CC, Wood and paper products CD, Printing, publishing and recorded media CE, Petroleum, chemical, plastic and rubber products CF, Non-metallic mineral products CG, Metal products CH, Machinery and equipment CI, Furniture and other
D Electricity, gas and water supply	DA, Electricity, gas and water supply
E Construction	EA, Construction
F Wholesale trade	FA, Wholesale trade
G Retail trade	GA, Retail trade
H Accommodation, cafes and restaurants	HA, Accommodation, cafes and restaurants
I Transport and storage	IA, Transport and storage
J Communication services	JA, Communication services
K Finance and insurance	KA, Finance and insurance
L Property and business services	LC, Business services

Table 1 *continued*
Measured sector covered by Statistics New Zealand Productivity Estimates

ANZSIC division	Industry aggregates used in productivity estimates
M Government administration and defence	Not in scope
N Education	
O Health and community services	
P Cultural and recreational services	PA, Cultural and recreational services
Q Personal and other services	QA, Personal and other services

After considering a variety of sources, the 'book value of land' variable from the Annual Enterprise Survey was deemed the most reliable source of **distribution** of current price land value across industries. The distribution of these values was used to allocate the known volume of land from the QV data. The AES land values do not distinguish between types of land, which was determined using other sources where available, and judicious estimation where it is not.

Many of the major categories in the QV zoning system map neatly onto published industries. Mining land has been allocated exclusively to the mining industry. Commercial and industrial land are finely subcategorised in the QV dataset; in many cases there is an obvious one-to-one connection between use and industry (ie accommodation, cinema, elderly, liquor, motor vehicle, retail, service station) or the choice of a few options (ie parking, heavy industrial, light industrial, noxious/dangerous, warehouse). The ambiguous and residual categories (ie multi/other commercial, office, vacant, other/mixed industrial, service) require a more probabilistic approach to allocation based on confrontation with other data sources.

Allocation by industry involved a three-stage process:

1. The proportional distribution of AES book value of land across all industries and those included in the measured sector covered by our productivity estimates.

2. The measured sector proportions were purposively distributed across the available land categories (commercial, industrial, mining and other), using the 1999-2004 mean ratio of commercial to industrial land within the QV data as a benchmark.

