Improving the quality and scope of forestry forecasting work in Australia

Research undertaken as a Gottstein fellow

Mihir Gupta

Research funded in collaboration by the Gottstein Trust and the Australian Bureau of Agricultural and Resource Economics and Sciences

The information contained in this report is published for the general information of industry. Although all reasonable endeavour has been made to verify the accuracy of the material, no liability is accepted by the Author for any inaccuracy therein, nor by the Trustees of the Gottstein Memorial Trust Fund. The opinions expressed are those of the author and do not necessarily represent the opinions of the Trustees.

Ownership of intellectual property rights

Copyright © Trustees of the J.W. Gottstein Memorial Trust Fund 2012. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior written permission of the Trustees.

JOSEPH WILLIAM GOTTSTEIN MEMORIAL TRUST FUND

The Joseph William Gottstein Memorial Trust Fund was established in 1971 as a national educational Trust for the benefit of Australia's forest products industries. The purpose of the fund is "*to create opportunities for selected persons to acquire knowledge which will promote the interests of Australian industries which use forest products for the production of sawn timber, plywood, composite wood, pulp and paper and similar derived products.*"

Bill Gottstein was an outstanding forest products research scientist working with the Division of Forest Products of the Commonwealth Scientific Industrial Research Organization (CSIRO) when tragically he was killed in 1971 photographing a tree-felling operation in New Guinea. He was held in such high esteem by the industry that he had assisted for many years that substantial financial support to establish an Educational Trust Fund to perpetuate his name was promptly forthcoming.

The Trust's major forms of activity are,

1. Fellowships and Awards - each year applications are invited from eligible candidates to submit a study programme in an area considered of benefit to the Australian forestry and forest industries. Study tours undertaken by Fellows have usually been to overseas countries but several have been within Australia. Fellows are obliged to submit reports on completion of their programme. These are then distributed to industry if appropriate. Skill Advancement Awards recognise the potential of persons working in the industry to improve their work skills and so advance their career prospects. It takes the form of a monetary grant.
2. Seminars - the information gained by Fellows is often best disseminated by seminars as well as through the written reports.
3. Wood Science Courses - at approximately two yearly intervals the Trust organises a week-long intensive course in wood science for executives and consultants in the Australian forest industries.
4. Study Tours - industry group study tours are arranged periodically and have been well supported.

Further information may be obtained by writing to,

The Secretary,
J.W. Gottstein Memorial Trust Fund,
Private Bag 10,
Clayton South, VIC 3169, Australia
secretary@gottsteintrust.com

Cataloguing data

Gupta, M 2016, *Improving the quality and scope of forestry forecasting work in Australia,* ABARES report to client prepared for the Gottstein Trust, Canberra, February, CC BY 3.0.

Contents

1 Introduction **1**

2 Research activities in the United States **3**

Research at Forest Economics Advisors 4

Meetings with Washington State Department of Natural Resources 9

3 Applications for ongoing ABARES research **12**

ABARES Forest Resource Use Model 12

Econometric consumption and trade models 17

Potential future modelling and forecasting work 18

4 Outcomes from my research activities **19**

Appendix A: Itinerary 21

References and publications 22

Tables

Table 1 Some major publications released by Forest Economics Advisors 3

Table 2 Some major publications released by the Department of Natural Resources, Washington State 4

Table 3 Consumption of wood products is linked to end use markets 7

Table 4 Modelling housing activity 7

Table 5 Australia's data gaps and the potential applications for these variables in Australia 20

Table A1 Itinerary for research activities undertaken in the United States 21

Figures

Figure 1 Analysis of US labour markets 6

Figure 2 Housing commencements, real gross domestic product and population growth 14

Figure 3 Structure of the Forest Resource Use Model (FORUM) 16

1 Introduction

In consultation with various stakeholders both in the Department of Agriculture and Water Resources and in industry associations such as Forest and Wood Products Australia (FWPA), I put forward my research proposal to the Gottstein trust to "improve the scope and quality of forestry forecasting work in Australia". ABARES has developed models in-house including the Forest and Resource Use Model (FORUM) and econometric models for domestic forestry consumption and trade that are key for ongoing work. The outputs, which include estimates for production, consumption and trade of wood products, can be used by stakeholders to inform short and long term investment decisions, planning policies and to improve forestry operations. ABARES constantly seeks to improve the reliability and forecasting capabilities of these models.

The Gottstein fellowship enabled me to travel to the United States and work with colleagues from Forest Economic Advisors (FEA) in Boston and the Department of Natural Resources (DNR) in Olympia, Washington State. FEA is a company that undertakes detailed analysis and forecasts for the US forest products industry using sophisticated mathematical and econometric methods. Their team is comprised of experienced economists and researchers. DNR is a state government organisation that manages state trust lands in Washington State. DNR manages 5.6 million acres of forest, agricultural, aquatic and commercial lands to generate revenue while also ensuring the preservation of the natural ecosystem. Colleagues at DNR are very knowledgeable about the forestry sector and undertake extensive data collection, analysis and reporting to support the DNR objective.

During the two weeks I spent at FEA and the one week with DNR, I focussed on three key areas of work:

- Gain a better understanding of the datasets and methodologies underpinning analyses undertaken by these organisations. This activity could further improve the quality of ABARES data reporting and analysis. It may also assist in building a framework for reporting additional data – such as price information that is currently unavailable in Australia.

- Research price elasticities of major wood commodities. Price information for the forestry industry in Australia can be improved and this research could greatly assist in developing robust forecasting models that examine price effects for short-term supply and demand outlooks.
    - I sought to understand analysis of price trends and forecasts undertaken by my host organisations.

- Examine research being conducted and models being developed at these organisations for forecasts of trends in wood product supply and demand and outlooks for the forestry industry.

    - I sought to examine the estimation and projections for underlying model inputs such as housing starts (building commencements of new houses) and inventory levels, with the view that improving the estimation process for these inputs could improve the quality and reliability of our output projections.

