



LEADING LOCALLY, COMPETING GLOBALLY

*Measuring the University of Wollongong's
Contribution to Economic and Social Prosperity*

UNIVERSITY OF
WOLLONGONG



Leading Locally, Competing Globally

*Measuring the University of Wollongong's
Contribution to Economic and Social Prosperity*

Centre for
Small Business
and Regional
Research

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Verification Notice:

The methodology, analysis and findings of this study have been independently peer reviewed and verified by Deloitte Access Economics and the Regional Research Institute, West Virginia University.

Disclaimer:

The estimates provided in this report represent the research team's best efforts to provide a comprehensive and reliable overview of UOW's economic and social significance, based on the data and resources available. Estimates and subsequent views or opinions expressed in this document are those of the authors and do not necessarily represent that of UOW.

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EXECUTIVE SUMMARY

E1. BACKGROUND

In its 2013-2018 Strategic Plan the University of Wollongong (UOW) states its intention of playing a leading role in attracting “vitality and economic growth to Australia and our region”. This report provides the first comprehensive assessment of UOW's performance against this goal. It details the findings of a six-month study undertaken by a research team from the *Centre for Small Business and Regional Research* (CSBRR), which sought to reliably and objectively describe the overall influence of the University of Wollongong (UOW) on economic and social prosperity in Australia, and in particular, its home region.

After a brief background on the University's operations and its home region of Wollongong (defined by the local government areas of Wollongong, Shellharbour and Kiama), the report looks at the direct, indirect and induced impacts of the University's operations, student expenditure (excluding expenditure on UOW tuition already included in the first item), visitor expenditure and capital expenditure. The estimates are provided for the economy at the regional, state and national levels, using the 2011 calendar year as the basis for this analysis. This analysis is followed by an assessment of UOW's broader role in developing human capital, before examining the likely longer-term economic consequences of university research activity on the economy. Finally, looking beyond the purely economic benefits of UOW, the report provides a descriptive overview of the various non-pecuniary social and cultural contributions UOW makes to the communities within which it engages.

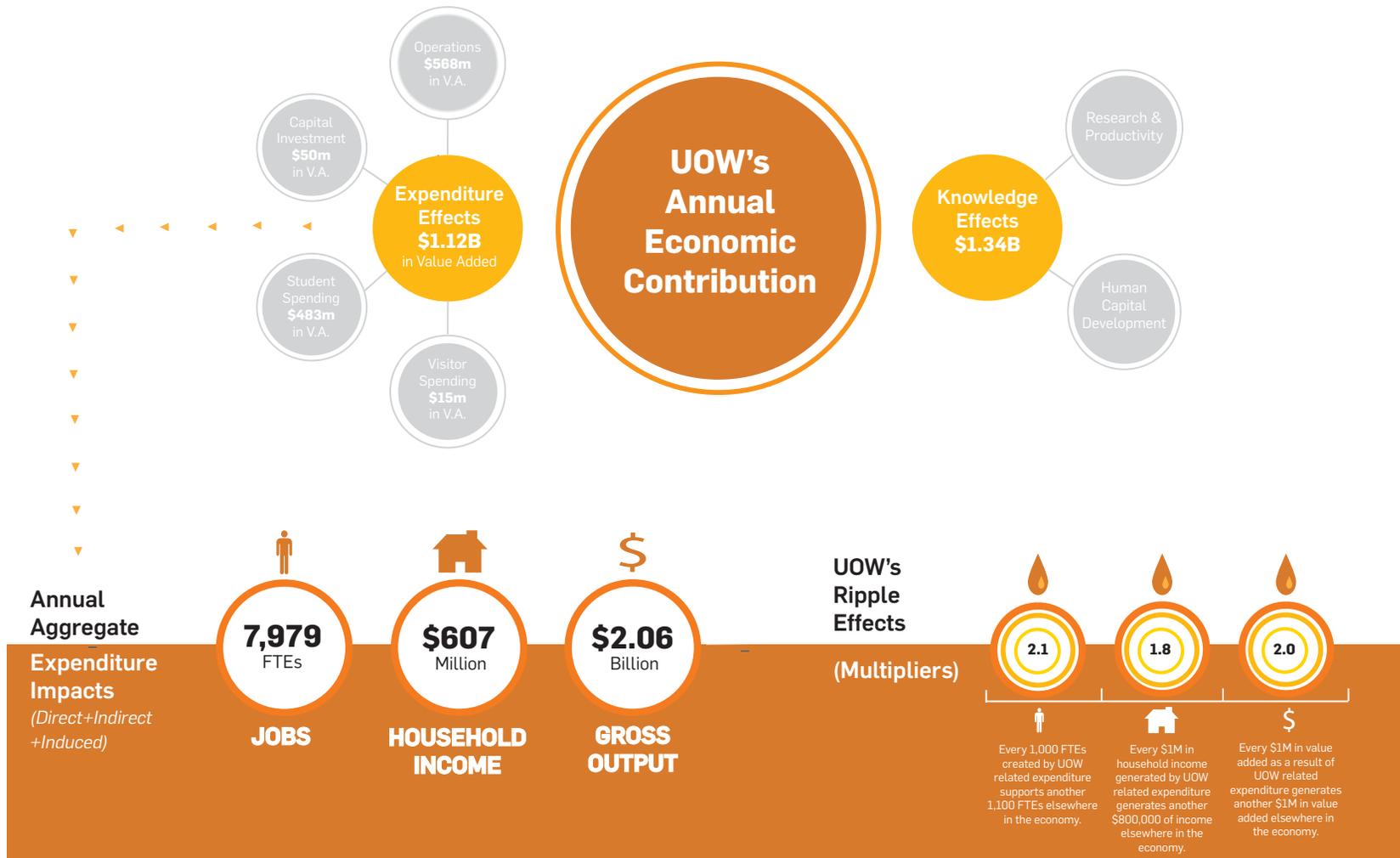
This report highlights UOW's role as an economic driving force leading Australia's ninth largest city to a much-needed revitalised economic future. This study also highlights, however, the fact that UOW makes a broader contribution to society than mere dollars and ‘sense’. Indeed, UOW represents invaluable national and state knowledge infrastructure, a fully engaged local partner, and an agent for positive economic, social and cultural change.

E2. UOW'S ECONOMIC FOOTPRINT

Figure E 1 summarises several aspects of the estimated economic activities of UOW in 2011. It shows that UOW has an annual direct, indirect and induced contribution estimated at \$1.12 billion to Gross Domestic Product, with half of this effect (\$568 million) resulting from UOW operations. Taking into account direct, indirect and induced impacts, the various activities related to UOW helped generate \$2.06 billion in gross economic output, \$607 million in household income and 7,979 full time equivalent jobs.

UOW's input to the development of Australia's stock of human capital is estimated at \$1.34 billion, including a net annual earnings premium of \$992 million for UOW's working alumni and \$343 million in extra government tax revenue flowing from this earnings differential. This overall effect estimate does not currently include the very real (but difficult to quantify) economic spillover effects of UOW's research efforts.

Figure E 1 UOW's Economic Contribution (2011)



E3. EXPENDITURE IMPACTS

As summarised in Table E 1, in 2011, UOW generated total (direct + indirect + induced) gross output in excess of \$2.06 billion, value added of \$1.1 billion, and nearly 8,000 full time equivalent jobs throughout the Australian economy. The regional Value Added measure of \$659m is the metric most comparable to the Gross Regional Product of Wollongong, which is \$14.3 billion, resulting in UOW activities accounting for about 5% of the local economy.

Table E 1 Summary of four key indicators of UOW-related economic activity*

Indicator	Total Effects (Direct + Indirect + Induced)		
	Wollongong	NSW	Australia
Gross Output (\$m)	\$1,374	\$1,662	\$2,061
Value Added (\$m)	\$659	\$882	\$1,116
Income (\$m)	\$395	\$509	\$607
Employment (FTEs)	4,825	6,272	7,979

* Aggregate of direct, indirect and induced effects of operational, capital, student and visitor expenditure.