3. The four land categories were rescaled to 100 percent, keeping the industry distribution within categories intact.

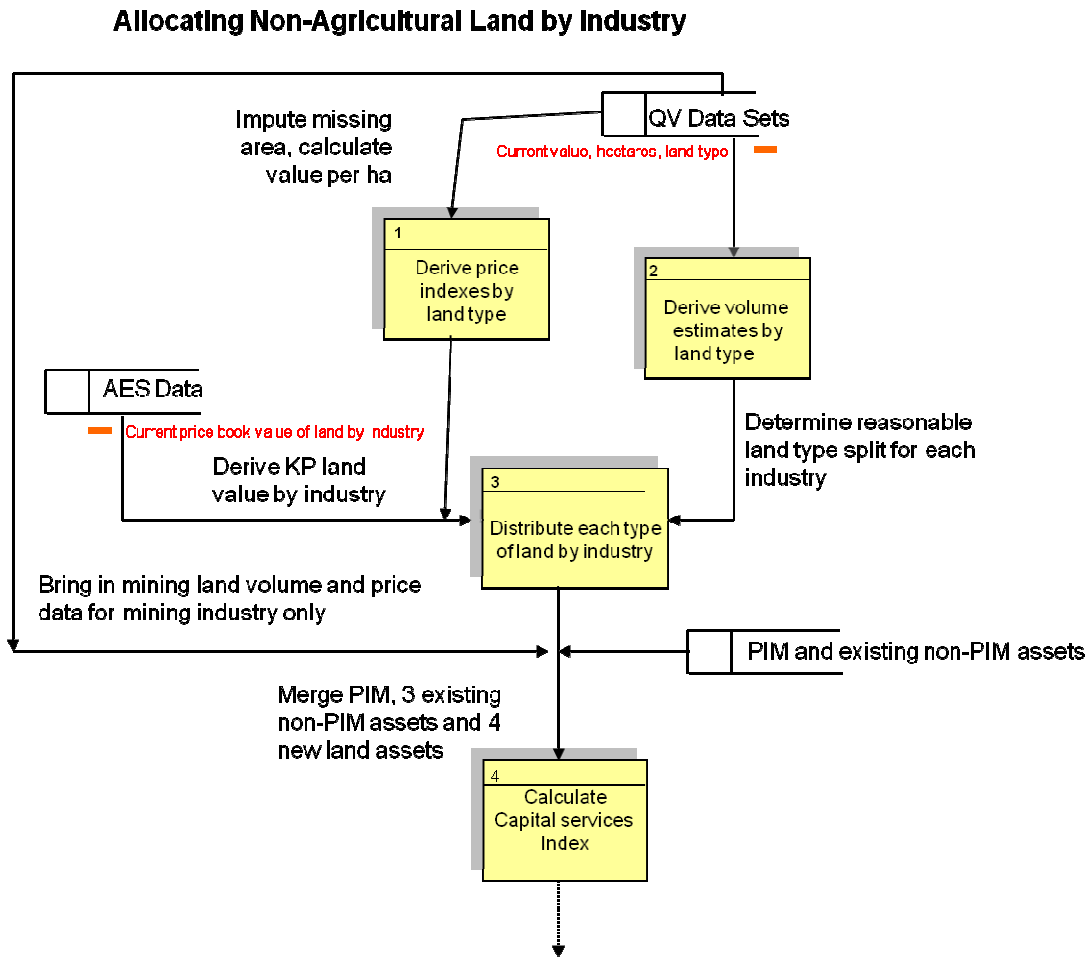
Table 2
Percentage Allocation of Non-agricultural Land to Measured Sector Industry Aggregates

ANZSIC division	Industry distribution of mean AES land value 1999–2004		Distribution of measured sector non-agricultural land across QV categories				Distribution of non-agricultural land volumes by type across measured sector industries			
	All ind	Measured sector only (rescaled)	Comm'l	Ind'l	Mining	Other	Comm'l	Ind'l	Mining	Other
B	0.38	0.99	…	…	0.99	...	…	…	100.00	…
C	5.76	14.94	…	14.94	…	...	…	44.16	…	…
D	1.17	3.03	…	…	…	3.03	…	…	…	23.26
E	0.68	1.76	…	1.76	…	…	…	5.22	…	…
F	3.90	10.13	…	10.13	…	…	…	29.93	…	…
G & H	5.98	15.51	15.51	…	…	…	29.74	…	…	…
I	10.02	26.01	14.01	7.00	…	5.00	26.85	20.70	…	38.00
J	1.26	3.28	3.28	…	…	…	6.29	…	…	…
K & L	3.24	8.42	8.42	…	…	…	16.14	…	…	…
P & Q	6.14	15.93	10.93	…	…	5.00	20.97	…	…	38.37
Total	38.53	100.00	52.15	33.83	0.99	13.03	100.00	100.00	100.00	100.00
Symbol: … not applicable										

These final proportions within each land asset type were applied to the constant price productive capital stock (PKS_KP) from the QV data to produce constant price productive capital stock by industry for commercial, industrial, and other land. Current price productive capital stock by industry was created by reflating the allocated constant price values using the price index from the appropriate series.

Figure 1 recaps the process visually, including the combination of the new land assets with the asset data coming from our perpetual inventory model (PIM).

