ACIL ALLEN

PEXA

2015–2025

PEXA ECONOMIC IMPACT REPORT

Connecting People to Place - How Australia's digital property settlement platform has contributed to the Australian economy

CONTENTS

FOREWORD

I am pleased to present the PEXA Economic Impact Report. For the first time, we have a clear picture as to exactly how the world's first electronic lodgement network has contributed to the Australian economy over the last decade. That understanding is important given PEXA's stewardship over a technology platform that has transformed one of the economy's most important processes — property settlement — into a faster, safer and more efficient experience for all Australians.

To ensure a robust and independent assessment, **PEXA commissioned ACIL Allen**, a leading Australian economics and policy advisory firm, to quantify and model the platform's contribution to the national economy. These results provide a compelling picture about that impact and the benefit PEXA delivers to Australia.

Established in 2010 as a joint initiative between the Federal and State Governments, and privatised in 2019, PEXA was tasked with delivering a single, national eConveyancing solution.

More than a decade on, we have fulfilled that vision. In August 2025, PEXA achieved 100% national coverage, and our platform is trusted by the property industry across the country, supporting around 20,000 transactions each week and helping thousands of Australians to achieve the dream of home ownership. Since our first transaction in 2013, we have facilitated more than 15 million property settlements, totalling over $5 trillion in value securely exchanged.

The PEXA platform represents Australian innovation at its finest: building confidence, supporting wealth creation and serving the public interest. It also signals to the world our capability to transform critical processes through innovative digital solutions. By modernising a previously fragmented and paper-heavy system, we have created a seamless, transparent and resilient piece of national critical infrastructure that reduces errors and transforms hours of work into minutes.

In this sense, PEXA's progress reflects Australia's broader success in pioneering digital transformation — and this report articulates exactly how.

The transformation PEXA enabled has delivered tangible benefits for consumers, financial institutions, governments, and the broader economy. Between 2015 and 2025, PEXA's productivity improvements are estimated to have added more than $3 billion to Australia's GDP and nearly as much to its Gross National Income. These are not just numbers: they reflect the real value of efficiency, security and reliability in an economy built on property. They also affirm our mission of Connecting People to Place, ensuring that every transaction we enable contributes to stronger communities, greater confidence, and more Australians realising their dream of home ownership.

Our journey demonstrates the profound national and international benefits of investing in digital infrastructure that works for everyone.

Russell Cohen – PEXA, Chief Executive Officer and Group Managing Director

EXECUTIVE SUMMARY

PEXA: A $3.02 billion contribution to the Australian economy. Real economic value, real people supported.

- Between 2015 and 2025, PEXA's productivity improvements are estimated to have boosted Australia's economy by $3.02 billion in Gross Domestic Product.
- Direct efficiency gains accounted for $2.4 billion, while broader flow-on effects through the economy added a further $0.6 billion.

A clear demonstration of the value of digital transformation at scale.

At a Glance: The PEXA Impact

$3.02b
Gross Domestic Product boost (2015–2025)

$2.99b
Gross National Income uplift (2015–2025)

$480m+
annual economic impact since 2022

At a Glance: PEXA today

15m+
property transactions completed

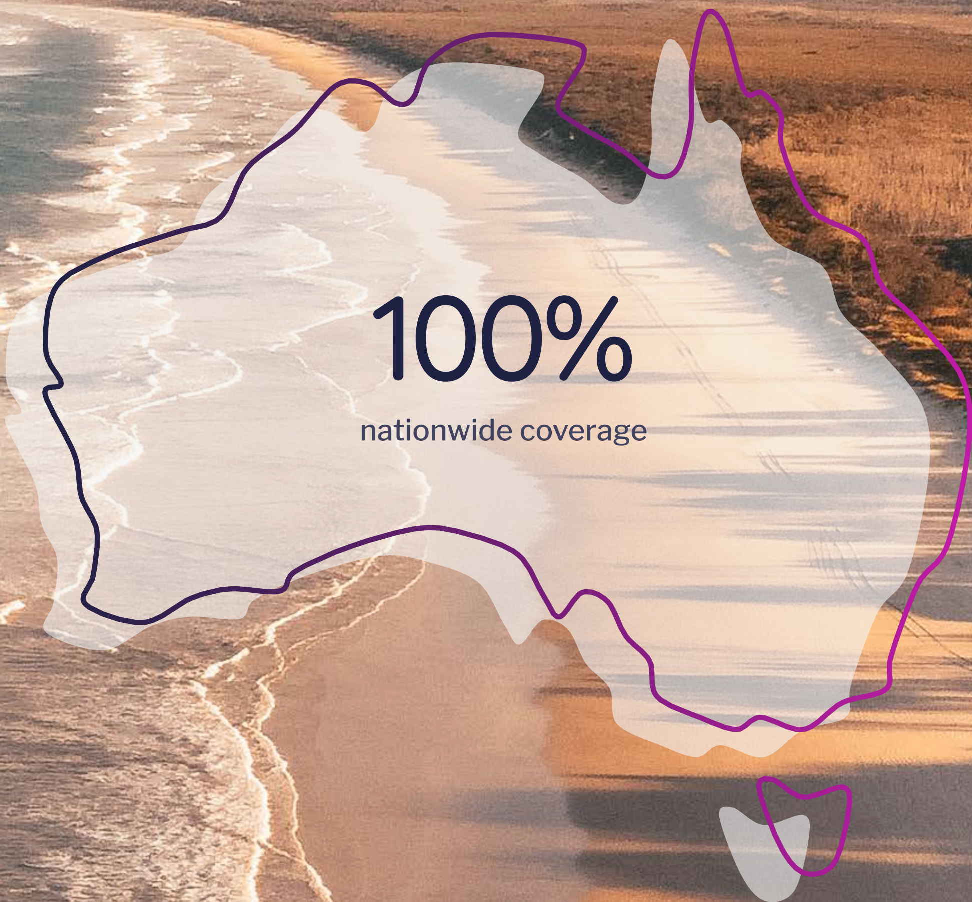
$5 trillion
in value securely exchanged

20,000
transactions supported each week

$141
price-protected consumer fee

89%
Customer Satisfaction score FY25

1,000+
employees



100%
nationwide coverage

THE EVOLUTION OF CONVEYANCING

About PEXA

PEXA is Australia's leading digital property settlement platform, responsible for processing the majority of property transactions across Australia. PEXA's unique platform has transformed Australian conveyancing and is the backbone of the property ecosystem.

PEXA provides the Australian property industry with a fast, safe, efficient and transparent property settlement solution. The platform is trusted by the property industry nationally, providing a reliable and secure property settlement solution.

Customers include more than 10,000 legal practitioners and more than 160 financial institutions, including "the big four" banks. These stakeholders benefit from a simple integrated end-to-end experience, improving security and reliability for buyers and sellers.

PEXA was established in 2010 as a joint initiative between Australia's Federal and State Governments to deliver a single, national electronic property conveyancing solution. After driving continued growth in market share over the past decade, PEXA became the preferred method of eConveyancing nationally and was privatised in 2019 before listing on the ASX in 2021. This transformation from a government initiative to a publicly listed technology company that is expanding on a global stage represents one of Australia's most successful examples of digital transformation in the property sector.

The economic impact of eConveyancing in Australia is, in practical terms, synonymous with the availability of PEXA. In that sense this report provides an important analysis of exactly how PEXA has contributed to the Australian economy, beyond the provision of eConveyancing services to practitioners and financial institutions.