The total effects summarised in Table E 1 are the cumulative result of several different aspects of UOW-related expenditures in the economy. This report investigates four broad areas of UOW-related economic influence: (1) Operations, including all aspects of running the day-to-day 'business' of the university; (2) Capital investment, including construction and maintenance; (3) Student expenditure, including all day-to-day living expenditure by UOW students; and (4) Visitor expenditure, including graduation ceremonies, conference visitation, tourism to UOW's Science Centre, and special events. The effects of each of these specific areas is summarised below:

University Operations

The University's operations represent a major generator of economic activity. Taking into account direct, indirect and induced effects, UOW operations generated \$950 million in gross output, \$568 million in value added, \$357 million in household income and 3,801 FTEs in 2011.

Capital Investment

Taking into account direct, indirect and induced effects, UOW capital expenditure generated \$140 million in gross output, \$50 million in value added, \$31 million in household income and 485 FTEs.

Over the past decade the University's rapid expansion has seen over a billion dollars (\$1.19b) of capital expenditure through infrastructure development alone. Over the next five years, budgeted UOW construction and refurbishment projects will result in a further half a billion of capital expenditure.

Student Expenditure

Taking into account direct, indirect and induced effects, the living expenditure of UOWs student population generated close to a further billion dollars (\$941m) of gross output, \$483 million in value added, \$211 million in household income, and 3,553 FTEs throughout the economy. This relates only to expenditure by students to third-parties, and not the revenue accruing to UOW that is already included earlier in University Operations (such as tuition fees).

Visitor Expenditure

Taking into account direct, indirect and induced effects, UOW-related visitation contributed \$30 million to gross output, \$15 million in value added, \$8 million to household income, and helped sustain 140 FTEs within the economy. As for Students, we only count the expenditure by Visitors that is not already captured in UOW operational revenues above.

A Major Regional Exporter

Figure E 2 summarises the geographic spread of UOW-related economic activity. It shows that approximately two-thirds of all economic effects are concentrated on the Wollongong region. In fact, from a regional perspective, UOW is the third largest exporter after coal and steel manufacturing, with UOW-related activities injecting nearly \$700 million into the local economy from external sources each year. Nearly 90% of the University's revenues are derived from federal, state and private sources outside the Wollongong region. An important fact to note is that the majority of the revenue brought in to the region remains in the region, with approximately 75% of the budget of the consolidated UOW entity spent within its home region on salaries, purchases of goods and services and construction projects.

Figure E 2: The four key UOW-related measures of economic activity (2011)



E4. KNOWLEDGE IMPACTS

The economic estimates summarised in Section E3 do not take into account the dynamic effects or longer-run national productivity gains from knowledge transfer and workforce training, nor do they include the substantial economic spillover effects of UOW research and development activities to the communities within which it operates. This report includes these important aspects of UOW's economic role, with the findings summarised below:

Human Capital Development

UOW graduates have been enriched intellectually and armed with a qualification that can reap significant financial benefits. In fact, our research shows that UOW degree holders can on average expect to earn roughly three-quarters of a million dollars (\$741,409) in excess of their Year 12 graduate counterparts over their working life.

Moreover, our research indicates that the return on investment to a UOW degree is very attractive. Based on the net present value of future earnings less the costs of undertaking a UOW degree, we estimate the private rate of return to a UOW degree to be in the order of 16%, and we estimate the public (or social) rate of return on a UOW degree to be in the order of 14%.

When the net earnings premiums of all on-shore UOW alumni are considered, the annual economic benefit in terms of increased personal income flowing through the economy is estimated to be nearly a billion dollars (\$992m), and the annual public returns, in the form of increased government revenue from taxes on this extra income, is estimated to be approximately \$343 million.

Research and Development

Whilst difficult to quantify, the leading-edge research and innovation undertaken at UOW generates significant benefits. The University has received nearly half a billion dollars (\$431m) from government and industry research partners over the last decade alone and, apart from the direct, indirect and induced effects of this investment, the outcomes of UOW research have a substantial and dynamic effect by enhancing productivity and efficiency within the economy. Current efforts are seeking to quantify these spillover effects of UOW research and innovation.

E.5 BROADER CONTRIBUTION

There are many facets of UOW's impact on society that are not easily measured. Within this report we provide specific examples of UOW's social, cultural and other contributions.

Research and Innovation

UOW research and development activities play a major role in shaping regional innovation and in helping to find solutions to some of society's biggest issues. UOW has a strong focus on the conversion of its research into tangible knowledge that can be utilised by the private and public sector to improve key aspects of society such as health, infrastructure, sustainability and enterprise.

Human Capital Development

The development of skills and knowledge assets in the workforce is an important part of UOW's mission. UOW enables access to quality higher education in regional, rural and remote areas of southern NSW through its system of satellite campuses, and has a proud history of working closely with each of its communities to drive increased participation and attainment amongst disadvantaged groups. With an Alumni population of over 106,000, UOW graduates are making significant contributions throughout Australian society and a growing body of overseas alumni is connecting our region, state and nation to cultures, governments and industry in 143 countries.

Enterprise, Business Development and Growth

UOW is an incubator and catalyst for new business ideas and innovation and provides an invaluable source of information and advice to industry and government. Efforts such as the iAccelerate project are helping to develop a new culture of entrepreneurship and innovation with the region. UOW is also a magnet for attracting and retaining creative knowledge workers to its operating regions, and is a portal for the promotion and connection of Wollongong, NSW and Australia to influential people throughout the world.

Enhancing Social and Cultural Life

UOW contributes substantially to social and cultural activities within its communities. It is committed to best practice engagement for which it has been duly recognised nationally and internationally.

E.6 CONCLUSION

UOW's contribution to regional, state and national prosperity is immense. In particular, this study highlights the fact that UOW has a crucial role to play in the economic, social and cultural fortunes of its home region. UOW's expanding reach and growing reputation for excellence in teaching and research combined with its pioneering spirit, are of great advantage to the region of Wollongong as it seeks to meet the pressures of globalisation that demands innovation and renewal. It is fortunate for the region of Wollongong, the state of NSW and Australia that UOW continues to "lead locally" by "competing globally".

SECTION 1: INTRODUCTION

1.1 Why a Study on UOW's Contribution?

In [the] new economy, knowledge and ideas are a critical component of economic advantage, with intellectual capital being a pivotal resource. Taken in the context of this broader economic transformation, it stands to reason that the university's role is becoming increasingly important as an economic and social institution." (Florida, 1999, p1)

The University of Wollongong (UOW) has established an enviable reputation as one of the world's leading 'young' universities¹. This has been a result of UOW's high quality teaching and culture of research intensity, which have enabled it to consistently produce five-star graduate outcomes and make contributions to the international scientific community. But, in keeping with Florida's insight above, UOW has an important economic and social role to play in the communities within which it operates. In this light, it would seem sensible to ask: what economic and social contribution is UOW making to society?

With this question in mind, UOW engaged the *Centre for Small Business and Regional Research* (CSBRR) to develop a wide-ranging assessment of the role it plays in its region and beyond. The aim of the study is to provide UOW and its stakeholders with a reliable picture of the breadth and depth of its effects – ranging from individuals to society at large. The result is a comprehensive assessment report that signifies a landmark moment in the history of the University of Wollongong. For the first time, this document provides a holistic statement of the contribution UOW makes to the economic, social, cultural and scientific fabric of society.

The findings of this study are of significance to both UOW and its home region of Wollongong. With its objective of joining the world's top 1% of universities within the next decade - this report will serve to enlist the support of its many stakeholders by providing compelling evidence as to the benefits of being a university region.