Working at FEA has put me in a position to better contribute to and develop the short-term and long-term outlooks for Australian forestry currently being researched in ABARES. In particular, I found potential applications in Australia for the methodology used by FEA for various input projections. Improving the quality of these inputs directly improves the quality of our forecasts and outlook studies. During my time at DNR, I found that there a number of similarities in the annual reports published by ABARES and DNR. I gained valuable insights into the forestry statistics and methodologies released in such publications as well as the workings of the forestry industry in Washington State.

This report summarises the activities and research I undertook at these organisations. In the second chapter I summarise the discussions I had with colleagues at FEA and DNR, outlining the research undertaken by those organisations and some of the methodologies and modelling frameworks they use. In the third chapter, I provide an overview of current forestry modelling frameworks used by ABARES and what aspects could be improved using the knowledge I have gained as a Gottstein fellow. In the fourth chapter I summarise the potential applications for this research in Australia by discussing some major data and knowledge gaps for our models and how we could benefit from having access to this information.

2 Research activities in the United States

To pursue my research proposal, I identified forest economic advisory organisations in the United States that I could visit; namely Forest Economic Advisors near the Boston area and the Department of Natural Resources in Olympia, Washington State.

Forest Economics Advisors (FEA) is a leading forestry analysis and research organisation providing data, analysis and forecasts for forest products with a particular emphasis on North American markets. FEA operates on a subscription service, providing their clients with access to comprehensive reports and spreadsheets as well as consultative services for queries about forest product markets. Some of FEA's major publications are listed in Table 1. Working with FEA offered me an exciting opportunity to compare and improve methodologies and models currently being developed at ABARES for short-term and long-term outlooks for the forestry industry.

Table 1 Some major publications released by Forest Economics Advisors

Publication titles and links
Monthly Lumber (sawnwood) Advisor – a monthly report providing analysis and forecasts of North American softwood lumber markets.
getfea.com/lumber/monthly-lumber-advisor/forecast-summary
Monthly Structural Panel Advisor – a monthly report for Oriented strandboard and softwood plywood markets.
getfea.com/structural-panels/monthly-sp-advisor/forecast-summary
Monthly Particleboard and MDF Advisor – a monthly report for particleboard and medium density fibreboard markets.
getfea.com/structural-panels/monthly-sp-advisor/forecast-summary
Monthly Macroeconomic Advisor – provides analysis and forecasts for the US and Canadian economies.
getfea.com/macroeconomy/monthly-macro-advisor/forecast-summary

Note: For more information, contact the FEA team using the information on their website: getfea.com/contact-us. Lumber is defined as a manufactured product derived from a log through sawing or planing.

The Washington State Department of Natural Resources (DNR) publishes a number of annual reports on the US forestry industry in a similar manner to publications such as the Australian Forest and Wood Product Statistics (AFWPS) released by ABARES. Some of DNR's major publications are listed in Table 2. DNR is effectively a trust manager that manages and generates revenue from state-owned natural resources, and regulates how people use these resources. Visiting DNR offered me an opportunity to better compare the available forestry statistics and methodologies released in such publications while also providing me with insights into the US forestry industry.

Table 2 Some major publications released by the Department of Natural Resources, Washington State

Publication titles and links
Washington State Timber Harvest reports – annual report detailing the volume of log harvest from public and private forests. dnr.wa.gov/TimberHarvestReports
Quarterly Economic and Revenue Forecasts – includes analysis of current economic conditions and projections of future revenue. dnr.wa.gov/about/fiscal-reports/quarterly-economic-and-revenue-forecasts
Washington State Mill Surveys – biennial publication that reports key statistics for Washington State's wood processing industry. dnr.wa.gov/about/fiscal-reports/washington-state-mill-surveys

Note: For more information, contact DNR using the information on their website:
dnr.wa.gov/about-washington-department-natural-resources

Research at Forest Economics Advisors

I had the opportunity to engage extensively with the researchers and analysts at FEA over a two week period. Paul F. Jannke, one of the principals at FEA, has extensive experience studying North American lumber (sawnwood) markets and provided me with insights into the forecasting techniques and modelling framework used at FEA. I also had the opportunity to discuss panel markets with Greg Lewis and timber (log) availability forecasts with Rocky Goodnow. Paul was my primary contact at FEA and showed me the technicalities of their datasets and models, as well as the process they undertake to ensure their forecasts are relevant and reliable for the forestry industry in North America. Rather than forecast at a national level, FEA focuses on developing regional forecasts which are then aggregated to derive state or national estimates. Regional demand-side data in Australia is limited and econometric models or other models used by ABARES typically provide national aggregated forecasts. Analysts at FEA put in a lot of effort in analysing the cyclical patterns in historic economic variables. These are also applied to their forecasts to investigate peaks and troughs in business cycles and the potential implications for the forest industry.

Paul demonstrated the workings of the price models for lumber (sawnwood) used at FEA. One of the essential variables required for price forecasting at FEA is a measure of inventory or stocks. Analysts of lumber (sawnwood) markets in North America have access to extensive and comprehensive datasets including price and inventory data. Much of the information is collected through detailed and long-running surveys operated by third parties. For example, "Random Lengths" (randomlengths.com), is a company providing the forest products industry with reports of market activity and prices, related trends, issues and analyses. Their weekly report summarises price information for more than 1600 different types of wood products, presents analysis that could affect prices (such as changes in the housing market, production, log supply