THE PEXA TRANSFORMATION

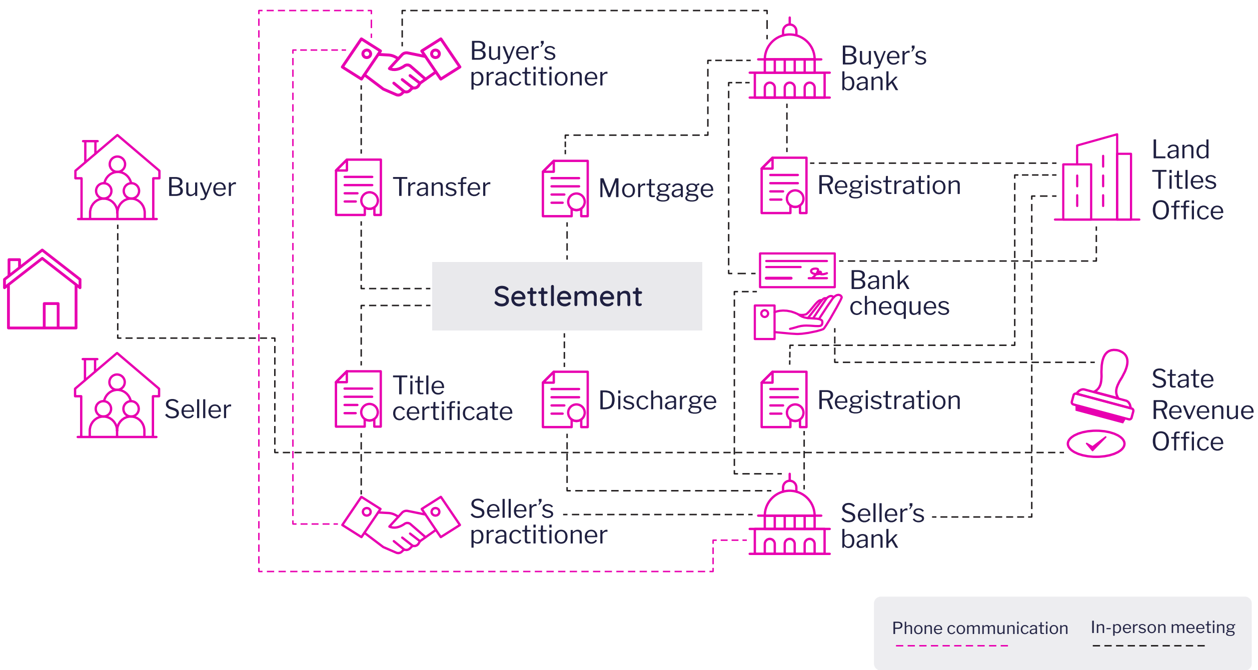
Before PEXA, conveyancing was a fragmented and inefficient process. Each participant — banks, lawyers, conveyancers — prepared documents and cheque directions in isolation, with communication often limited to emails or phone calls.

eConveyancing has transformed what was once hours of work into minutes. PEXA eliminates time-consuming paper-based processes and phone calls, reduces the risk of error and enables faster settlements.

Before PEXA vs after PEXA

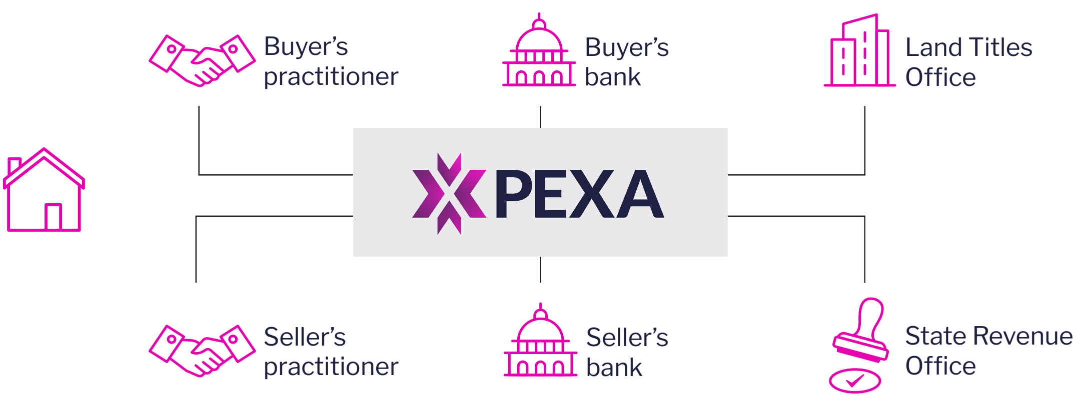
PROPERTY SETTLEMENT IN AUSTRALIA

BEFORE PEXA (1850-2013)



Paper-based process with significant manual effort and rework	Settlement dates coordinated via multiple phone calls	Multiple disparate processes - lack of coordination between parties

AFTER PEXA



Central solution for coordination between parties	Single source of truth	Digital registration and settlement avoids manual steps and rework

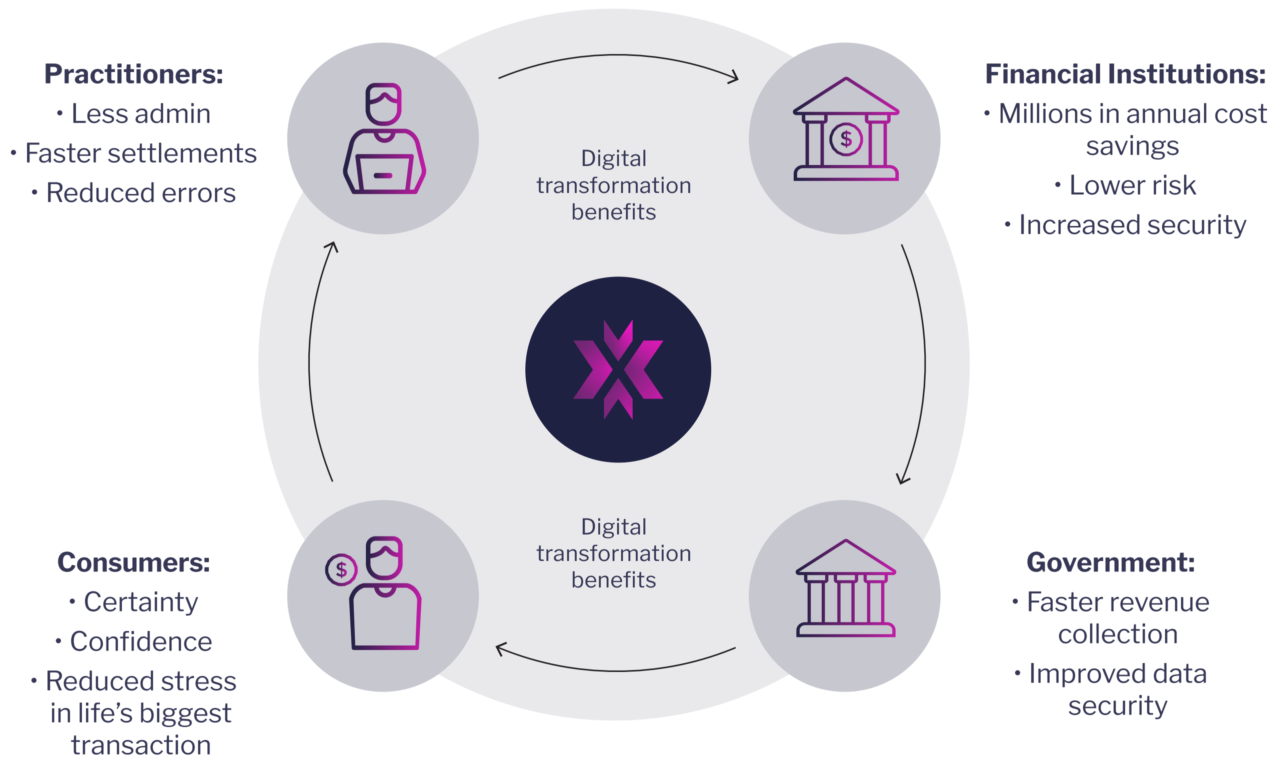
HOW PEXA CREATES VALUE

This project focuses on measuring the economic impact of eConveyancing productivity improvements on the Australian economy over the decade to 2025.