Wollongong, perhaps more than any other region in Australia, needs its university to succeed. At the same time as UOW sets course for a place amongst the top 1% of higher education institutions in the world, Wollongong finds itself at an economic crossroads. Decades of economic uncertainty and related social consequences have left Australia's ninth largest city in need of economic leadership. It is a region with structural unemployment (particularly amongst its youth), consistently weak local labour demand, and a lack of private investment. Wollongong needs UOW to grow and help create new industries, entrepreneurs and innovators in order to lead the way to prosperity. UOW is well positioned and able to lead its home out of the economic darkness and into a bright future as a globally competitive and innovative region.

¹ UOW was ranked =33 globally in the 2012 Times Higher Education Top 100 Under 50 Rankings, http://www.timeshighereducation.co.uk/Journals/THE/THE/31_May_2012/attachments/THE_100_Under_50_.pdf

1.2 Aims

This study aims to deliver the following outcomes:

1. To provide evidence of UOW's return on public and private investment;
2. To enable the economic contribution of UOW to be evaluated within a regional, state and national context;
3. To develop a model capable of assisting UOW in planning and prioritizing future resource allocation;
4. To capture the value of the less tangible and less measurable contributions UOW makes to society.

1.3 Report Structure

This report has three sections. The remainder of Section One is given to an overview of our methodological approach to measuring UOW's contribution, and then describes the institutional and regional settings that provide the context within which the results of the study should be considered.

Section Two quantifies the economy-wide consequences of University activities. It includes analyses of UOW-related intermediate and final demand expenditure, including onshore operations; student living expenses; visitor spending (at graduation ceremonies, conferences, special events etc); and capital expenditure - accounting for the effects of these activities at the regional, state and national levels. This section finishes with an examination of the longer-run economic effects of UOW's commitment to developing human capital and undertaking world-class research activities.

Section Three assesses UOW's broader contribution to society.

1.4 Methodological Approach

An overview of the parameters and methods used to assess UOW's economic role are provided in this section. A more detailed methodological discussion is provided in the appendices.

1.4.1 Modelling Parameters

This study assesses UOW's economic activity at three geographic levels (Figure 1.1). In all aspects of our analysis, the effects of UOW on its home region of Greater Wollongong, the state of New South Wales (NSW), and Australia are considered. For the purposes of this study, as a region Greater Wollongong is defined as the geographic area starting 50km south of the Sydney CBD at Stanwell Tops, includes the cities of Wollongong, Shellharbour and Kiama, and is bordered by the small town of Gerroa to the south and the Illawarra escarpment to the west.

Figure 1.1 Geographic focus – Greater Wollongong / NSW / Australia



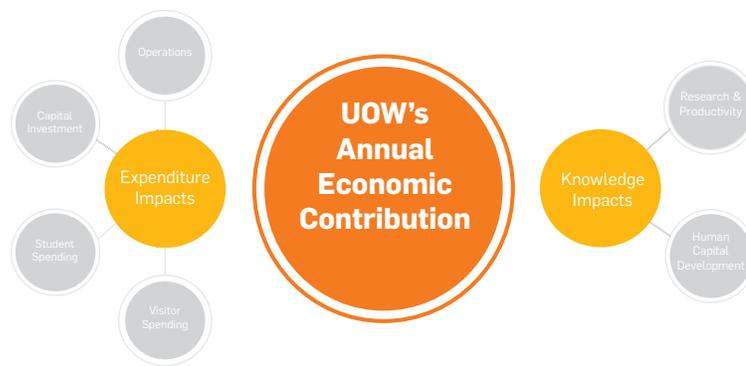
The economic modelling is based on data from **2011** and as such this is the basis for the analysis (apart from forward and backward projections of capital investment). This is the most recent year for which comprehensive data is available on the operations of the University. Conveniently, it coincides with the most recent Australian Bureau of Statistics Census (August 2011), which allows the model to use the most current population and employment figures.

1.4.2 Assessing UOW's influence on key measures of economic activity

Approximately two-thirds of this report is given to an assessment of the economic outcomes from UOW-related activities. An explanation of the methodological approach used is now provided.

This study attempts to provide a robust and reliable measure of UOW's economic activities and their influence. A best-practice methodology that takes account of the literature dedicated to the theory and measurement of the economic effects of universities (see Florax, 1992; Arbo & Benneworth, 2007; and Drucker & Goldstein, 2007 for a comprehensive review) has been applied. Figure 1.2 provides an adaptation of the framework advocated by spatial econometrician Raymond Florax (1992, p80-81), for undertaking a comprehensive assessment of a university's economic effect. It proposes a two separate areas analysis: *expenditure impacts* and *knowledge impacts*. The research team adopted this framework and then sought to employ methodologically rigorous modelling approaches to capture the economic outcomes as comprehensively and reliably as possible.

Figure 1.2 Economic assessment approach



Expenditure Impacts
(Demand-side effects)

The direct, indirect and induced effects of government expenditure and educational and visitation exports. Fairly straightforward measurement using input-output / econometric modelling.

Knowledge Impacts
(Supply-side effects)

The private and social (i.e. public) benefits of increased knowledge and skills, and the longer-run benefits of research-led innovation and spillovers into the wider economy. Tend to be more difficult to quantify.

1.4.2.1 *Estimating expenditure impacts*

UOW-related expenditures have an impact at the local, state and national levels in a number of ways. UOW's operational and construction activities provide linkages with firms through the purchase of goods and services as inputs to its operations, and through the employment of workers who in turn spend within the economy. Similarly, students and visitors attending the University contribute to the economy through the consumption of goods and services.

Choosing an appropriate economic modelling approach

The most common way to measure these types of demand-side effects is through modelling the impacts of economic activity on key macro-level indicators. But there is a wide range of modelling approaches and it is important to select the right one for the task at hand.

Input-output modelling revolutionised the study of economic structure. The first empirical inter-industry model was developed by Leontief in the 1930's in his study of the American economy (Leontief, 1936). Since then, input-output has developed from a relatively simple and naïve tool to one with a seemingly infinite variety of modifications and adaptations. Modern input-output models bear little relationship to their forebears. The statement by Richard Stone (1984), the inventor of the social accounting system, some thirty years ago that:

The development of the I/O model seems to be leading in directions in which the I/O core is becoming less and less discernible. This is as it should be, because it shows the possibility of improving the very simple relationships which were used initially

is even more relevant today.

There are a number of inter-industry modelling approaches, ranging from simple input-output (IO) through extended demo-economic and commodity-activity models to input-output – econometric (IOEC) and computable general equilibrium (CGE) models. Like a mechanic's toolkit, there is no single tool (model) which will solve all problems. The type of model selected will depend on various factors; the particular application (macro/inter-industry, static/dynamic), type of region (national/large/small, open/closed), available resources (time, cost), data availability (primary/secondary, real/imposed), and last but not least, perceived reality. The last refers to the modeller's perception of how the economy behaves, which in turn determines the assumptions used to assemble the model relationships and to estimate the parameters (West and Jensen, 2003).

For example, the standard computable general equilibrium (CGE) model relies heavily on neoclassical economic theory and all that implies; perfect competition where markets operate without friction, full capacity and full market clearing of goods and services, and perfect or near-perfect knowledge. However, it is an optimisation model, as distinct from a 'real world' model, where all economic actors behave optimally in a world of perfect information without the realities of lags in production and other regulatory, geographic and institutional constraints, i.e. it provides the 'optimal' reallocation of resources in response to an exogenous shock. Secondly, the behavioural relationships are imposed, as are the parameters, unlike econometrically based models which allow the real-world data to speak for itself. Thirdly, some would argue that a unique static general equilibrium does not occur in the real world. Finally, how the region of interest interacts with the surrounding regions and nation as a whole affects model specification. This interaction occurs mainly through prices and interregional trade. In the small region case, it is assumed that

the region on its own is too small to affect the terms of trade; in other words the region is a price taker so external prices become exogenous. It has been demonstrated that under 'small region' assumptions, the CGE solution converges to the input-output solution (McGregor and Swales, 1994). This implies that constructing a computable general equilibrium model for a small region, like Wollongong, while not invalid, may not be an efficient use of resources given the considerable difficulties associated with parameterising the large number of parameters.