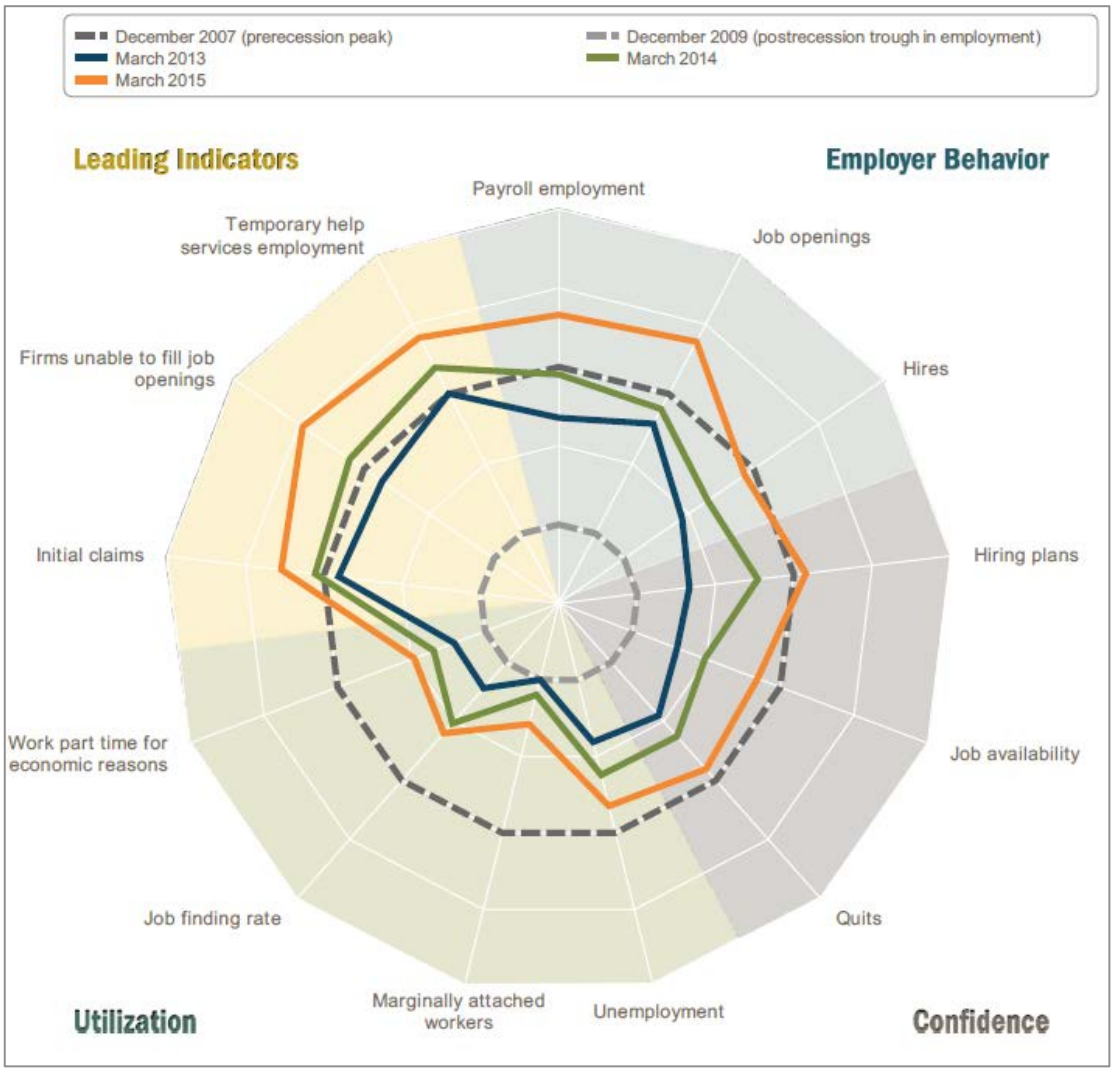
and labour markets), and gives industry news on new companies or changes in existing companies amongst other data and information. Random Lengths' staff collect this information through hundreds of telephone interviews each week with buyers and sellers of wood products. These include producers, wholesalers, distributors, secondary manufacturers, buying groups, and large retailers. In their surveys, Random Lengths focus on prices of completed purchases and sales of wood products.

Paul also spoke to me about his general outlook for North American lumber (sawnwood) markets and the factors considered by FEA when making projections for lumber markets. A number of macroeconomic factors are considered including real GDP growth, consumer spending, investment measures, activity in the manufacturing sector, employment and demographics amongst a range of other variables. These factors are forecast by Brendan K. Lowney, a principal and macroeconomist at FEA. Brendan analyses the North American and international economic landscape which shapes the projections for lumber and wood product markets.

For lumber market outlooks, Paul also examines the major end-use markets and factors influencing these markets including the US housing sector, population growth, residential improvements (or renovations and alterations), furniture markets and non-residential construction. One of the interesting things I learned was that historically, North American markets have been quite self-contained – typically, domestic production was almost completely used for domestic consumption. However, over the past decade, domestic demand has weakened and North American markets are increasingly affected by global timber markets and developments in emerging economies such as China. Imports and exports of wood products have increased and the focus for companies such as FEA is progressively to expand their coverage of developments and activity in international markets.

I was shown a very interesting graphic used to examine trends in labour markets (Figure 1). This analysis is used to inform the general economic outlook as well as implications for the housing sector and is used in FEA's modelling framework. The figure also demonstrates the data-rich environment that the United States operates in. The graphic takes 13 employment metrics and groups them in 4 categories: leading indicators, employer behaviour, confidence, and utilisation (FRBA 2015). The basic idea behind Figure 1, is to show how far away the labour market is from the conditions that prevailed at the peak of the last economic cycle (December 2007) and from the conditions that prevailed when the labour market was at its cyclical low (December 2009). At a glance, it illustrates that as of March 2015, utilisation and confidence in US labour markets are below the peak of the last economic cycle but employer behaviour and leading indicators are above the previous peak.

Figure 1 Analysis of US labour markets



Forecasts for the housing sector drive the modelling framework at FEA. Consumption of structural timber is estimated for each end-use and linked to activity in the housing sector; for example, consumption of aggregated structural timber for detached dwelling construction is linked to commencements of detached dwellings, the average size of a detached dwelling and estimates for timber usage per square foot of a detached dwelling. Similarly, consumption of panel products is linked to furniture sales (Table 3).

Table 3 Consumption of wood products is linked to end use markets

Model output	Inputs used
Consumption of structural wood products for detached dwellings	Number of detached dwellings (DD) commencements, estimate for timber usage in DD, average size of DD
Consumption of structural wood products for multi-dwellings	Number of multi-dwellings (MD) commencements, estimate for timber usage in MD, average size of MD
Consumption of panel products	Data for furniture sales, estimates for timber usage for different types and grades of furniture

Paul also offered some very useful insights for projections of housing starts and incorporating estimates for the potential demand for housing, thereby providing inventory estimates for the following period. Housing inventory levels are essentially a built-up stock of new houses that have been constructed in the previous period but as yet have not been used by new households. He suggested estimating a "headship rate" for different age brackets (age groups) that is based on the number of households and the population for each age bracket. This variable is similar in concept to "household formations" in Australia and can be used as a proxy for the demand for housing and can be compared to the number of housing commencements (or supply) and can inform expectations for built up supply or demand of houses. The approach also allows them to further consider differences in markets due to underlying differing trends in age brackets. Projections for housing commencements are based on trend estimates that incorporate business cycle movements as well as market expectations based on economic variables such as gross domestic product (GDP) (Table 4).