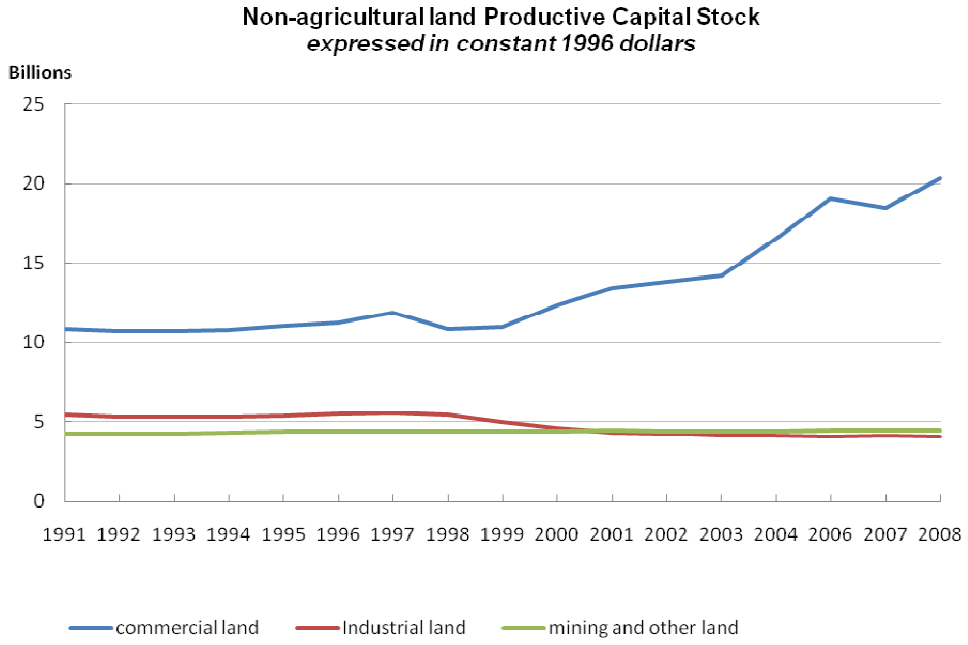
Figure 1



Results

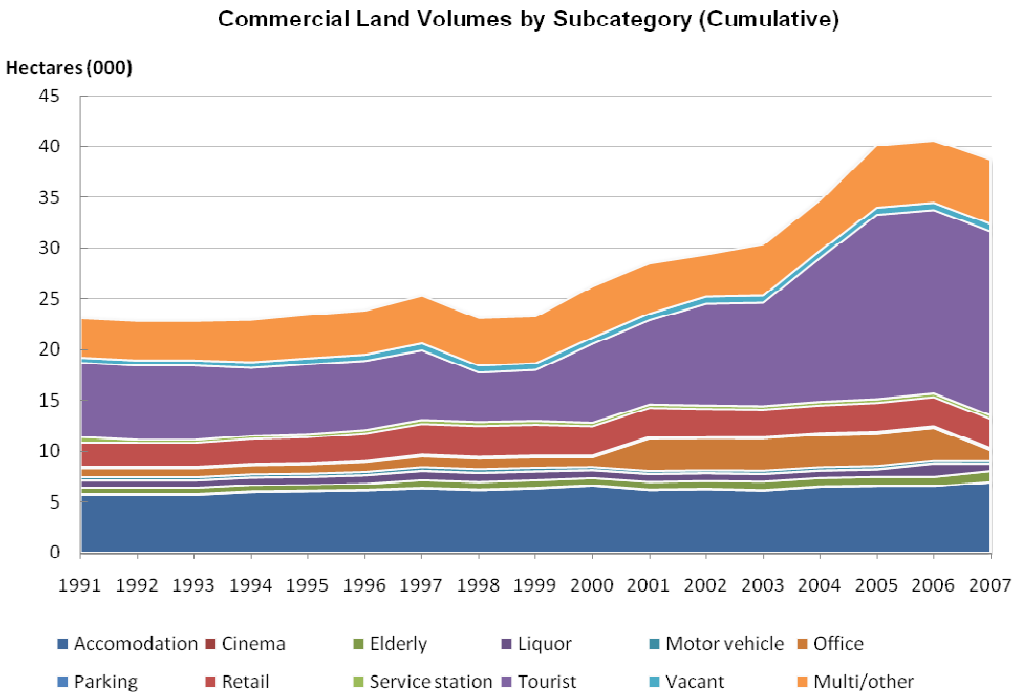
The productive capital stock (PKS) of the non-agricultural land, expressed in constant 1996 dollars, are shown in figure 2. Commercial land stands out with twice the PKS of the other types at the beginning of the series through to 1999, and climbing from that point forward to nearly double in volume by 2007. By comparison, the stock of mining and other non-agricultural land has been relatively static and the stock of industrial land has declined slightly from a peak in 1997.