An alternative modelling approach which attempts to overcome some of the perceived limitations of the computable general equilibrium approach is input-output econometrics. The concept of conjoining input-output and econometric techniques is not new and dates back to the 1970s. Glickman (1977) suggested combining the "good qualities" of both approaches, while Klein (1989) also recommended this approach. While the early generations of input-output econometric models remained predominantly demand driven, the current generation of models have full price response mechanisms without any hint of an aggregate driver model. They use variable coefficient input-output tables to bring together the "real side" (industry outputs, etc.), the "price side" (prices and income) and the "accountant".

The basic accounting identities of more traditional models are still there, but they are surrounded by behavioural equations for consumption, investment, exports, imports, productivity, profits and wages. The aim is to retain the detailed sectoral disaggregation of the input-output system and close it using a system of endogenous econometric relationships generally expressed in elasticity form. This closure forms the basis of the feedback mechanism between primary factors and final demand and also, because the econometric equations can have a dynamic structure, captures the response through time as the economy is subjected to external shocks. This dynamic structure of the integrated model enables the temporal distribution of the indirect and induced effects to be studied. More generally, the impact (short-run) multipliers, lag multipliers and dynamic (long-run) multipliers can be studied and the cumulative effects of dynamic effects which occur over several years can be analysed.

National integrated models have been operational for many years, for example the INFORUM family of models (Almon, 1991), based at the University of Maryland, comprises a consortium of research groups from 13 countries; Canada, Mexico, Japan, South Korea, Italy, France, Germany, Belgium, the United Kingdom, Spain, Austria, China and the United States. In the United States, the most widely implemented framework at the regional level is that established by Conway (1979, 1990), and adopted by the Regional Economic Applications Laboratory (REAL), a cooperative research venture between the University of Illinois and the Federal Reserve Bank of Chicago, in the early 1990s, as a means of providing an impact and forecasting capability with a strong regional flavour (see, eg, Israilevich et al., 1994). Similar models have been constructed for the States of Washington, Illinois, Iowa and Ohio, and metropolitan areas including Chicago, Cincinnati and Columbus.

The model used in this study is a derivative of the theoretical and empirical development of input-output econometric models at the University of Queensland, primarily the Queensland Impact and Projection Model (QUIP), the Interregional Input-Output and Econometric Model of Queensland (RIEM) and The Australian Regional Dynamic Interindustry Modelling System (ARDIMS). Under the ARDIMS umbrella were the Australian Interindustry Macroeconomic (AIM) model, a Queensland – Rest of Australia interregional model (QIM) and a sub-Queensland interregional model of the Queensland labour force regions (QRIM), as well as INFORUM Bilateral Trade Model (BTM). These models examined some of the problems that arise when econometrically determined relationships are used to close the input-output model in order to

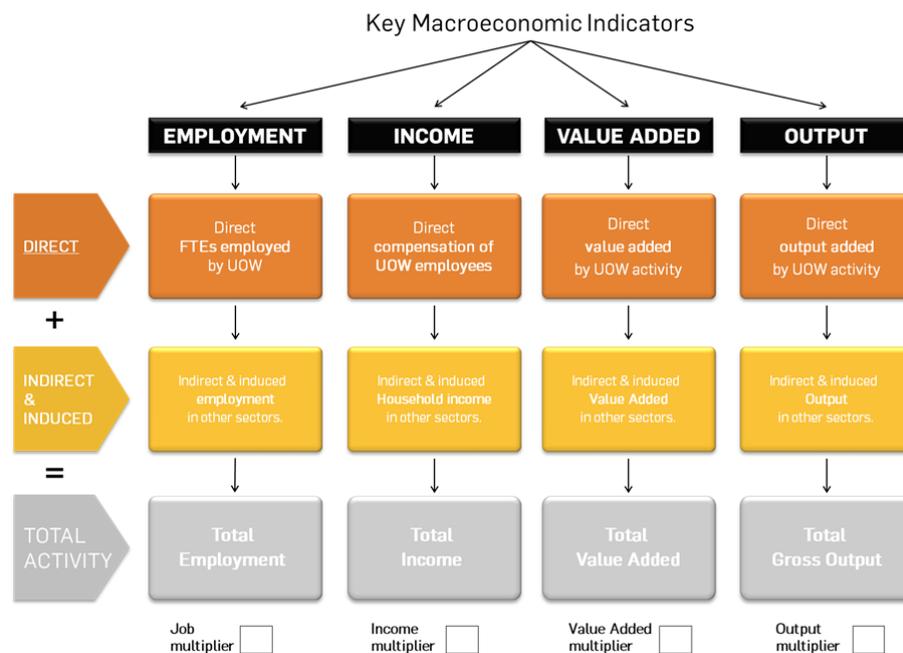
provide a more complete model of the economy. Some of these issues, including comparative studies against alternative models and model validation, are documented in various academic publications (Dewhurst and West, 1990, 1991; West, 1991, 1994, 1995, 1996, 1999, 2000, 2002; West and Jackson, 1995, 1998, 2003, 2005; Rey, West and Janikas, 2004).

With greater behavioural detail than the typical regional input-output model, the model used in this study incorporates many of the features of CGE models without the restrictive behavioural assumptions of input-output. Without the prohibitive construction costs and data requirement of CGE, the trade-off is the model lacks the complexity of capturing the full range of behaviours of CGE models, but within what the research team regard as a more realistic 'real data' region specific framework.

The Illawarra Interregional Input-Output Econometric Model (IIRi-oEM)

The model developed for this study - the Illawarra Interregional Input-Output Econometric Model (IIRi-oEM) - traces intermediate demand at various levels of the economy by mapping the inter-sector flows of revenues and purchases across 30 industry sectors for Wollongong, NSW and Australia. It also maps other key inputs to and outputs of production, including private and public final demand, compensation of employees, full-time equivalent employment, gross operating surplus, mixed income, imports and exports across all 30 sectors. It provides a detailed picture of the interactions between the various sectors in the economy and their level of influence on each other. Primary survey data of local businesses and key secondary sources such as the national accounts and 2011 Census of Population and Housing informed the model's construction. An input-output econometric model provides an ability to gain a detailed understanding of the flow-on and multiplier effects of UOW-related activities on employment, income, value added and output at the regional, state and national levels as shown in Figure 1.3. Indirect effects relate to inter-industry by UOW's suppliers, who purchase inputs to production in order to meet UOW's demand for their products (goods or services). Induced effects relate to the change in household income as a result of employment and resultant increased consumption expenditure.

Figure 1.3 Four measures of UOW's direct, indirect and induced effects



Understanding the indicators (refer to Figure 1.3):

The effects are measured on four key economic indicators:

- I. **Value added.** Gross expenditure measures are susceptible to multiple counting because they sum all the intermediate transactions over all stages of production during the production process. Consequentially, they can substantially overstate the contribution to economic activity. A preferred measure of the contribution to economic growth is value added. This is technically defined as wages and salaries and supplements paid to labour plus gross operating surplus plus indirect taxes on products and production less subsidies, but for practical purposes measures payments to factors of production (labour and capital), including net taxes on production. The sum of all industry value added is equal to gross regional product (GRP), so value added impacts refer to the contribution to GRP (or gross state product (GSP) at the state level and gross domestic product (GDP) at the national level). This is the accepted economic measure of what an economy produces.
- II. **Gross Output:** is the value of goods and services produced by an economic entity (such as UOW). Output is equal to total revenue plus internal consumption as a result of intermediate production.
- III. **Income.** This is the income earned by employees (or compensation of employees (COE)) as part of the normal operations of the economy.
- IV. **Employment.** The number of full-time equivalent jobs generated.