Table 4 Modelling housing activity

Variable	Inputs used
Housing demand - estimated by projections for household formations	Number of households by age brackets, population data, and economic indicators including employment.
Housing supply	Trend estimates incorporating business cycle movements, and economic indicators including GDP.

The approach presented to me by FEA colleagues for estimating consumption of timber by each end-use allows for an estimation of implied consumption levels or demand for wood products. FEA then compares these estimates with apparent consumption to derive inventory levels for some wood products. While timely and robust inventory data are available for logs and sawnwood, such estimations are usually required to derive inventory levels for wood-based panels. FEA estimates consumption for each end-use by region which is then aggregated to derive a national estimate. Their ability to model consumption by region is a good indication of

the comprehensive data they have access to on the demand side. Recent consumption and outlook models built by ABARES for wood products are built for national estimates, partly due to the lack of robust data at the regional level. Having estimated consumption at a national level, FEA use the following equation to derive inventory levels in each time period:

$$Inventory\ (Stock) = \ Production - Domestic\ Consumption - Exports + Imports$$

In Australia we estimate a variable called 'Apparent Consumption' which essentially represents total usage of a particular product. It is defined as follows:

$$Apparent\ Consumption = Production + Imports - Exports$$

Hence, the estimation for Inventory used by FEA can be arranged as follows:

$$Inventory\ (Stock) = \ Apparent\ Consumption - Domestic\ Consumption$$

Colleagues at FEA advised that we in Australia have better access to supply side data than our counterparts in the US. The information published by ABARES in the Australian Forest and Wood Product Statistics for the gross value of production, estimates for the availability and harvest of logs by different log types, and production estimates for aggregate wood products such as sawnwood and wood-based panels was very well received in the United States. This is a testament to the collaborative nature of the relationship between ABARES and industry stakeholders which allows us to generate survey estimates in a useful manner. The Forests at a Glance publication which summarises some of this useful information was particularly well received in the United States and ABARES has already shipped a number of copies on request to our colleagues at FEA.

Summary of discussions

Colleagues at FEA provided insights for the estimation of a number of key variables including inventory and housing activity. These variables are used extensively by ABARES for modelling of consumption of wood products and can feed into potential future work on modelling of price elasticities for structural wood products.

FEA broadly estimates inventory levels for wood-based panels and some other wood products by comparing apparent consumption with actual domestic consumption. Domestic consumption is estimated directly by each end-use and incorporates estimates for timber usage for each end-use. For example, timber consumption (sawnwood) for detached dwelling construction is measured using detached dwelling commencements, the average size of a detached dwelling and estimates for timber usage per square foot of a detached dwelling.

Estimates for housing demand at the FEA incorporate age brackets for households and population, and the consequential variability that may exist between different age brackets. Data for population and number of households by age brackets is used to formulate headship rates which are an estimation of the number of persons per household for each age bracket. Combined with forecasts for population, these headship rates can be used as a proxy for the demand for housing by age brackets. Incorporating age bracket information allows FEA to consider the variations between different types of households and the implications for housing demand. For example, young singles and couples may prefer apartments, the impact of the retiring baby generations on retirement homes and so on. Housing commencements (or housing supply) are typically based on trend estimates but also incorporate expectations based on market movements in economic variables such as GDP and employment.

FEA has access to excellent demand side data detailed even at the regional level but has poorer access to supply side data. This demonstrates the usefulness of some of the key surveys conducted by ABARES including the GVP survey, the mill survey and the plantations survey.

Meetings with Washington State Department of Natural Resources

At the Department of Natural Resources (DNR) in Olympia, Washington State, I had the opportunity to engage in discussions with David Chertudi, Kristoffer Larson and Dorian Smith who work in the Office of Budget and Economics. As economic analysts for DNR with extensive experience and expertise in analysing regional timber markets, they publish reports and provide data and forecasts in a similar manner to the role played by the Forest Economics section at ABARES.

The Department of Natural Resources was created to manage state trust lands in Washington State to generate revenue and preserve forests, water and habitat. DNR manages 5.6 million acres of forest, range, agricultural, aquatic, and commercial lands. DNR has two main areas of focus – proprietary and regulatory. The proprietary focus for the department is to manage state-owned natural resources (such as forests) and generate revenue for the state. The regulatory focus is to enforce laws that govern how people use state-owned natural resources (for example laws that govern how people harvest logs).

The department is effectively a trust manager and, in the case of forestry, manages monthly auctions of timber harvest licenses to harvest logs within a certain area. Timber sales prices are documented through the auction process and feed directly into estimates for revenue calculations for the state. The availability of state-owned logs is driven by sustainable harvest requirements and policy guidelines – that a sustainable supply of wood is available to mills and

forest management practises are met. Logs available from state-owned forests are typically of a higher quality with a longer rotation period than private forests.

Dorian talked about the annual Timber Harvest reports (DNR 2015a) at length; the process undertaken to collate and summarise the comprehensive information presented in these reports. These reports provide a periodic accounting for how much wood is available and how much has been harvested for production. The data for this report is collected by the state's Department of Revenue to calculate the Forest Excise Tax. Data for the volume of log harvest is available by different categories including ownership (such as private or public), counties (similar to Local Government Areas in Australia) and species (both softwood and hardwood species).

Dorian also provided valuable insights into the extensive surveys undertaken by DNR and how this information is analysed, summarised and presented in the biennial State Mill Survey report (DNR 2015b). The survey questionnaires are quite detailed and separated out by different types of forestry operations including surveys for: chipping facilities, log export facilities, pulp mills, sawmills, veneer and plywood manufacturers and engineered wood product manufactures. The survey forms are freely available on DNR's website (DNR 2015b). The report itself provides key statistics about Washington State's wood products processing industry including: a regional and ownership breakdown of where logs used in sawmills are harvested, products that are processed and manufactured by mills, and how logs are exported.