Figure 2



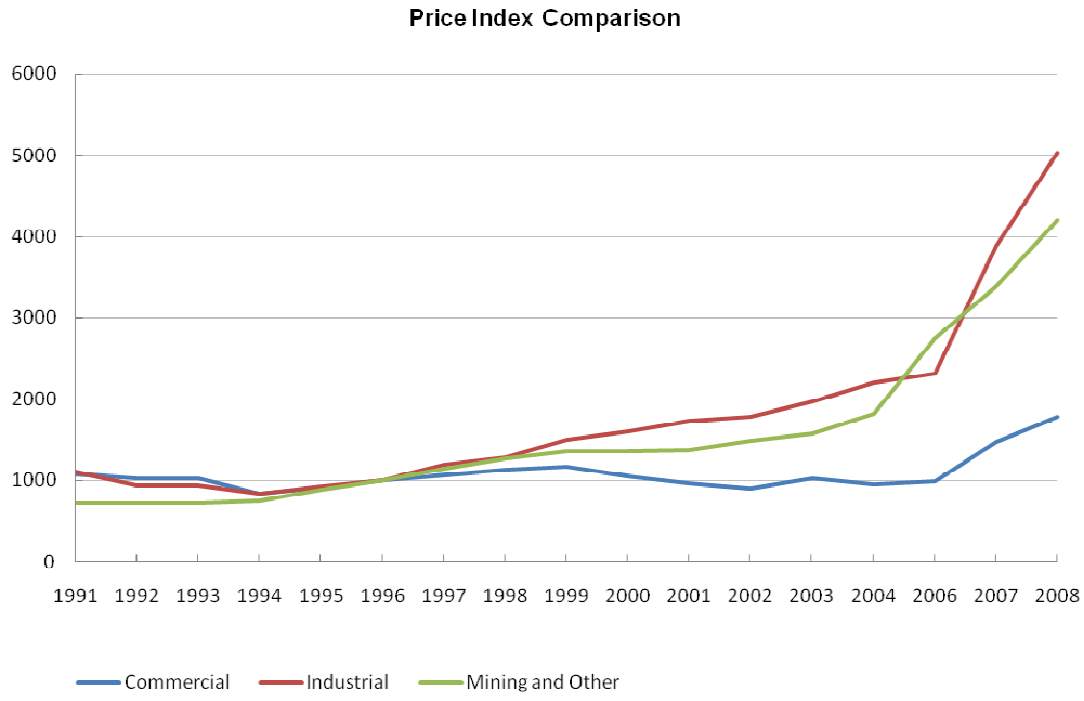
Small additions can be reclaimed through drainage and infill, but we expect the total stock of land in New Zealand to remain reasonably static. This increase in commercial land volume represents the rezoning of land from types outside of the measured sector of the economy (such as the release of government land and conversion of farmland), as well as the conversion of a small fraction of industrial land to commercial use. The movements of the underlying subcategory volumes show that the increase in commercial land volume is driven by growth in land devoted to tourism.

Figure 3



Because of the three-yearly valuation cycle and the nationwide scope of this measure, price movement is somewhat muted in comparison with the price movement of property sales in major urban centres. Nonetheless, the price change in recent years is striking in historical context. The price indexes for industrial, mining, and other non-agricultural land rose steadily from 1994 to 2004, and then began to shoot upward abruptly in a price bubble. Both indexes increased by half from 2003 to 2007, a portion of which are expected to retrace with falling prices in 2009. Somewhat counter-intuitively, the price index for commercial land falls from 1999 to 2002 because overall price increases are diluted by the conversion of more remote and less valuable land from other types into commercial (see figure).