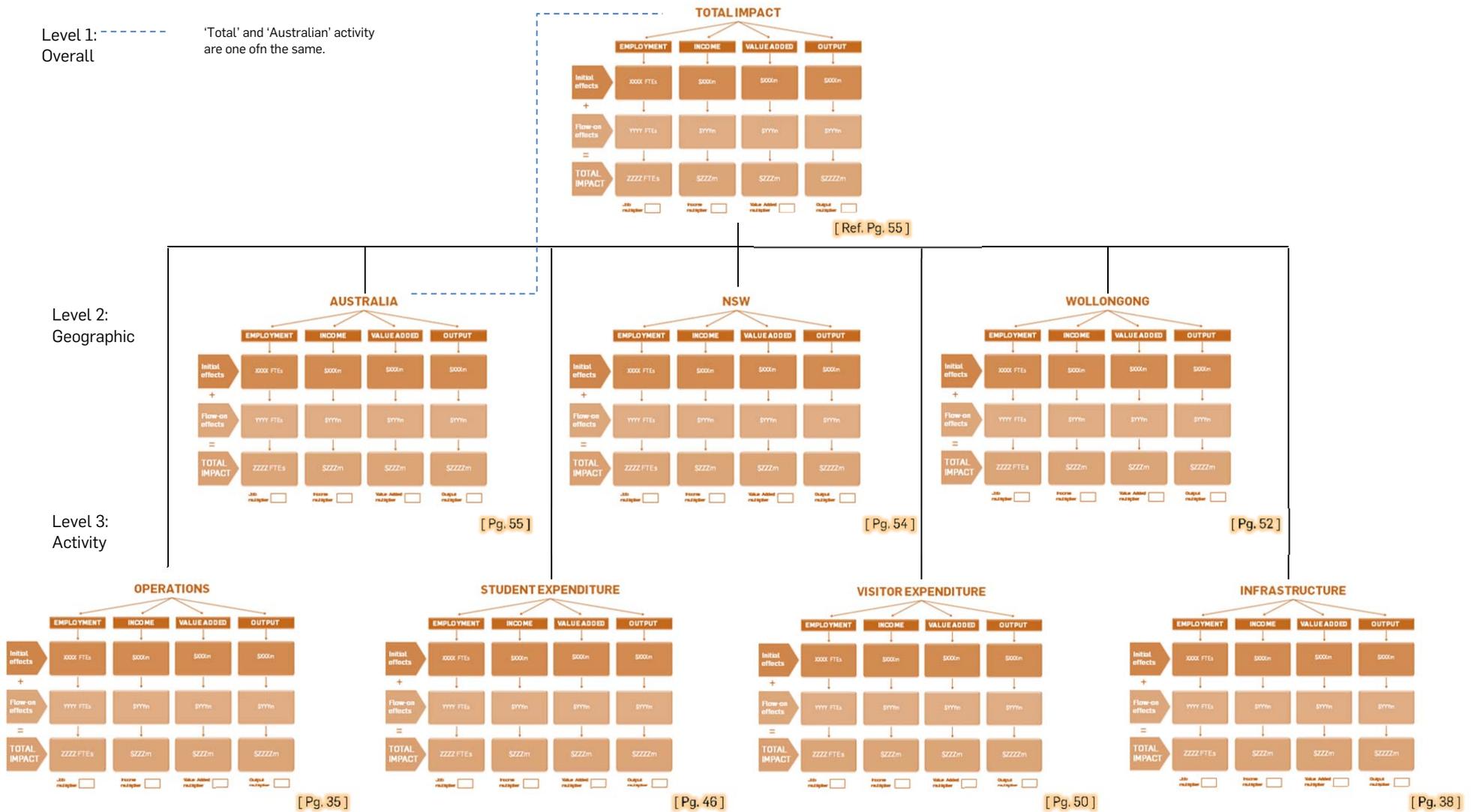
Understanding the different levels of economic influence (refer to Figure 1.4):

Level 1 - Overall: 'Total' within this report refers to UOWs complete effect – across all geographic and expenditure areas stated at Levels 2 and 3 below.

Level 2 - Geographic: economic effects have been modeled and reported at three geographic levels - regional (Wollongong), state (NSW) and national (Australia). Total state effects include our modelling of 'Wollongong' + 'Rest of NSW'. Likewise, total national effects include our modelling of 'Wollongong' + 'Rest of NSW' + 'Rest of Australia'. Purely from an "export earnings" or "import substitution" perspective, the regional effects are by far the most significant. Nonetheless, it is useful to look at the economic activity supported by UOW's various expenditure effects at broader levels such as the state and national levels.

Level 3 – Expenditure Area: economic effects have been modeled and reported for four distinct UOW-related expenditure areas. *UOW Operations* includes all aspects of the University's day-to-day activities (including teaching, research and commercial activities). It is important to note that student fee income is modelled under this activity and not under student expenditure. *Student expenditure* includes all living expenses of international and non-local domestic students, and also includes the specific university-related expenses of local students (the data for this activity is based on an extensive expenditure and income survey completed by over 1,400 UOW students in 2011). *Visitor expenditure* includes visitors for UOW events, such as graduation ceremonies, conferences and workshops, tourism visitation to the Science Centre, and special events. 'Capital expenditure' includes all UOW construction and refurbishments.

Figure 1.4 Levels of Reporting on the Direct, Indirect and Induced Economic Effects of UOW



1.4.2.2 *Estimating knowledge effects*

Graduate Premium & Private Returns

Most individuals and the broader community receive both financial and non-financial benefits as a result of an individual undertaking university studies. This study assesses both these types of benefits within the context of gaining a UOW degree. The non-pecuniary benefits are presented in Section 3.

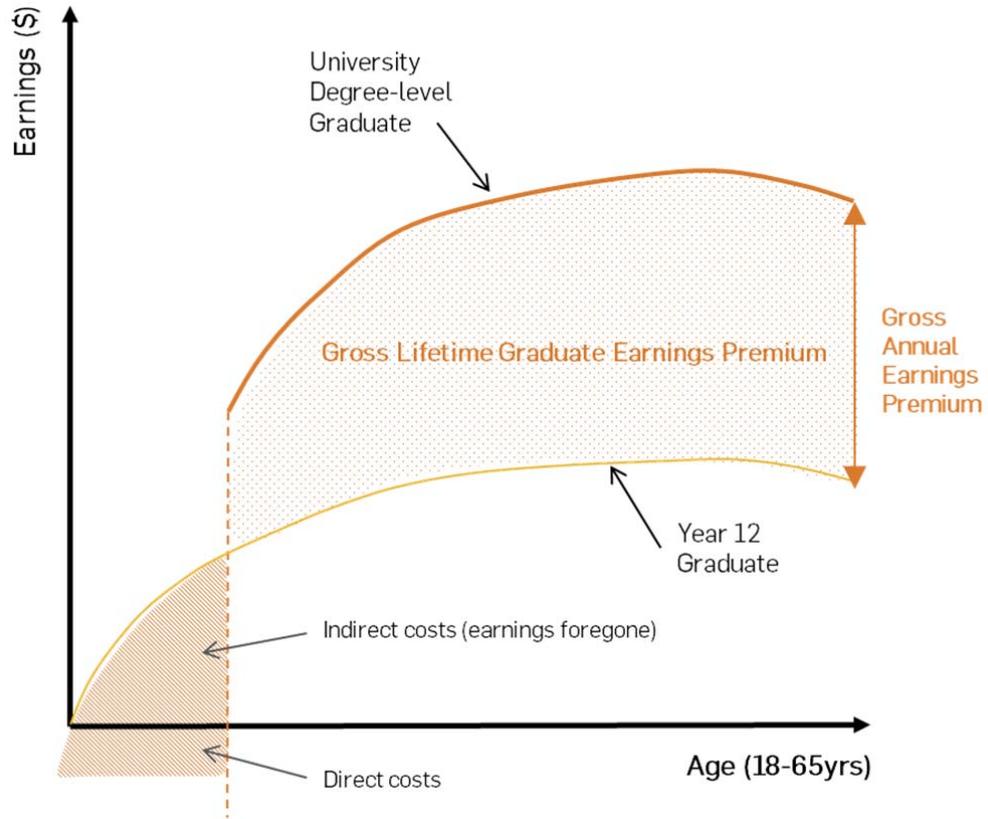
In order to measure these economic benefits, one of the key tasks of this study was to measure the *lifetime graduate premium* of UOW alumni and the subsequent return to both the individual and society. This section provides an overview of the methodological approach taken to calculate the graduate premium of a UOW degree holder and, in turn, estimating the Internal Rate of Return to individuals and society.