It compares the benefits of eConveyancing services with traditional paper-based conveyancing to capture the overall economic value created by the transition to a digital process.

PEXA's operations delivered substantial productivity benefits over the decade to 2025. Direct efficiency gains accounted for $2.4 billion, while broader flow-on effects through the economy added a further $0.6 billion, bringing the total economic impact to $3.02 billion. These results highlight the significant wider economic value created beyond PEXA's immediate productivity improvements.

PEXA STAKEHOLDERS



Estimations of the economic benefits of eConveyancing focus on the productivity gains associated with the substantially more efficient delivery of services enabled by PEXA's eConveyancing services. The analysis spans 2015 to 2025, and includes the productivity time savings net of PEXA investment and labour cost.

AUSTRALIA

2015-2025

Practitioners	Financial Institutions	Government
Direct = $0.67b	Direct = $1.13b	Direct = $0.59b
Indirect = $0.18b	Indirect = $0.30b	Indirect = $0.15b
TOTAL = $0.85b	**TOTAL = $1.43b**	**TOTAL = $0.74b**

= $3.02 billion

Source: ACIL Allen

Total productivity savings by stakeholder

TOTAL ECONOMIC IMPACT RESULTS

Between 2015 and 2025, PEXA's productivity improvements are estimated to have boosted Australia's economy by $3.02 billion in Gross Domestic Product (GDP), including $2.99 billion in Gross National Income (GNI). From 2022, the average annual economic impact comprised over $480 million in GDP and GNI.

PEXA's operations

Delivered substantial productivity benefits over the decade to 2025. Direct efficiency gains accounted for **$2.4 billion**, while broader flow-on effects through the economy added a further **$0.6 billion**, bringing the total economic impact to **$3.02 billion**. These results highlight the significant wider economic value created beyond PEXA's immediate productivity improvements.

Gross Domestic Product

The economic impact of productivity improvements from eConveyancing grew since 2015 as the number of eConveyancing transactions increased. By 2022 the impact on GDP had increased to over **$480 million** per annum and has remained relatively stable at that level since.

Gross National Income

Similarly, GNI impact of productivity improvements from eConveyancing grew since 2015 as the number of eConveyancing transactions increased. By 2023 the impact on GNI had increased to approximately **$480 million** per annum and has remained relatively stable at that level since.

IMPACT ON PRODUCTIVITY

The table below summarises the productivity value, in dollar terms, by stakeholder group across Australia. The total productivity benefit grew in line with the increase in eConveyancing transactions, reaching an annual saving of approximately $400 million in 2022, after which it has remained broadly stable.

This pattern indicates that the estimated benefit is largely proportional to the number of transactions. Anecdotally, however, the productivity gain per transaction has likely increased over time. For this analysis, we have taken a conservative approach and assumed that per-transaction savings remain at the levels identified in the 2018 and 2020 research.

RESULTS OVERVIEW

Increased productivity

The estimated productivity saving of PEXA's eConveyancing services is estimated at over **$390 million** dollars in 2025.

Between 2015 and 2015 this totalled **$2.4 billion**.

Productivity improvement by stakeholder

This productivity improvement included:

$0.67 billion to practitioners

$1.13 billion to financial institutions

$0.59 billion to government.

Economic impact

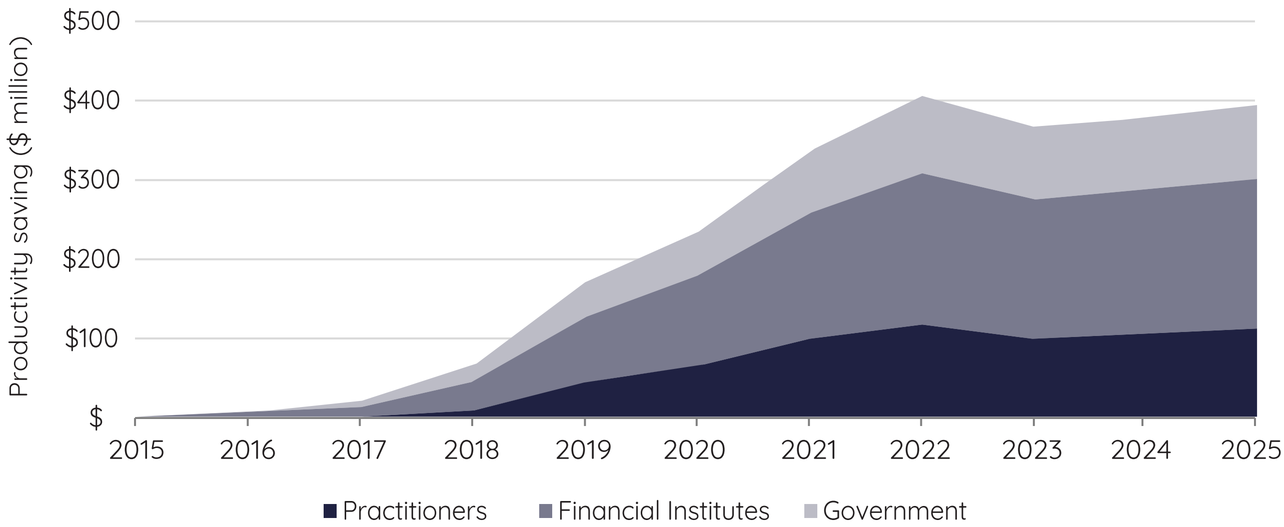
The impact of this productivity gain on the economy includes:

$480 million in GDP per annum in 2025

$3.02 billion in GDP since 2015.

ECONOMIC IMPACT

The total productivity benefit grew in line with the increase in eConveyancing transactions, reaching an annual saving of approximately $400 million in 2022, after which it has remained broadly stable.