Figure 4



Should this uneven price movement be a cause for concern? Asset price is used in calculating the user cost of capital, which in turn feeds into the asset weights and the capital services index. The table below shows the relative weights of each land asset across the entire measured sector from the time of their introduction. When put into the mix with all other assets, which are also experiencing price and volume movements, the relatively massive land price movement translates to an increase in relative weight for commercial and industrial land from 2.4 percent in 2002 to 3.5 percent in 2007, and from 0.9 percent to 1.6 percent for other non-agricultural land. These movements are well within the parameters of normal asset weight movements and are not considered any cause for alarm.

Table 3
Percentage of Asset Weights by Land Type
1997–2007

	Commercial	Industrial	Mining and other
1997	2.84	2.33	0.98
1998	2.85	2.41	1.08
1999	2.76	2.71	1.14
2000	2.75	2.78	1.13
2001	2.60	2.56	1.02

Table 3 *continued*
Percentage of Asset Weights by Land Type
1997–2007

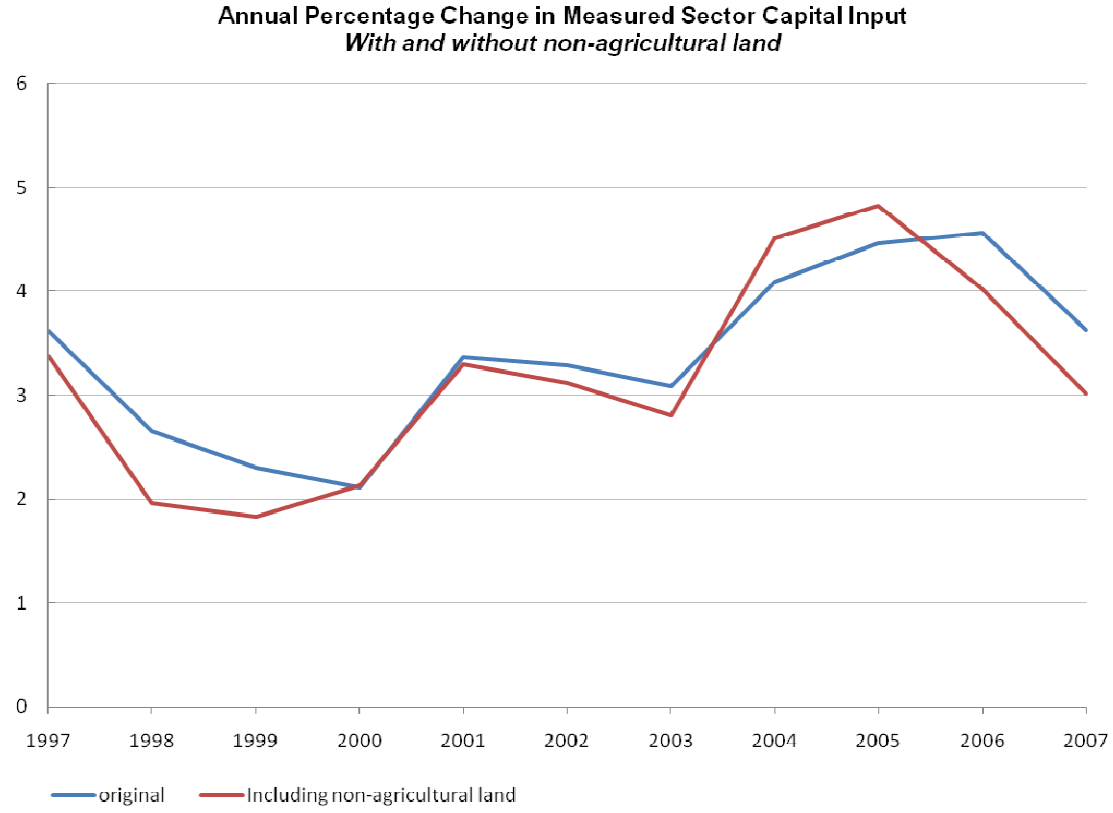
	Commercial	Industrial	Mining and other
2002	2.43	2.42	0.91
2003	2.69	2.48	0.99
2004	3.09	2.58	1.16
2005	3.24	2.80	1.27
2006	3.23	2.93	1.43
2007	3.54	3.55	1.63