The benefits of a UOW degree, to individuals and to society, can be calculated using methods developed in the economic literature. The literature commonly quantifies individual returns in one of two ways: either via some variant of the earnings equation developed by Jacob Mincer (1974), or via the Internal Rate of Return method. Both methods have advantages and limitations. The Mincerian equation is popular amongst labour economists for measuring the returns to education more generally (a recent example of its use within the Australian context is Leigh, 2008).

However, this approach does have important limitations. Foremost is the fact that the Mincerian approach does not consider the *actual costs* incurred in undertaking tertiary studies (Daly et al, 2012). Students not only incur the direct costs of education, but also the 'cost' of foregone earnings during the period they are studying. Moreover, there are costs to account for in measuring government/societal returns: including the direct expenditure of subsidising student learning, and the opportunity cost of not investing elsewhere, as well as the loss of tax revenue whilst students are undertaking education and not working. It is important to capture these costs as closely as possible.

A second method commonly used to quantify individual and public returns on higher education is to calculate the Internal Rate of Return of investment in a degree. This approach considers the costs incurred and earnings foregone in undertaking tertiary studies. It considers the Net Present Value (NPV) of an investment in higher education by accounting for the costs incurred versus the potential future earnings benefits (appropriately discounted). The advantage of this method is that it *considers the full investment decision* of undertaking a degree relative to the counterfactual (high school completion only), and calculates the net benefit (or cost). The goal is to invest when the NPV is positive. Figure 1.5 illustrates a simplified version of the lifetime earnings profile of a university graduate.

Figure 1.5 The costs and benefits of gaining a university degree



Source: Based on Daly et al, 2012.

In this study the focus is on quantifying the private and public pecuniary returns of a UOW education using the Internal Rate of Return (IRR) method, similar to the approaches applied by Michael (1996), Borland et al. (2000), Larkins (2001), Borland (2002) and Daly et al. (2012). The internal rate of return for a 3-year degree is calculated using equation (1):

$$\sum_{t=1}^3 \frac{Ct}{(1+r)^t} = \sum_{t=4}^{42(f)44(m)} \frac{Rt}{(1+r)^t} \quad (1)$$

where:

Ct = opportunity costs of university degree in year t;

Rt = benefit of university degree in year t;

r = rate of return.

Economic returns to university research

Knowledge effects are as much about the value added through research as they are about the human capital universities develop. Research undertaken within UOW's institutes and centres has the goal of generating public good or commercially useful outcomes. However, the question of how to reliably and accurately measure the dynamic effects of university research and development (R&D) on the economy is one of on-going debate in the academic literature.

The first serious attempt to measure the dynamic effects of university R&D on the economy was undertaken by American academic Adam Jaffe in the late 1980s, who measured the economic "spillover" (or external) benefits of innovation and commercialisation of university research to industry (Jaffe, 1989). His study provided evidence that university R&D in the United States had significant spillover effects on commercial patents and indirect effects on local innovation and commercial R&D spending (1989, p957). Since then, Jaffe (1993) and others such as Audretsch and Feldman (1996), have provided convincing empirical evidence that such R&D spillovers are most intense within the region where the innovation and new knowledge is generated, suggesting that UOW's R&D impacts are likely to most benefit both the Greater Wollongong region and the state of NSW – although there will be instances where UOW expertise, innovation and high technology infrastructure will also benefit a broader region (such as Australia as a whole, Oceania, Southeast Asia and beyond).

Another approach that has gained increased attention in recent times has been an attempt to separate out that part of long-run total factor productivity (TFP) that can be directly attached to university R&D efforts. Of particular note, Fernand Martin (1998) undertook an increasingly cited study that quantified that component of Canadian total factor productivity attributable to Canadian university sector R&D. Several Canadian universities have since used Martin's methodology in an attempt to estimate the spillover effects of their R&D on total factor productivity (for example see Sudmant, 2009, Sun & Lee, 2011 and Briggs & Jennings, 2012).

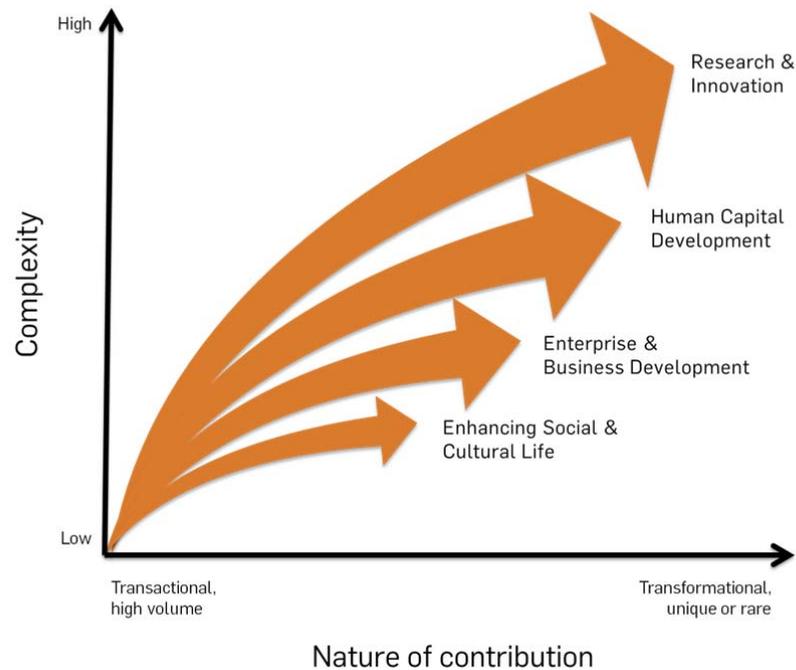
The benefit of approaches such as those touched on above is that they can provide an estimate of the aggregate impact of a wide array of economic drivers of innovation and productivity growth (Sudmant, 2009). However, an attempt to develop a model of the dynamic long-run economic effects of UOW R&D is beyond the scope of the current study. Instead, for the time being, we present an overview of the extent of UOWs direct research and development effects below.

1.4.3 Assessing UOW's Broader Role in Society

In addition to economic benefits, universities make other contributions to society. In 2011 the European Commission engaged urban and regional development scholar Professor John Goddard, of the Centre for Urban and Regional Development Studies at Newcastle University (UK), to develop a guide evaluating university contributions to the communities and regions within which they operate (European Commission, 2011).

A slightly modified version of Goddard's framework is used in this study. Figure 1.6 explains how this study assesses UOW's contribution under four broad areas of influence: (1) research and innovation; (2) human capital development; (3) enterprise and business development; and (4) enhancing social and cultural life.