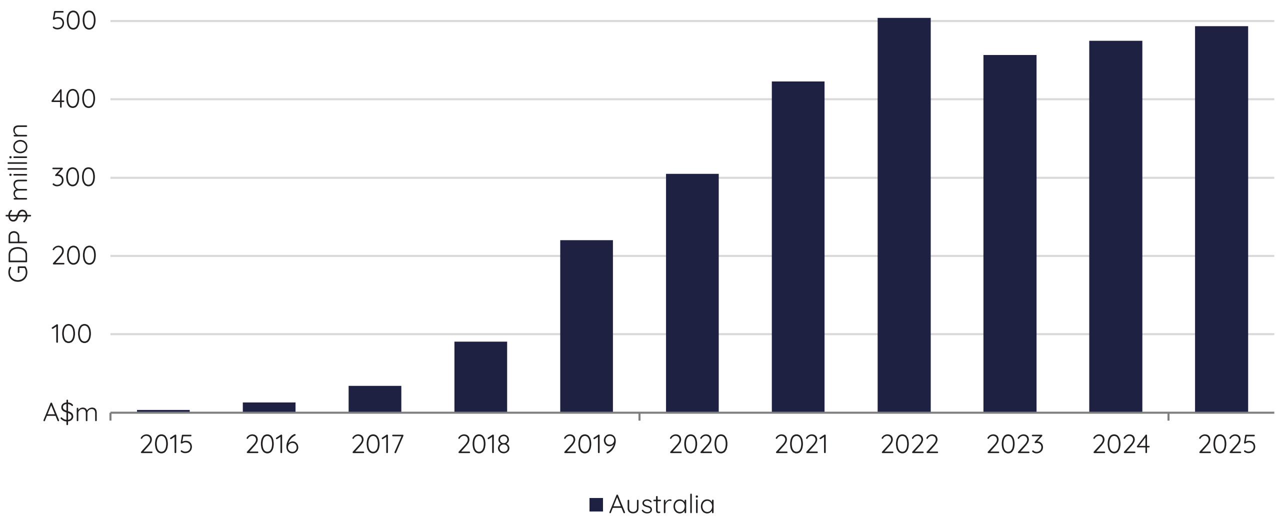
The PEXA Benefit - Efficiency & time savings

“Every day we’d lose people for a couple of hours just to go and do settlements. With PEXA, I can be doing all this in the comfort of my own home.”

PEXA Customer

GROSS DOMESTIC PRODUCT

The economic impact of productivity improvements from eConveyancing grew since 2015 as the number of eConveyancing transactions increased. By 2022 the impact on GDP had increased to over $480 million per annum and has remained relatively stable at that level since.



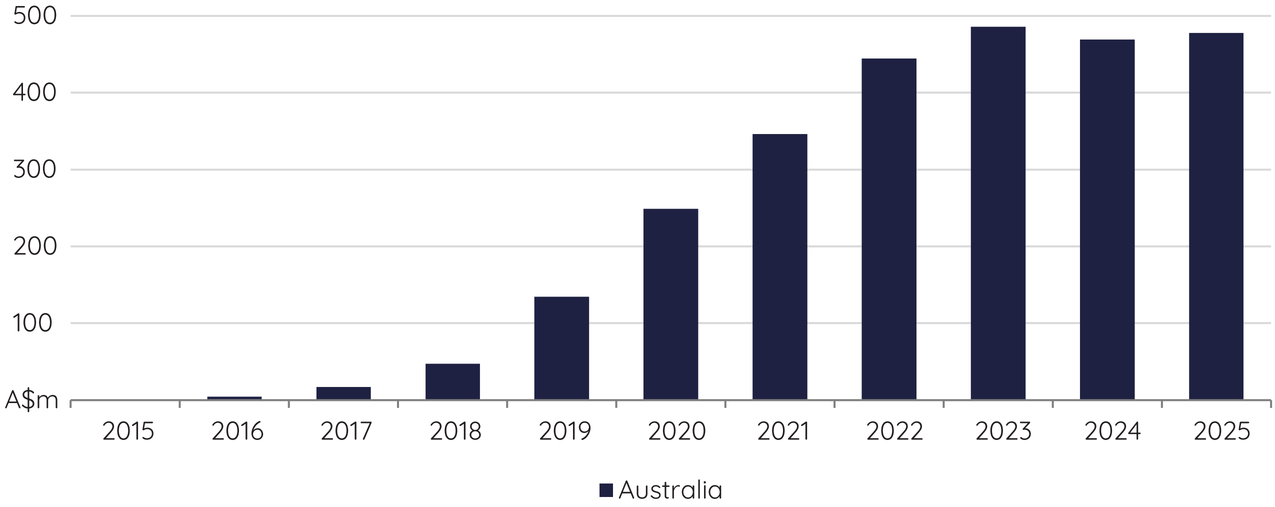
The PEXA Benefit – Reducing settlement failures

“The problem with the paper system was you’d get to settlement and there’d be an issue with a document. PEXA won’t even let you get to that stage – it irons those problems out.”

PEXA Customer

GROSS NATIONAL INCOME

The Gross National Income impact of productivity improvements from eConveyancing grew since 2015 as the number of eConveyancing transactions increased. By 2023 the impact on GNI had increased to approximately $480 million per annum - similar to GDP impact - and has remained relatively stable at that level since.



THE PEXA Benefit – removing barriers

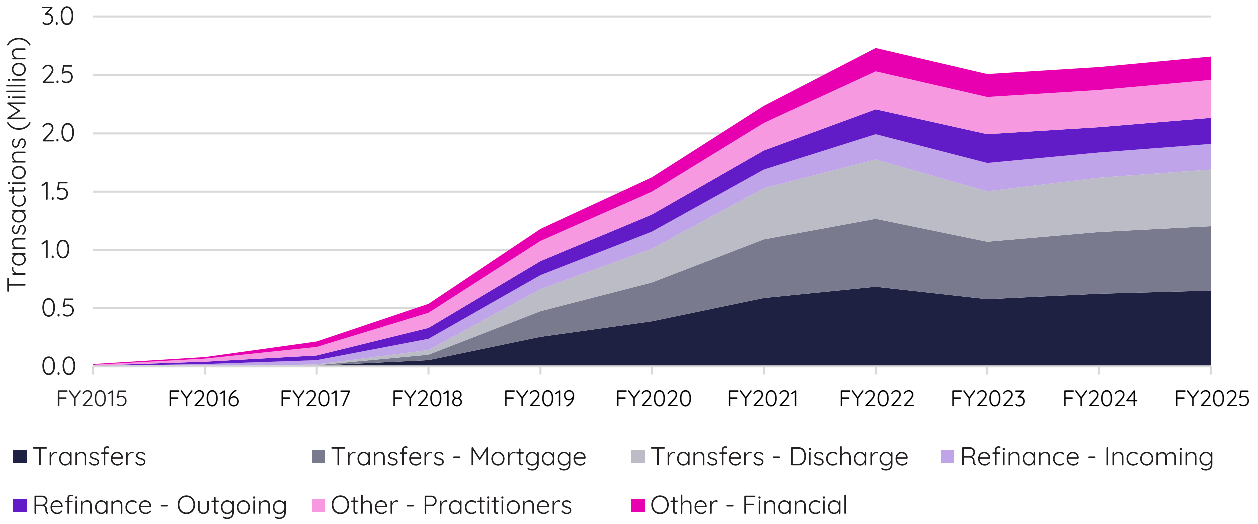
"Regional communities came on board quicker than city for most part. The need for hundreds of kilometres of travel to execute settlements was eradicated."

PEXA Customer

ECONOMIC IMPACT FINDINGS AND METHODOLOGY

The total number of applicable transactions which accrue a time saving increased from initial adoption in 2015 to close to over 2.5 million in 2022 and has remained at similar levels.

PEXA TRANSACTIONS BY TYPE



Note: these transaction counts relate to the productivity time saving instances below and may differ from reported transactions or billing events more broadly. *Source: ACIL Allen*

Time savings by type

The time savings estimated per transaction are summarised below. It shows the key time savings by stakeholder group and transaction type. These estimates are based on per-transaction time savings identified in existing research conducted in 2018 and 2020.