The 2012 State Mill Survey reported that the total number of mills in Washington State dropped from 125 in 2010 to 105 in 2012 and the total volume of logs processed fell to 3.35 billion board feet from 3.7 billion board feet in 2010. However, log exports from Washington State increased in both 2012 and 2010. Veneer and plywood mills no longer occupied niche markets and faced increasing competition from engineered wood products like Oriented Strand Board. These mills pursued new opportunities such as hardwood veneer products and sanded or textured plywood. It was very interesting to note some of the similarities in industry trends between Washington State and Australia where the number of mills has declined in recent years and log exports have increased. DNR is currently preparing the 2014 State Mill Survey report which will be available on their website.

Economic analysts David and Kristoffer explained the methodology used for analysis of trends in prices and for forecasting price movements. They use price projections obtained from RISI (an international forestry economic analysis agency) and FEA which are weighted based on analysis of historical trends and a proportional breakdown of timber harvest by species (mainly Douglas Fir and Hemlock). Their work is used for quarterly Economic and Revenue Forecasts (DNR 2015c) published on the DNR website. The quarterly reports provide a projection for

revenues from Washington state lands managed by DNR for state trust funds and their beneficiaries. Each quarterly report builds on the previous one, emphasising ongoing changes, and re-evaluating world and national macroeconomic conditions and the demand and supply for forest products. The reports also assess the impact of changes in economic conditions on the projected revues from DNR-managed lands.

The most recent Economic and Revenue Forecast report highlights that over the last decade timber stumpage revenue has constituted over 75 per cent of total revenues for DNR. Therefore, the report aims to provide a better understanding of price movements as well as the underlying supply and demand side issues that may affect prices and therefore the overall revenues generated by DNR. It includes a comprehensive discussion of the US housing market as it is particularly important to overall timber demand in the US. The September quarter report mentions that lumber (sawnwood) demand for residential construction has increased slightly from the trough in 2009–11 but emphasises that the recovery in housing demand and housing starts remains modest. The supply side discussion in the report includes a section on changes in timber supply and the flow-on effects for prices. Each report also contains a segment on variables affecting macroeconomic conditions such as US gross domestic product, employment and wage trends, exchange rates and economic trends in major international wood product markets (DNR 2015c).

3 Applications for ongoing ABARES research

This chapter provides a background for existing forestry forecasting models at ABARES and upcoming modelling work with Forest and Wood Products Australia (FWPA), and how the research activities undertaken through the Gottstein fellowship could benefit this work. The organisations I worked with undertake similar forestry research projects to ABARES and establishing a collaborative working relationship provides opportunities to better develop forestry methodologies and models.

ABARES was recently tasked by the Australian Department of Agriculture and Water Resources to analyse wood supply and demand scenarios over the longer term and assess future investment potential in forestry. To deliver this analysis, FORUM combined a large number of datasets and estimated optimal economic allocations of resources across Australia's forestry sector to 2050. ABARES completed and published this research in April 2015 (Burns et. al. 2015) and a link to this report is provided in the list of publications at the end of this report.

More recently, ABARES commenced a joint work programme with FWPA to fill information gaps in industry statistics (such as trade statistics for major trading partners and market information) for the Australian forest industry. This work will provide new information and improve the reliability of existing information. This joint work program draws on ABARES strengths in data gathering, analysis and modelling. As part of this research ABARES may look to develop short-term forecasting models and estimate price elasticities for structural wood products by working collaboratively with the Australian forestry industry. The knowledge and contacts I have made through the Gottstein fellowship will be invaluable for this work.

ABARES Forest Resource Use Model

The ABARES Forest and Resource Use Model (FORUM), is a modelling framework used to assess the optimal uses for Australia's forest resources for wood production under different scenarios. ABARES uses FORUM to project future harvest volumes, allocate logs among processors, assess future processing investment opportunities and determine the economically efficient mix of domestic production and net trade to meet Australia's future wood products consumption needs (Burns et. al 2015).

FORUM is a dynamic mixed-integer linear programming model that uses a cost–benefit analysis approach to simulate the flow of resources within the forestry sector and maximise returns from the use of forest resources. The model attempts to maximise the aggregate profits in the forestry sector value chain, from harvesting to primary processing (including paper

manufacturing). Using this framework, it is possible to measure and quantify the direct economic impact of changes in log availability, industry development options (at the local, regional, state and national level) and domestic and international market outlooks. FORUM links directly to other components of the forecasting analysis through its inputs and outputs (Figure 3).

The use of market variables in FORUM

The role of prices

Wood product prices, comprising domestic and export prices, were assumed to be exogenous to the forest production estimates modelled in FORUM. It was assumed that domestic production will be set at a level where the marginal cost of production of each product equals these exogenous prices. For the recent forecasting work, FORUM analysis assumed wood products imports and consumption were independent (derived from structural econometric models and used as inputs in FORUM), while wood product output was determined by demand from domestic and export markets using FORUM (Figure 3). The interaction between domestic and export markets was driven largely by prices – effectively both markets were accessible to producers and supply into these markets depended on whether prices were sufficient to compensate for the costs of production.

For this analysis ABARES made a simplifying assumption that domestic and international prices for wood commodities follow identical trajectories to 2050. A desktop analysis of international markets was undertaken on the basis of international outlook studies published by UNECE, FAO and other such organisations. This analysis was used to determine long-term price movements for wood commodities for the business-as-usual scenario. Given that Australia generally accounts for only a small proportion of world trade in wood commodities, it was assumed that Australian supply into export markets was unconstrained and did not affect world prices.

The research activities I undertook through the Gottstein fellowship can directly improve the quality of this modelling input. I had the opportunity to discuss the estimation of price elasticities and analysis of price trends for structural wood products with colleagues at FEA and DNR. Such information could potentially be incorporated into FORUM in future ABARES work allowing us to better model the interactions between domestic and export markets. Furthermore, the contacts I have gained could provide us better access to global price movements and trends – particularly in North American markets.