Figure 1.6 Framework for assessing the broad university contribution



Source: Adapted from European Commission (2011: 5-7)

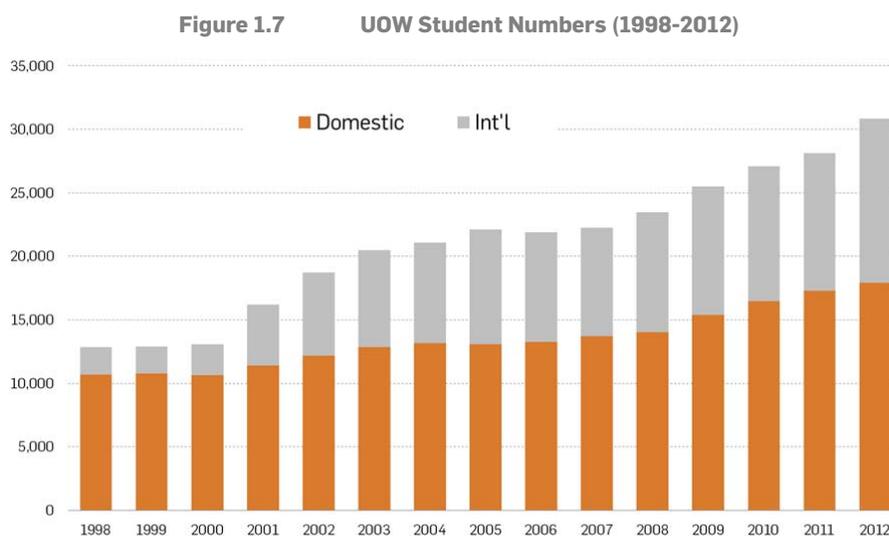
1.5 Organisational Context

1.5.1 Operational Overview

The University of Wollongong is a relatively new university, having been incorporated in 1975. In an Australian sector consisting of many institutions that have existed for more than 100 years, UOW has managed to expand rapidly, now offering over 450 undergraduate and postgraduate degrees within five broad faculties, across nine campuses within Australia and overseas.

1.5.2 Student Population

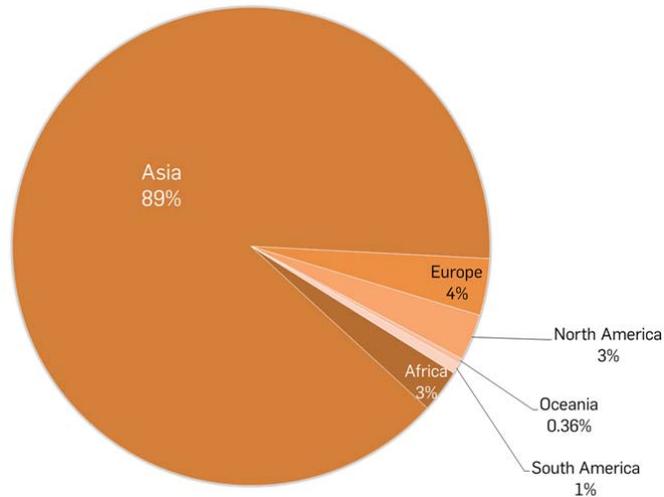
UOW had 30,516 students enrolled in 2012. UOW student numbers have grown strongly over the past decade (Figure 1.7), driven by steady growth in domestic student numbers and very significant growth in international student numbers. In 1992, UOW had just over 1,000 international students. By 2012 it had 12,946 international students. Many of these students are 'on-shore' and contribute significant export earnings to the economy at the regional, state and national levels.



Source: UOW Performance Indicators Unit, Nov 2012.

The UOW student population is diverse, consisting of 143 nationalities. Despite a broad cross-section of nationalities, as Figure 1.8 shows, the international student population is dominated by Asian countries which account for 89% of international students at UOW. Moreover, China provides a large proportion of students from Asian countries.

Figure 1.8 UOW International Student Origin (2011)



Source: UOW Performance Indicators Cube, Nov 2012.

1.5.3 Student Living Expenditure

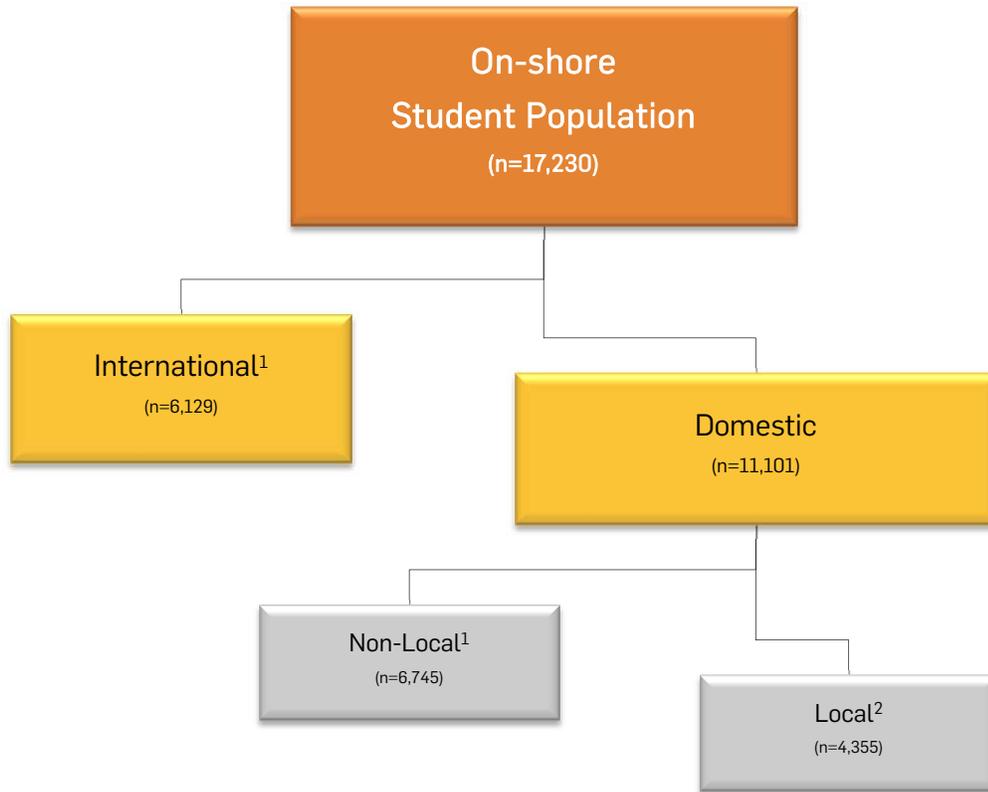
With a population of over thirty thousand students, UOW's presence in each of its operating regions results in considerable final demand effects. Section 2 utilises the results of an extensive student expenditure survey conducted in 2011 to estimate the direct, indirect and induced effects of student spending at the *Greater Wollongong*, *Rest of NSW* and *Rest of Australia* levels.

Local vs. Non-Local Student Expenditure

One important measurement issue is whether or not to include local student expenditure in the analysis. As shown in Figure 1.9 below, 5,621 students attending UOW are 'local', and were UOW not to exist many of these students would be likely to attend university outside the region. This study has taken a conservative approach to estimating local student expenditure, by excluding all non-university related expenses, as it could be assumed that this expenditure would have occurred within the region regardless of whether they were attending UOW.

The population of UOW students can be classified as 'on-shore' (i.e. domestic and international students at Wollongong and other Australian campuses) and 'off-shore' (i.e. students at overseas campuses undertaking UOW degrees). Figure 1.9 provides a breakdown of the onshore student population, which is the focus of this study. Off-shore students have an impact on UOW's operational surplus that may flow back into Australia, however, for the purposes of this study this aspect of UOW's economic impact has been discounted as data on overseas operations was not available.

Figure 1.9 2011 UOW On-Shore Student Breakdown (EFTSL)²



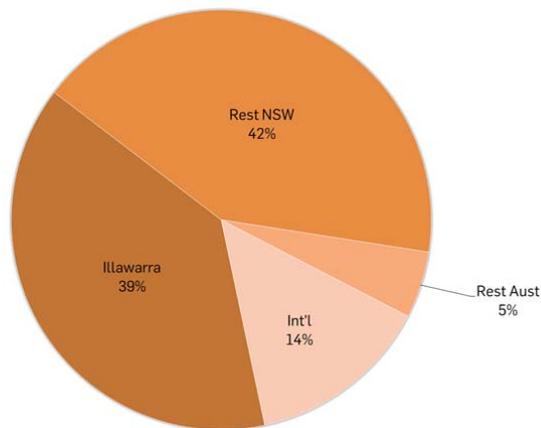
1. *Non-Local Students*: All expenditure by students who come from outside the Greater Wollongong region. This cohort would not have come to the region without the University's existence and their expenditure would hence not have resulted.
2. *Local Students*: Most local student expenditure (e.g. food, housing, utilities etc.) and flow-on effects would have occurred even without the existence of the university. The counter argument to this is that, if there were no other university in the region the expenditure of many local students would be 'lost' to another region for at least the time it takes to complete their studies. Our analysis only includes that proportion of expenditure by local students that can be attributed to the completion of university studies (e.g. transportation to and from university, parking, on-campus expenditure such as food, books and amenities fees etc).