Although anecdotal evidence suggests that productivity gains per transaction have likely increased over time, this analysis adopts a conservative approach by assuming that productivity improvements remain at the levels identified in those earlier studies.

ESTIMATED TIME SAVING BY STAKEHOLDER AND TRANSACTION TYPE

Transaction Type	Vendor's practitioner*			Purchaser's practitioner*			Practitioner#	Government#		Other#
	Pre	Settle	Post	Pre	Settle	Post	Other	LROs	SROs	Financial
Size of time saving										
Hours	2.5	1	0.25	3	1	0.25	1	0.8	0.6	3.2
Transfers										
Transfer	✓	✓	✓	✓	✓	✓		✓	✓	
Mortgage										✓
Discharge										✓
Refinance										
Incoming								✓		✓
Outgoing								✓		✓
Other (including: caveats, priority notice, transmission, lease)										
Practitioner							✓	✓		
Financial								✓		✓

Pre – Pre Settlement, Post – Post Settlement, LROs – State Land Registry Offices, SROs – State Revenue Offices, Financial – Financial institutions,

Source: PEXA, *KPMG 2018 Electronic Conveyancing Analysis of the benefits of electronic conveying to conveyancers and lawyers in NSW, #Serdar Avsar & David Horton 2020 The Net Economic Value of E-Conveyancing in FY20 Across Australian Mainland States.

Average PEXA fee by type

To account for the offsetting cost of providing eConveyancing services, such as software development, maintenance, hardware and delivery labour costs, we include the average fee charged for key groupings of eConveyancing transactions. This is summarised in the table below, together with assumed wages for valuing time savings across stakeholders.

AVERAGE FEES AND ASSUMED WAGES

Transaction Type	Average fee per transaction (ex GST)	Average wages across stakeholder groups
Transfers		
Transfer (per billing event)	$278 ($121)	$55
Mortgage	$63	$55
Discharge	$46	$55
Refinance		
Incoming (per side of transaction)	$109 ($54)	$55
Outgoing (per side of transaction)	$109 ($54)	$55
Other (including: caveats, priority notice, transmission, lease)		
Practitioner	$29	$55
Financial	$29	$55

Source: ACIL Allen

Other key assumptions

As part of the modelling we are able to set the labour market response. For this project we have conservatively assumed that national employment is fixed, as such there is no net impact on employment nationally.

A NOTE ON METHODOLOGY

The methodology used to calculate the time and cost savings driven by PEXA are conservative and relate to core PEXA functionality offered since 2015, such as title transfers, lodgements, purchase and settlements, mortgages and discharges. The calculations do not take into account potential savings driven by the implementation of platform improvements introduced in recent years, such as auto-balance and mobile signing, and new products such as PEXA Key, PEXA Projects, PEXA Planner and PEXA Tracker. This conservative approach ensures that the economic impact assessment is as accurate as possible, given the impact of these new products would be more difficult to quantify. The overall impact would likely be much higher inclusive of these initiatives.

APPENDIX

A Tasman Global

Introduction.

A.1 Overview

Tasman Global is a dynamic, global CGE model that has been developed by ACIL Allen for the purpose of undertaking economic impact analysis at the regional, state, national and global level.

A CGE model captures the interlinkages between the markets of all commodities and factors, taking into account resource constraints, to find a simultaneous equilibrium in all markets. A global CGE model extends this interdependence of the markets across world regions and finds simultaneous equilibrium globally. A dynamic model adds onto this the interconnection of equilibrium economies across time periods. For example, investments made today are going to determine the capital stocks of tomorrow and hence future equilibrium outcomes depend on today's equilibrium outcome, and so on.

A dynamic global CGE model, such as *Tasman Global*, has the capability of addressing total, sectoral, spatial and temporal efficiency of resource allocation as it connects markets globally and over time. Being a recursively dynamic model, however, its ability to address temporal issues is limited. In particular, *Tasman Global* cannot typically address issues requiring partial or perfect foresight. However, as documented in Jakeman et al (2001), it is possible to introduce partial or perfect foresight in certain markets using algorithmic approaches. Notwithstanding this, the model does have the capability to project the economic impacts over time of given changes in policies, tastes and technologies in any region of the world economy on all sectors and agents of all regions of the world economy.

Tasman Global was developed from the 2001 version of the Global Trade and Environment Model (GTEM) developed by ABARE (Pant 2001) and has been evolving ever since. In turn, GTEM was developed out of the MEGABARE model (ABARE 1996), which contained significant advancements over the Global Trade Analysis Project (GTAP) model of that time (Hertel 1997).

A.2 A dynamic model

Tasman Global is a model that estimates relationships between variables at different points in time. This is in contrast to comparative static models, which compare 2 equilibriums (one before an economic disturbance and one following). A dynamic model such as *Tasman Global* is beneficial when analysing issues for which both the timing of and the adjustment path that economies follow are relevant in the analysis.

A.3 The database

A key advantage of *Tasman Global* is the level of detail in the database underpinning the model. The database is derived from the GTAP database (Aguiar et al. 2019). This database is a fully documented, publicly available global data base which contains complete bilateral trade information, transport and protection linkages among regions for all GTAP commodities. It is the most detailed database of its type in the world.

Tasman Global builds on the GTAP database by adding the following important features:

— a detailed population and labour market database

— detailed technology representation within key industries (such as electricity generation and iron and steel production)

- disaggregation of a range of major commodities including iron ore, bauxite, alumina, primary aluminium, brown coal, black coal and LNG
- the ability to repatriate labour and capital income
- explicit representation of the states and territories of Australia
- the capacity to represent multiple regions within states and territories of Australia explicitly.

Nominally, version 10.1 of the *Tasman Global* database divides the world economy into 153 regions (145 international regions plus the 8 states and territories of Australia) although in reality the regions are frequently disaggregated further. ACIL Allen regularly models Australian or international projects or policies at the regional level including at the state/territory/provincial level for various countries.

The *Tasman Global* database also contains a wealth of sectoral detail currently identifying up to 76 industries (**Table A.1**). The foundation of this information is the input-output tables that underpin the database. The input-output tables account for the distribution of industry production to satisfy industry and final demands.

Industry demands, so-called intermediate usage, are the demands from each industry for inputs. For example, electricity is an input into the production of communications. In other words, the communications industry uses electricity as an intermediate input.

Final demands are those made by households, governments, investors and foreigners (export demand). These final demands, as the name suggests, represent the demand for finished goods and services. To continue the example, electricity is used by households – their consumption of electricity is a final demand.

Each sector in the economy is typically assumed to produce one commodity, although in *Tasman Global*, the electricity, transport and iron and steel sectors are modelled using a 'technology bundle' approach. With this approach, different known production methods are used to generate a homogeneous output for the 'technology bundle' industry. For example, electricity can be generated using brown coal, black coal, petroleum, base load gas, peak load gas, nuclear, hydro, geothermal, biomass, wind, solar or other renewable based technologies – each of which has its own cost structure.

The other key feature of the database is that the cost structure of each industry is also represented in detail. Each industry purchases intermediate inputs (from domestic and imported sources) primary factors (labour, capital, land and natural resources) as well as paying taxes or receiving subsidies.