Housing sector activity

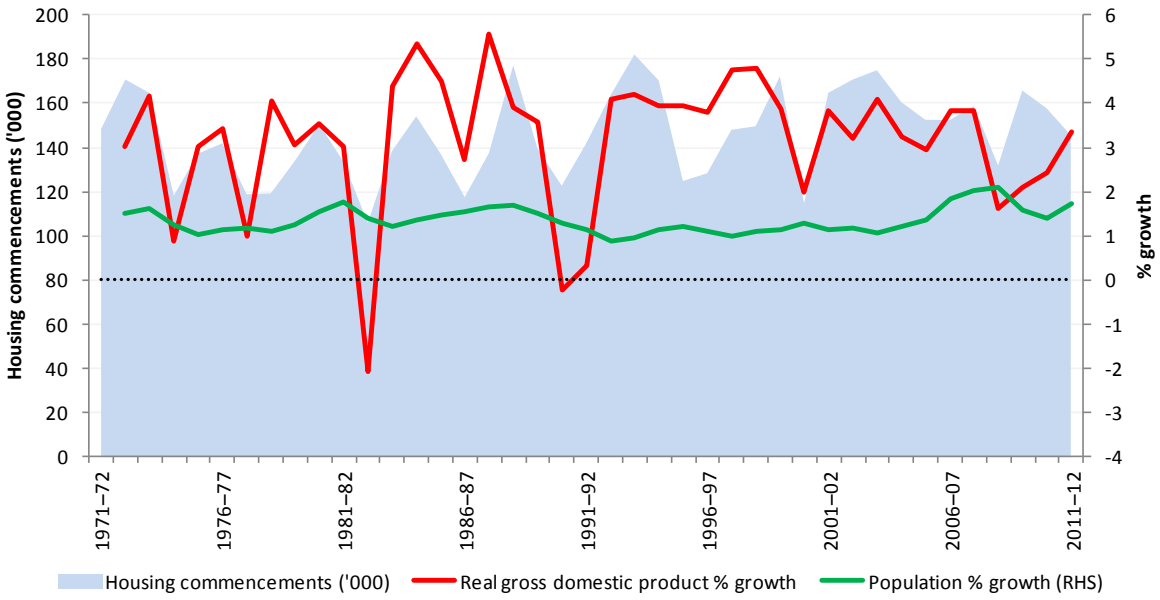
Housing sector activity is one of the key driving factors for estimating future demand for wood products in domestic consumer markets in Australia. The interactions between the housing construction sector and domestic and export timber markets is subject to changes in demand

for housing. For previous outlook studies, ABARES analysed historical trends in population, household size and the type of houses constructed to estimate the long-term outlook for housing in Australia. Renovation activity was also estimated based on GDP and population growth. This is described in detail in Gupta and colleagues (2013).

As one of the key modelling inputs for forestry forecasting work, I discussed at length methodologies for estimating housing sector with colleagues at FEA. While population growth is one of the key variables when forecasting housing demand, colleagues at FEA provided insights in to the use of age classes (and thereby variable demand for housing for different classes) and inventory estimations.

When analysing historical trends in housing, Burns and colleagues (2015) found that while population growth was relatively consistent over the past 40 years, housing commencements (construction of new houses in Australia) exhibited more volatility (Figure 2), leading to fluctuating demand for structural wood products such as sawnwood and wood-based panels. Colleagues at FEA actually incorporate this cyclical activity into their forecasts for housing as it illustrates one of the key challenges for forest growers and wood processors when seeking to maintain reliable incomes and profitability over time.

Figure 2 Housing commencements, real gross domestic product and population growth