Finally, we turn our attention to the capital services index. Having confirmed that the price bubble is not distorting the importance of land in the overall capital mix, what is the impact of the inclusion of non-agricultural land on capital inputs? Table 4 shows the year-on-year percentage changes in capital input, before and after the inclusion of land.

Table 4
Annual Percentage Change in Measured Sector Capital Input
With and without non-agricultural land
1979–2007

	Original	Including non-agricultural land	Difference
1979	0.06	0.06	
1980	0.96	0.96	
1981	1.39	1.39	
1982	3.72	3.72	
1983	4.94	4.94	
1984	6.20	6.20	
1985	7.28	7.28	
1986	7.08	7.08	
1987	4.72	4.72	
1988	5.01	5.01	
1989	3.95	3.95	
1990	3.69	3.69	
1991	2.91	2.91	
1992	0.40	0.40	
1993	0.22	0.22	
1994	1.86	1.86	
1995	2.95	2.95	
1996	3.06	3.06	
1997	3.62	3.38	-0.0024
1998	2.65	1.96	-0.0069
1999	2.30	1.83	-0.0047
2000	2.11	2.13	0.0003
2001	3.36	3.30	-0.0006
2002	3.29	3.12	-0.0017
2003	3.08	2.80	-0.0027
2004	4.08	4.51	0.0043
2005	4.46	4.82	0.0036
2006	4.56	4.01	-0.0054
2007	3.63	3.01%	-0.0061

Figure 5



The impact on percentage change is strongest in abrupt shifts in the direction and intensity of movement, where the land-inclusive series is smoother than the original series. Gaps between the two series open from 1997 to 2000, and again from 2003 to 2007. The impact is small, ranging from -0.43 percentage points in 2004 to 0.69 percentage points in 1998.

Appendix

Appendix table 1
Quotable Value Land Classification Categories

Land categories					
Arable	**Commercial**	**Dairying**	**Forestry**	**Horticulture**	**Industrial**
Irrigated	Accommodation	Factory	Exotic	Berry	Heavy
Non-irrigated	Cinema	Town supply	Indigenous	Citrus	Light
	Elderly		Protected	Flower	Noxious/dangerous
	Liquor		Vacant	Glasshouse	Other/mixed
	Motor vehicle			Kiwifruit	Service
	Multi/other			Market garden	Vacant
	Office			Pip fruit	Warehouse
	Parking			Stone fruit	
	Retail			Vines	
	Service station			Other/mixed	
	Vacant				
Land categories					
Lifestyle	**Mining**	**Other**	**Pastoral**	**Residential**	**Specialist**
Vacant	Coalfield	Assembly/halls/etc	Fattening	Vacant block land	Aquaculture
Improved	Gas	Educational	Grazing	Converted flat	Deer
	Limestone quarry	Health	Run	Dwelling	Horses
	Precious metals	Māori	Stud	Oyo flat	Poultry
	Rock/shingle	Passive reserve		Home and income	Pigs
	Other/mixed	Religious		Vacant flat land	Other/mixed
		Sporting		Purpose build flat	
		Utilities		Vacant	
		Vacant		Other/mixed	
		Other/mixed			

References

Diewert, E (2000). The challenge of total factor productivity measurement. *International Productivity Monitor,* 1, 45–52.