Table A.1 Standard sectors in the Tasman Global CGE model

No	Name	No	Name
1	Paddy rice	39	Diesel (incl. nonconventional diesel)
2	Wheat	40	Other petroleum, coal products
3	Cereal grains nec	41	Chemical, rubber, plastic products
4	Vegetables, fruit, nuts	42	Iron ore
5	Oil seeds	43	Bauxite
6	Sugar cane, sugar beet	44	Mineral products nec
7	Plant- based fibres	45	Ferrous metals
8	Crops nec	46	Alumina
9	Bovine cattle, sheep, goats, horses	47	Primary aluminium
10	Pigs	48	Metals nec
11	Animal products nec	49	Metal products
12	Raw milk	50	Motor vehicle and parts
13	Wool, silk worm cocoons	51	Transport equipment nec
14	Forestry	52	Electronic equipment
15	Fishing	53	Machinery and equipment nec
16	Brown coal	54	Manufactures nec

No	Name	No	Name
17	Black coal	55	Electricity generation
18	Oil	56	Electricity transmission and distribution
19	LNG	57	Gas manufacture, distribution
20	Other natural gas	58	Water
21	Minerals nec	59	Construction
22	Bovine meat products	60	Trade
23	Pig meat products	61	Road transport
24	Meat products nec	62	Rail and pipeline transport
25	Vegetables oils and fats	63	Water transport
26	Dairy products	64	Air transport
27	Processed rice	65	Transport nec
28	Sugar	66	Warehousing and support activities
29	Food products nec	67	
30	Wine	68	Communication
31	Beer	69	Financial services nec
32	Spirits and RTDs	70	Insurance
33	Other beverages and tobacco products	71	Business services nec
34	Textiles	72	Recreational and other services
35	Wearing apparel	73	Public Administration and Defence
36	Leather products	74	Education
37	Wood products	75	Human health and social work activities
38	Paper products, publishing	76	Dwellings

Note: nec = not elsewhere classified.

Source: ACIL Allen

A.4 Model structure

Given its heritage, the structure of the *Tasman Global* model closely follows that of the GTAP and GTEM models and interested readers are encouraged to refer to the documentation of these models for more detail (namely Hertel 1997 and Pant 2001, respectively). In summary:

— The model divides the world into a variety of regions and international waters.
  – Each region is fully represented with its own 'bottom-up' social accounting matrix and could be a local community, an LGA, state, country or a group of countries. The number of regions in a given simulation depends on the database aggregation. Each region consists of households, a government with a tax system, production sectors, investors, traders and finance brokers.
  – 'International waters' are a hypothetical region in which global traders operate and use international shipping services to ship goods from one region to the other. It also houses an international finance 'clearing house' that pools global savings and allocates the fund to investors located in every region.
  – Each region has a 'regional household'[7] that collects all factor payments, taxes, net foreign borrowings, net repatriation of factor incomes due to foreign ownership and any net income from trading of emission permits.
— The income of the regional household is allocated across private consumption, government consumption and savings according to a Cobb-Douglas utility function, which, in practice, means that the share of income going to each component is assumed to remain constant in nominal terms.

[7] The term "regional household" was devised for the GTAP model. In essence it is an agent that aggregates all incomes attributable to the residents of a given region before distributing the funds to the various types of regional consumption (including savings).

- Private consumption of each commodity is determined by maximising utility subject to a Constant Difference of Elasticities (CDE) function which includes both price and income elasticities.
- Government consumption of each commodity is determined by maximising utility subject to a Cobb-Douglas utility function.
- Each region has *n* production sectors, each producing single products using various production functions where they aim to maximise profits (or minimise costs) and take all prices as given. The nature of the production functions chosen in the model means that producers exhibit constant returns to scale.
  - In general, each producer supplies consumption goods by combining an aggregate energy-primary factor bundle with other intermediate inputs and according to a Leontief production function (which in practice means that the quantity shares remain in fixed proportions). Within the aggregate energy-primary factor bundle, the individual energy commodities and primary factors are combined using a nested Constant Elasticity of Substitution (CES) production function, in which energy and primary factor aggregates substitute according to a CES function with the individual energy commodities and individual primary factors substituting with their respective aggregates according to further CES production functions.
  - Exceptions to the above include the electricity generation, iron and steel and road transport sectors. These sectors employ the 'technology bundle' approach developed by ABARE (1996) in which non-homogenous technologies are employed to produce a homogenous output with the choice of technology governed by minimising costs according to a modified-Constant Ratios of Elasticities of Substitution, Homothetic (modified-CRESH) production function. For example, electricity may be generated from a variety of technologies (including brown coal, black coal, gas, nuclear, hydro, solar, wind etc.), iron and steel may be produced from blast furnace or electric arc technologies while road transport services may be supplied using a range of different vehicle technologies. The 'modified-CRESH' function differs from the traditional CRESH function by also imposing the condition that the quantity units are homogenous.
- There are 4 primary factors (land, labour, mobile capital and fixed capital). While labour and mobile capital are used by all production sectors, land is only used by agricultural sectors while fixed capital is typically employed in industries with natural resources (such as fishing, forestry and mining) or in selected industries built by ACIL Allen.
  - Land supply in each region is typically assumed to remain fixed through time with the allocation of land between sectors occurring to maximise returns subject to a Constant Elasticity of Transformation (CET) utility function.
  - Mobile capital accumulates as a result of net investment. It is implicitly assumed in *Tasman Global* that it takes one year for capital to be installed. Hence, supply of capital in the current period depends on the last year's capital stock and investments made during the previous year.
  - Labour supply in each year is determined by endogenous changes in population, given participation rates and a given unemployment rate. In policy scenarios, the supply of labour is positively influenced by movements in the real wage rate governed by the elasticity of supply. For countries where sub-regions have been specified (such as Australia), migration between regions is induced by changes in relative real wages with the constraint that net interregional migration equals zero. For regions where the labour market has been disaggregated to include occupations, there is limited substitution allowed between occupations by individuals supplying labour (according to a modified-CET utility function) and by firms demanding labour (according to a modified-CES production function) based on movements in relative real wages.
  - The supply of fixed capital is given for each sector in each region.

  The model has the option for these assumptions to be changed at the time of model application if alternative factor supply behaviours are considered more relevant.
- It is assumed that labour (by occupation) and mobile capital are fully mobile across production sectors implying that, in equilibrium, wage rates (by occupation) and rental rates on capital are equalised across all sectors within each region. To a lesser extent, labour and capital are mobile between regions

through international financial investment and migration, but this sort of mobility is sluggish and does not equalise rates of return across regions.