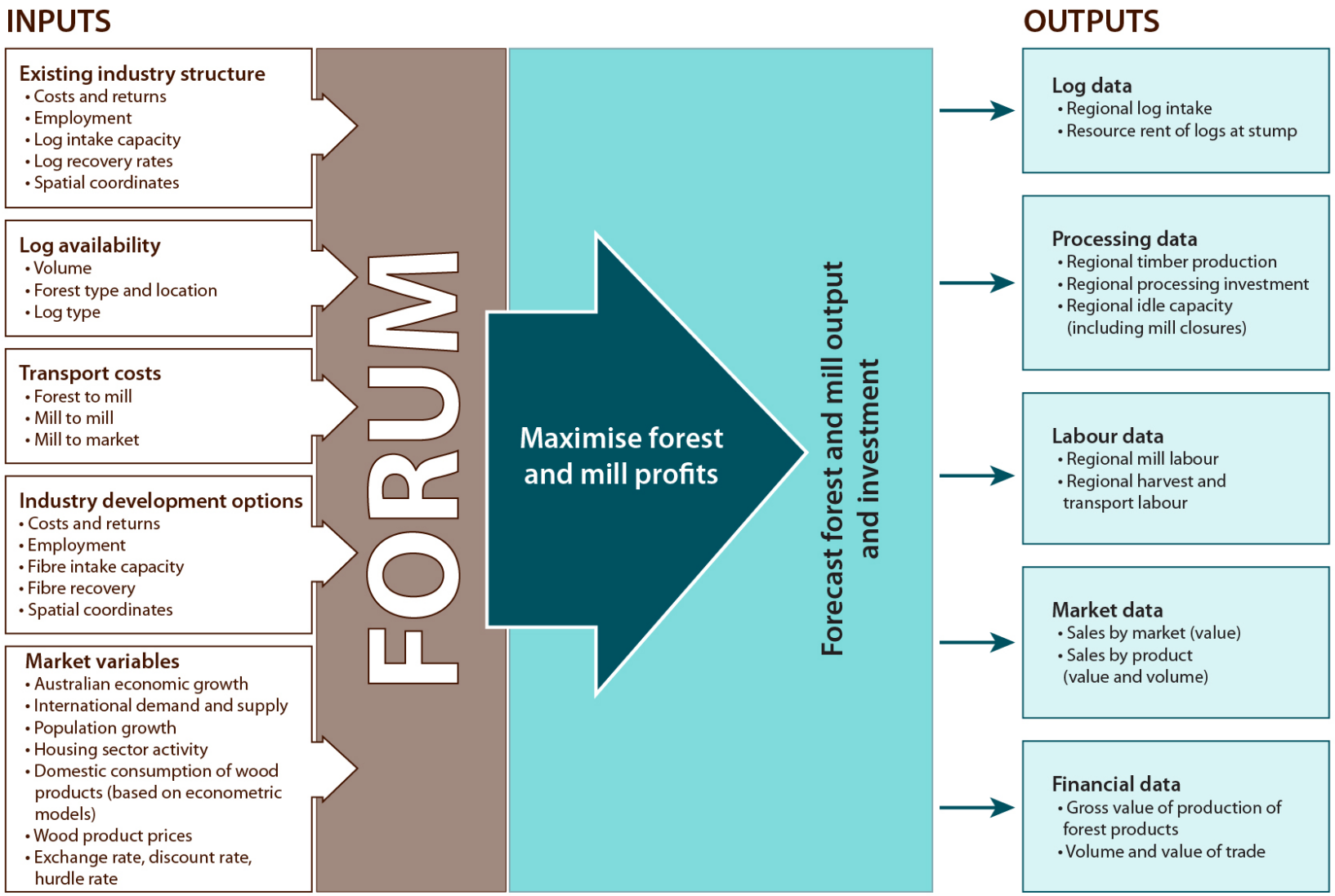


Source: Burns and colleagues (2015)

International demand and supply of wood products

At present, ABARES analyses trends in parameters such as real GDP in principal wood product markets, changes to global forest resources and global investments in processing infrastructure. However, these factors are not modelled explicitly; rather, they are implied in wood product price assumptions for international markets that were discussed earlier in this report. The contacts I have gained through the Gottstein fellowship should make it easier to access and analyse economic and timber market data for the North American markets improving our understanding of international markets and the ability to incorporate these factors in our models.

Figure 3 Structure of the Forest Resource Use Model (FORUM)



Source: Burns and colleagues (2015)

Econometric consumption and trade models

ABARES undertook econometric modelling to forecast imports and domestic apparent consumption of sawnwood, wood-based panels and paper and paperboard in Australia. The results of this work were published in May 2013 (Gupta et. al. 2013) and a link to the report is provided in the list of publications at the end of this report. The focus of this work was to present estimates for long-term demand for wood products and the econometric models were constructed on a primary demand variable and other macroeconomic variables likely to affect the volume of consumption and imports.

Consumption of structural timber was modelled to primarily be a function of housing starts and macroeconomic variables such as gross domestic product and population growth. Renovations and alterations to existing homes were also considered, primarily as an explanatory variable for consumption of wood-based panels. Forecasts for imports incorporated factors for domestic demand in Australia and were also influenced by domestic and international economic activity and world prices. However, data for domestic prices for structural wood products and panels is largely unavailable or inconsistent in Australia.

Paper and paperboard products comprise paper grades with a wide range of uses including newsprint, household and sanitary paper, packaging and industrial paper and printing and writing paper. However, given the available datasets at the time this work was undertaken, ABARES considered an aggregated forecast for total paper and paperboard products. As a result, one primary demand factor was considered; paper and paperboard was hypothesised to be a function of the value added by the manufacturing sector in Australia and other macroeconomic variables such as world prices, exchange rates and population. The manufacturing sector is a large user of packaging and industrial paper and printing and writing paper. As with structural wood products, availability of data for domestic prices for paper products is limited in Australia.

At the time this work was undertaken price data was scarce and unreliable and could not be incorporated into the modelling process. Increased access to comprehensive and informative price datasets for structural timber products would greatly benefit modelling and forecasting work for these products. Combined with the research activities I undertook as a Gottstein fellow, discussing analysis of price trends and estimation of price elasticities with colleagues at FEA and DNR, this can give us a much better understanding of the interactions between demand and actual consumption. For instance, if findings suggest structural timber products are largely price inelastic, consumption of these products would primarily be driven by the demand from the housing construction sector and be relatively insulated to changes in global prices. For those that are more technically inclined, the relationship between key demand variables and

consumption is described in the model coefficients. Analysing the sensitivity of structural wood products to prices would allow ABARES to greatly improve the model coefficients.

Potential future modelling and forecasting work

ABARES has the potential and expertise to undertake modelling and forecasting work in the future, particularly around short and long-term forecasts for selected disaggregated wood products. There are two key areas of research that could benefit from my activities as a Gottstein fellow.

Quarterly wood product forecasting

As more detailed information about forestry markets becomes available through data series, an opportunity exists to develop econometric forecasting models that could generate quarterly forecasts for a range of structural wood products. Subject to resourcing, ABARES could investigate potential explanatory variables and examine cyclical and trend patterns in demand for these products. ABARES models could also include input from industry on market expectations for product demand and future price movements.

Discussions with colleagues at FEA and DNR, particularly on the estimation of housing starts and analysis of price trends, can feed into this modelling process.

Estimation of price elasticities

The provision of more detailed commercial information could facilitate an opportunity to develop econometric models to analyse own-price and cross-price elasticities of demand for structural wood products. Understanding these measures can provide government and industry insight into market fluctuations and demand sensitivity to changes in price.

As discussed in more detail in the next chapter, engaging with FEA and DNR has provided me with valuable insights that may prove useful for this work. There may also exist opportunities to exchange ideas around methodology with FEA who are undertaking a similar project to estimate price elasticities for North American timber markets.

4 Outcomes from my research activities

The critical outcomes from my research activities as a Gottstein fellow were indentifying some data/knowledge gaps in information available in Australia (Table 5) and looking at ways in which domestic modelling frameworks could be improved. The aim of my visit to FEA and DNR was to study the models and data analysis techniques being used in the United States forestry sector. This gave me the opportunity to:

- compare models and data analysis techniques used at ABARES with similar research undertaken at international organisations;
- investigate the potential applications for this research at ABARES with a view to further improve the quality of our forecasting work; and
- develop lines of communication for a continuing exchange of knowledge and ideas between ABARES and international research organisations.

The insights offered by colleagues at FEA for estimations of variables such as inventory and housing starts can be directly tested and applied in models used by ABARES. Furthermore, FEA advised that they will be undertaking work on price elasticities in the near future and would be happy to collaborate and exchange ideas and modelling techniques given the overlapping nature of ABARES and FEA work.