- For most international regions, for each consumer (private, government, industries and the local investment sector), consumption goods can be sourced either from domestic or imported sources. In any country that has disaggregated regions (such as Australia), consumption goods can also be sourced from other intrastate or interstate regions. In all cases, the source of non-domestically produced consumption goods is determined by minimising costs subject to a CRESH utility function. Like most other CGE models, a CES demand function is used to model the relative demand for domestically-produced commodities versus non-domestically produced commodities. The elasticities chosen for the CES and CRESH demand functions mean that consumers in each region have a higher preference for domestically-produced commodities than non-domestic commodities and a higher preference for intrastate- or interstate-produced commodities than foreign commodities.
- The capital account in *Tasman Global* is open. Domestic savers in each region purchase 'bonds' in the global financial market through local 'brokers' while investors in each region sell bonds to the global financial market to raise investible funds. A flexible global interest rate clears the global financial market.
- It is assumed that regions may differ in their risk characteristics and policy configurations. As a result, rates of return on money invested in physical capital may differ between regions and therefore may be different from the global cost of funds. Any difference between the local rates of return on capital and the global cost of borrowing is treated as the result of the existence of a risk premium and policy imperfections in the international capital market. It is maintained that the equilibrium allocation of investment requires the equalisation of changes in (as opposed to the absolute levels of) rates of return over the base year rates of return.
- Any excess of investment over domestic savings in a given region causes an increase in the net debt of that region. It is assumed that debtors service the debt at the interest rate that clears the global financial market. Similarly, regions that are net savers gives rise to interest receipts from the global financial market at the same interest rate.
- Investment in each region is used by the regional investor to purchase a suite of intermediate goods according to a Leontief production function to construct capital stock with the regional investor cost minimising by choosing between domestic, interstate and imported sources of each intermediate good via the CRESH production function. The regional cost of creating new capital stock versus the local rates of return on mobile capital is what determines the regional rate of return on new investment.
- In equilibrium, exports of a good from one region to the rest of world are equal to the import demand for that good in the remaining regions. Together with the merchandise trade balance, the net payments on foreign debt add up to the current account balance. *Tasman Global* does not require that the current account be in balance every year. It allows the capital account to move in a compensatory direction to maintain the balance of payments. The exchange rate provides the flexibility to keep the balance of payments in balance.
- Detailed bilateral transport margins for every commodity are specified in the starting database. By default, the bilateral transport mode shares are assumed to be constant, with the supply of international transportation services by each region solved by a cost-minimising international trader according to a Cobb-Douglas demand function.
- Emissions of 6 anthropogenic greenhouse gases (namely, carbon dioxide, methane, nitrous oxide, HFCs, PFCs and SF_6) associated with economic activity are tracked in the model. Almost all sources and sectors are represented; emissions from agricultural residues and land-use change and forestry activities are not explicitly modelled but can be accounted for externally. Prices can be applied to emissions which are converted to industry-specific production taxes or commodity-specific sales taxes that impact on demand. Abatement technologies similar to those adopted in a report released by the

Commonwealth Government (2008) are available and emission quotas can be set globally or by region along with allocation schemes that enable emissions to be traded between regions.

More detail regarding specific elements of the model structure are discussed in the following sections.

A.5 Population growth and labour supply

Population growth is an important determinant of economic growth through the supply of labour and the demand for final goods and services. Population growth for each region represented in the *Tasman Global* database is projected using ACIL Allen's in-house demographic model. The demographic model projects how the population in each region grows and how age and gender composition changes over time and is an important tool for determining the changes in regional labour supply and total population over the projected period.

For each region, the model projects the changes in age-specific birth, mortality and net migration rates by gender for 116 age cohorts (0-114 and 115+). The demographic model also projects changes in participation rates by gender by age for each region, and, when combined with the age and gender composition of the population, endogenously projects the future supply of labour in each region. Changes in life expectancy are a function of income per person as well as assumed technical progress on lowering mortality rates for a given income (for example, reducing malaria-related mortality through better medicines, education, governance etc.). Participation rates are a function of life expectancy as well as expected changes in higher education rates, fertility rates and changes in the work force as a share of the total population.

Labour supply is derived from the combination of the projected regional population by age by gender and regional participation rates by age by gender. Over the projection period, labour supply in most developed economies is projected to grow slower than total population because of ageing population effects.

For the Australian states and territories, the projected aggregate labour supply from ACIL Allen's demographic module is used as the base level potential workforce for the detailed Australian labour market module, which is described in the next section.

A.6 The Australian labour market

Tasman Global has a detailed representation of the Australian labour market which has been designed to capture:

— different occupations

— changes to participation rates (or average hours worked) due to changes in real wages

— changes to unemployment rates due to changes in labour demand

— limited substitution between occupations by the firms demanding labour and by the individuals supplying labour

— limited labour mobility between states and regions within each state.

Tasman Global recognises 97 different occupations within Australia – although the exact number of occupations depends on the aggregation. The firms that hire labour are provided with some limited scope to change between these 97 labour types as the relative real wage between them changes. Similarly, the individuals supplying labour have a limited ability to change occupations in response to the changing relative real wage between occupations. Finally, as the real wage for a given occupation rises in one state relative to other states, workers are given some ability to respond by shifting their location. The model produces results at the 97 3-digit Australian and New Zealand Standard Classification of Occupations (ANZSCO) level which are presented in **Table A.2**.

The labour market structure of *Tasman Global* is thus designed to capture the reality of labour markets in Australia, where supply and demand at the occupational level do adjust, but within limits.

Labour supply in *Tasman Global* is presented as a three-stage process:

1. Labour makes itself available to the workforce based on movements in the real wage and the unemployment rate.
2. Labour chooses between occupations in a state based on relative real wages within the state.
3. Labour of a given occupation chooses in which state to locate based on movements in the relative real wage for that occupation between states.

By default, *Tasman Global*, like all CGE models, assumes that markets clear. Therefore, overall, supply and demand for different occupations will equate (as is the case in other markets in the model).

Table A.2 Occupations in the *Tasman Global* database, ANZSCO 3-digit level (minor groups)

ANZSCO code, Description	ANZSCO code, Description	ANZSCO code, Description
1. MANAGERS	**3. TECHNICIANS & TRADES WORKERS**	**5. CLERICAL & ADMINISTRATIVE**
111 Chief Executives, General Managers and	311 Agricultural, Medical and Science Technicians	511 Contract, Program and Project Administrators
Legislators	312 Building and Engineering Technicians	512 Office and Practice Managers
121 Farmers and Farm Managers	313 ICT and Telecommunications Technicians	521 Personal Assistants and Secretaries
131 Advertising and Sales Managers	321 Automotive Electricians and Mechanics	531 General Clerks
132 Business Administration Managers	322 Fabrication Engineering Trades Workers	532 Keyboard Operators
133 Construction, Distribution and Production	323 Mechanical Engineering Trades Workers	541 Call or Contact Centre Information Clerks
Managers	324 Panel beaters, and Vehicle Body Builders,	542 Receptionists
134 Education, Health and Welfare Services	Trimmers and Painters	551 Accounting Clerks and Bookkeepers
Managers	331 Bricklayers, and Carpenters and Joiners	552 Financial and Insurance Clerks
135 ICT Managers	332 Floor Finishers and Painting Trades Workers	561 Clerical and Office Support Workers
139 Miscellaneous Specialist Managers	333 Glaziers, Plasterers and Tilers	591 Logistics Clerks
141 Accommodation and Hospitality Managers	334 Plumbers	599 Miscellaneous Clerical and Administrative
142 Retail Managers	341 Electricians	Workers
149 Miscellaneous Hospitality, Retail and Service	342 Electronics and Telecommunications Trades	
Managers	Workers	**6. SALES WORKERS**
	351 Food Trades Workers	611 Insurance Agents and Sales Representatives
2. PROFESSIONALS	361 Animal Attendants and Trainers, and Shearers	612 Real Estate Sales Agents
211 Arts Professionals	362 Horticultural Trades Workers	621 Sales Assistants and Salespersons
212 Media Professionals	391 Hairdressers	631 Checkout Operators and Office Cashiers
221 Accountants, Auditors and Company Secretaries	392 Printing Trades Workers	639 Miscellaneous Sales Support Workers
222 Financial Brokers and Dealers, and Investment	393 Textile, Clothing and Footwear Trades Workers	
Advisers	394 Wood Trades Workers	**7. MACHINERY OPERATORS & DRIVERS**
223 Human Resource and Training Professionals	399 Miscellaneous Technicians and Trades Workers	711 Machine Operators
224 Information and Organisation Professionals		712 Stationary Plant Operators
225 Sales, Marketing and Public Relations	**4. COMMUNITY & PERSONAL SERVICE**	721 Mobile Plant Operators
Professionals	411 Health and Welfare Support Workers	731 Automobile, Bus and Rail Drivers
231 Air and Marine Transport Professionals	421 Child Carers	732 Delivery Drivers
232 Architects, Designers, Planners and Surveyors	422 Education Aides	733 Truck Drivers
233 Engineering Professionals	423 Personal Carers and Assistants	741 Storepersons
234 Natural and Physical Science Professionals	431 Hospitality Workers	
241 School Teachers	441 Defence Force Members, Fire Fighters and	**8. LABOURERS**
242 Tertiary Education Teachers	Police	811 Cleaners and Laundry Workers
249 Miscellaneous Education Professionals	442 Prison and Security Officers	821 Construction and Mining Labourers
251 Health Diagnostic and Promotion Professionals	451 Personal Service and Travel Workers	831 Food Process Workers
252 Health Therapy Professionals	452 Sports and Fitness Workers	832 Packers and Product Assemblers
253 Medical Practitioners		839 Miscellaneous Factory Process Workers
254 Midwifery and Nursing Professionals		841 Farm, Forestry and Garden Workers
261 Business and Systems Analysts, and		851 Food Preparation Assistants
Programmers		891 Freight Handlers and Shelf Fillers
262 Database and Systems Administrators, and ICT		899 Miscellaneous Labourers
Security Specialists		
263 ICT Network and Support Professionals		
271 Legal Professionals		
272 Social and Welfare Professionals		

Source: ABS (2009), ANZSCO – Australian and New Zealand Standard Classifications Of Occupations, First edition, Revision 1, ABS catalogue no. 1220.0.

The *Tasman Global* database includes a detailed representation of the Australian labour market that has been designed to capture the supply and demand for different skills and occupations by industry. To achieve this, the Australian workforce is characterised by detailed supply and demand matrices.

On the supply side, the Australian population is characterised by a five-dimensional matrix consisting of:

— 7 post-school qualification levels

— 12 main qualification fields of highest educational attainment

— 97 occupations

— 101 age groups (namely 0 to 99 and 100+)

— 2 genders.

The data for this matrix is measured in persons and was sourced from the latest ABS Census. As the skills elements of the database and model structure have not been used for this project, it will be ignored in this discussion.

The 97 occupations are those specified at the 3-digit level (or Minor Groups) under the ANZSCO (see **Table A.2**).

On the demand side, each industry demands a particular mix of occupations. This matrix is specified in units of FTE jobs where an FTE employee works an average of 37.5 hours per week. Consistent with the labour supply matrix, the data for FTE jobs by occupation by industry was also sourced from the ABS Census and updated using the latest labour force statistics.

Matching the demand and supply side matrices means that there is the implicit assumption that the average hours per worker are constant, but it is noted that, mathematically, changes in participation rates have the same effect as changes in average hours worked.

A.7 Labour Market Model Structure

In the model, the underlying growth of each industry in the Australian economy results in a growth in demand for a particular set of skills and occupations. In contrast, the supply of each set of skills and occupations in a given year is primarily driven by the underlying demographics of the resident population. This creates a market for each skill by occupation that (unless specified otherwise) needs to clear at the start and end of each time period. [8] The labour markets clear by a combination of different prices (i.e. wages) for each labour type and by allowing a range of demand and supply substitution possibilities, including:

- changes in firms' demand for labour driven by changes in the underlying production technology
  - for technology bundle industries (electricity, iron and steel and road transportation) this occurs due to changes between explicitly identified alternative technologies
  - for non-technology bundle industries this includes substitution between factors (such as labour for capital) or energy for factors
- changes to participation rates (or average hours worked) due to changes in real wages
- changes in the occupations of a person due to changes in relative real wages
- substitution between occupations by the firms demanding labour due to changes in the relative costs
- changes to unemployment rates due to changes in labour demand
- limited labour mobility between states due to changes in relative real wages.

All of the labour supply substitution functions are modified-CET functions in which people supply their skills, occupation and rates of participation as a positive function of relative wages. However, unlike a standard CET (or CES) function, the functions are 'modified' to enforce an additional constraint that the number of people is maintained before and after substitution.[9]

Although technically solved simultaneously, the labour market in *Tasman Global* can be thought of as a five-stage process:

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[8] For example, at the start and end of each week for this analysis. *Tasman Global* can be run with different steps in time, such as quarterly or bi-annually in which case the markets would clear at the start and end of these time points.

[9] As discussed in Dixon et al (1997), a standard CES/CET function is defined in terms of *effective units*. Quantitatively this means that, when substituting between, say, X_1 and X_2 to form a total quantity X using a CET function a simple summation generally does not actually equal X. Use of these functions is common practice in CGE models when substituting between substantially different units (such as labour versus capital or imported versus domestic services) but was not deemed appropriate when tracking the physical number of people. Such 'modified' functions have long been employed in the technology bundles of *Tasman Global* and GTEM. The Productivity Commission have proposed alternatives to the standard CES to overcome similar and other weaknesses when applied to internationally traded commodities.

- Labour makes itself available to the workforce based on movements in the real wage (that is, it actively participates with a certain number of average hours worked per week).
- The age, gender and occupations of the underlying population combined with the participation rate by gender by age implies a given supply of labour (the potentially available workforce).
- A portion of the potentially available workforce is unemployed, implying a given available labour force.
- Labour chooses to move between occupations based on relative real wages.
- Industries alter their demands for labour as a whole and for specific occupations based on the relative cost of labour to other inputs and the relative cost of each occupation.

By default, *Tasman Global*, like all CGE models, assumes that markets clear at the start and end of each period. Therefore, overall, supply and demand for different occupations will equate (as is the case in other markets in the model). In principle, (subject to zero starting values) people of any age and gender can move between any of the 97 occupations while industries can produce their output with any mix of occupations. However, in practice the combination of the initial database, the functional forms, low elasticities and moderate changes in relative prices for skills, occupations etc. means that there is only low to moderate change induced by these functions. The changes are sufficient to clear the markets, but not enough to radically change the structure of the workforce in the timeframe of this analysis.

Factor-factor substitution elasticities in non-technology bundle industries are industry specific and are the same as those specified in the GTAP database[10], while the fuel-factor and technology bundle elasticities are the same as those specified in GTEM.[11] The detailed labour market elasticities are ACIL Allen assumptions, previously calibrated in the context of the model framework to replicate the historical change in the observed Australian labour market over a five year period.[12] The unemployment rate function in the policy scenarios is a non-linear function of the change in the labour demand relative to the base case with the elasticity being a function of the unemployment rate (that is, the lower the unemployment rate the lower the elasticity and the higher the unemployment rate the higher the elasticity).

[10] Narayanan et al. (2012).

[11] Pant (2007).

[12] This method is a common way of calibrating the economic relationships assumed in CGE models to those observed in the economy. See for example Dixon and Rimmer (2002).