My visit also established lines of communication between FEA and ABARES allowing for closer collaboration on forestry related research between our two organisations. Australia is largely a price taker in international markets for forestry products. As we did for the recent work on outlook scenarios for the forest industry, ABARES typically models expectations for trade based on the expected outlook for global timber markets. FEA can provide valuable input for outlooks for North American markets and global markets which can be incorporated in the domestic modelling frameworks at ABARES. FEA is also looking to expand the scope of their research to cover global markets and incorporate international movements in timber markets. Establishing a relationship with ABARES also allows FEA to better understand Australian datasets reported in the Australian Forest and Wood Product Statistics.

Table 5 Australia's data gaps and the potential applications for these variables in Australia

Variable	Potential applications
Sales volumes for wood products and corresponding price data	Improvements to forecasting models that estimate volume of timber consumed for various applications such as structural. Allows for estimation and analysis of price elasticities which can feed into econometric forecasting models as well as outlook models such as FORUM Can also be used to inform estimation of inventory levels
Timber usage in housing	Facilitates estimation of consumption of structural wood products for particular end uses. This allows for estimating domestic consumption which can be compared to apparent consumption to derive inventory levels.
Number of households by age brackets, employment status, and so on.	May allow for estimation of household formations by different age brackets and form a proxy for housing demand. Allows for examination of potential variations in housing demand for different age brackets. This can also be compared to housing supply estimates.
Regional demand-side data	While regional supply-side data is readily available in Australia, regional demand-side data is sparse and unreliable. Access to this information would allow ABARES to model forestry outlooks and forecast domestic consumption and production at a regional level.

The colleagues I met in DNR undertake similar work programmes to the Forest Economics section at ABARES. Having made contact with David, Kris and Dorian, it will be very useful to exchange ideas and information in the future in terms of both data and methodology. For example, colleagues at DNR have already expressed interest in the transport costs model developed at ABARES for the previously discussed outlook study (Burns et. al. 2015).

David and Kris also suggested that we may find it useful to include probabilities for price projections that may be examined in the upcoming ABARES and FWPA joint work programme. This could provide reasons for being more or less optimistic than suggested model results and could provide a convenient way to incorporate adjustments based on market and industry expectations.

Overall, the Gottstein fellowship has provided me with considerable personal benefits, giving me with the opportunity to interact with international experts and discuss my modelling expertise and research interests with forestry colleagues in the United States. I have been able to successfully network with both FEA and DNR who were very supportive of my stay there and remain keen to develop a close working relationship with ABARES. The Gottstein fellowship has also given me the opportunity to further my skill set and has helped enhance my standing and credibility as an economist and researcher.

Appendix A: Itinerary

Table A1 Itinerary for research activities undertaken in the United States

Date	Location	Activity
4th July 2015	Canberra, Australia	Depart Canberra travelling to Sydney
4th July 2015	Sydney, Australia	Arrive in Sydney
5th July 2015	Sydney, Australia	Depart Sydney travelling to United States
5th July 2015	Los Angeles, United States	Arrive Los Angeles and catch connecting flight to Boston
5th July 2015	Boston, United States	Arrive in Boston
7th July 2015 – 17th July 2015	Westford, United States	Discussions with colleagues at Forest Economic Advisors.
		Westford is around an hour and half from Boston central. I was staying at a hotel in Chelmsford, located between Boston and Westford and around 30 minutes from Westford.
19th July 2015	Boston, United States	Depart Boston travelling to Seattle
19th July 2015	Detroit, United States	Arrive in Detroit and catch connecting flight to Seattle
19th July 2015	Seattle, United States	Arrive in Seattle and catch shuttle to Olympia.
21st July 2015 – 24th July 2015	Olympia, United States	Discussions with colleagues at the Department of Natural Resources, Olympia.
		Olympia is around a two hour drive from Seattle and is the capital of Washington State. State government agencies such as the Department of Natural Resources are located in Olympia.
25th July 2015	Olympia, United States	Depart Olympia and catch shuttle to Seattle airport.
25th July 2015	Seattle, United States	Depart Seattle travelling to Los Angeles
25th July	Los Angeles, United States	Depart Los Angeles travelling to Australia
27th July 2015	Brisbane, Australia	Arrive in Brisbane and catch connecting flight to Canberra
27th July 2015	Canberra, Australia	Arrive in Canberra

References and publications

Burns, K, Gupta, M, Davey, S, Frakes, I, Gavran, M & Hug, B 2014, *Outlook scenarios for Australia's forestry sector: key drivers and opportunities*, ABARES report to client prepared for the Department of Agriculture, Canberra, June, available at data.daff.gov.au/anrdl/metadata_files/pb_osafsd9abfe20150414_11a.xml.

DNR 2015a, Washington State Timber Harvest reports, Washington State Department of Natural Resources, Olympia, available at dnr.wa.gov/TimberHarvestReports.

DNR 2015b, Washington State Mill Surveys, Washington State Department of Natural Resources, Olympia available at dnr.wa.gov/about/fiscal-reports/washington-state-mill-surveys

DNR 2015c, Quarterly Economic and Revenue forecasts, Washington State Department of Natural Resources, Olympia, available at dnr.wa.gov/about/fiscal-reports/quarterly-economic-and-revenue-forecasts.

FEA 2015, Forest Economic Advisors website, getfea.com.

FRBA 2015, Labour Market Spider Chart, Center for Human Capital Studies, Federal Reserve Bank of Atlanta, available at frbatlanta.org/chcs/LaborMarket.aspx.

FWPA 2015, Statistics and Economics (programme), Forest and Wood Products Australia, fwpa.com.au/statistics-and-economics.html.

Gupta, M, Corrie, K, Hug, B & Burns, K 2013, *Preliminary long term forecasts of wood product demand in Australia*, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, available at data.daff.gov.au/anrdl/metadata_files/pb_lwpdad9abfe00420130503_11a.xml.

Random Lengths 2015, About Random Lengths, Random Lengths, available at randomlengths.com/About-RL/ (pdf 2.08 mb).