² Full academic year equivalent numbers reflect an estimate of the likely "head count" for a full academic year. Enrolments and Missing part of sentence here

1.5.4 Alumni

UOW has established a strong Alumni network. Since foundation, the University has conferred 106,220 awards (as at December 2012). As Figure 1.10 shows, 39% of UOW graduates reside in the Greater Wollongong region, while 42% reside elsewhere within the state (mainly Sydney), 5% reside elsewhere in Australia, and 14% live overseas. The 86% of UOW graduates living within Australia make an ongoing contribution to income, productivity and innovation that we have attempted to partially quantify later in the report.

Figure 1.10 UOW Alumni Location



Source: UOW Office of Advancement, Jan 2013.

Although outside the scope of the current study, the economic and social contributions of UOW graduates residing in other countries should not be overlooked.

1.5.5 Employment

UOW has experienced growth in staff numbers as its student body has expanded (Figure 1.11). With over 2,000 employees, UOW is amongst the top five employers within the Greater Wollongong region. It is worth noting that UOW has managed to maintain an efficient operating model. Figure 1.12 shows a scatterplot of full-time equivalent staff versus equivalent full-time student load for all higher education institutions in Australia. It shows that UOW is operating at a staff to student ratio substantially lower than the Group of

Eight universities³. Despite this, UOW has maintained the highest rating for teaching quality and is ranked ninth amongst all Australian universities for the quality of its research outcomes⁴.

Figure 1.11 UOW Staff Numbers (1998-2012)

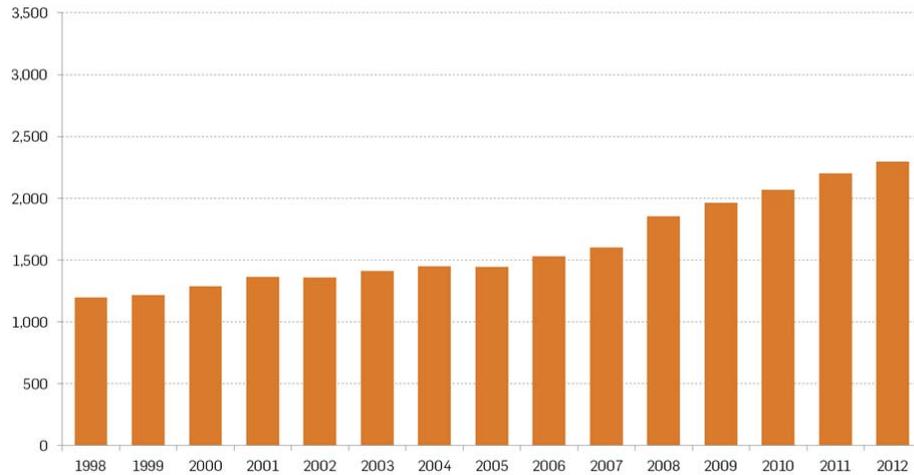
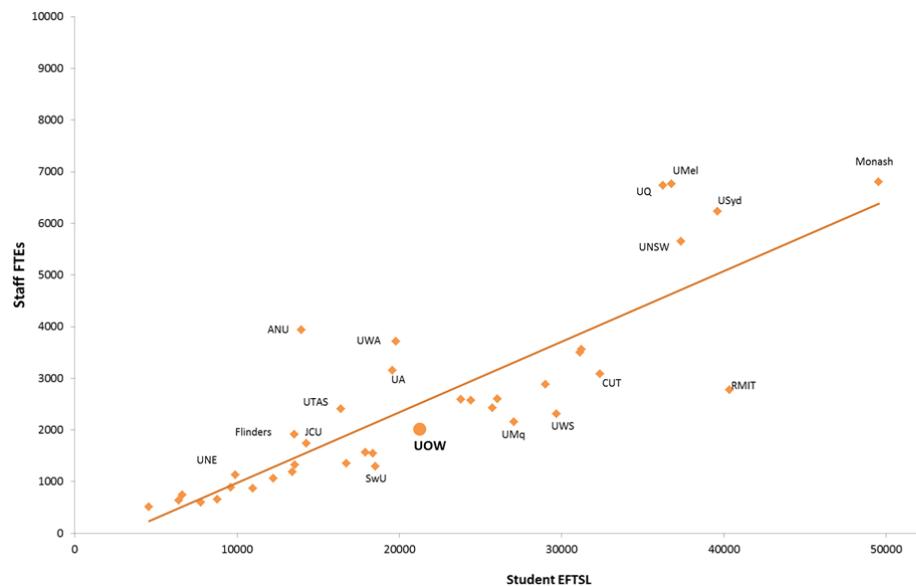


Figure 1.12 Staff vs. Students at Australian Universities (2011)



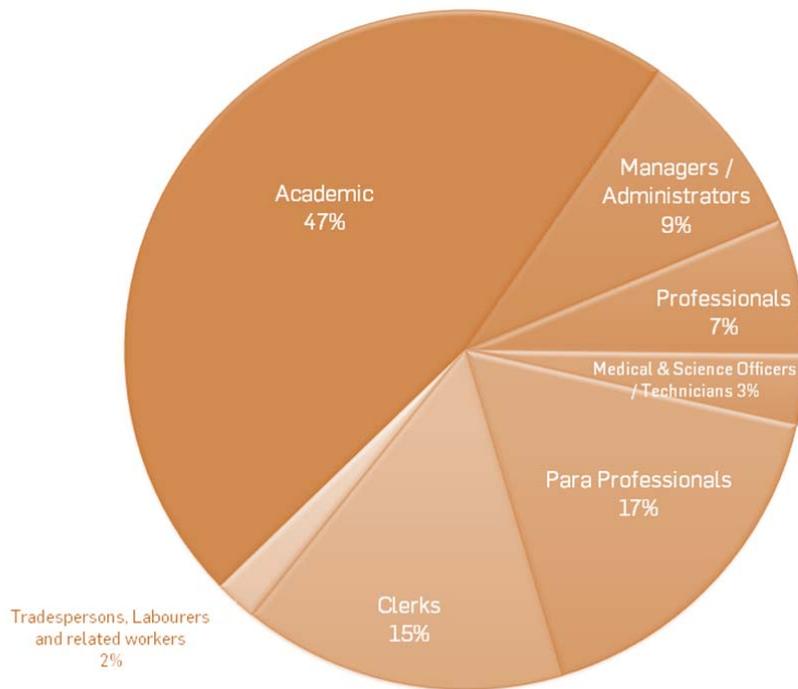
*Note: Staff FTEs include both academic and general staff. Counts relate to on-shore operations only.
Source: DEEWR, uCube. Accessed Dec 2012: <http://www.highereducationstatistics.deewr.gov.au/>.*

³ The Group of Eight is the formal network of Australia's leading universities and includes ANU, UWA, UNSW, USyd, Monash, UMel, Adelaide, UQ.

⁴ Based on the 2012 Excellence in Research institutional rankings published in The Australian, 6 Dec 2012. Access: <http://www.theaustralian.com.au/higher-education/how-universities-performed-in-era-2012/story-e6frgcjx-1226530828592>.

UOW's employees provide a major economic stimulus through their spending. Figure 1.13 provides a breakdown of UOW employees by occupation and highlights the large proportion of knowledge workers. Knowledge workers such as academics, professionals, technicians, managers and administrators receive wages above the regional average. These higher incomes create more wealth due to substantial flow-through effects within the regional economy.

Figure 1.13 UOW Staff Occupational Profile



Source: UOW Performance Indicators Cube.

1.6 Regional Context

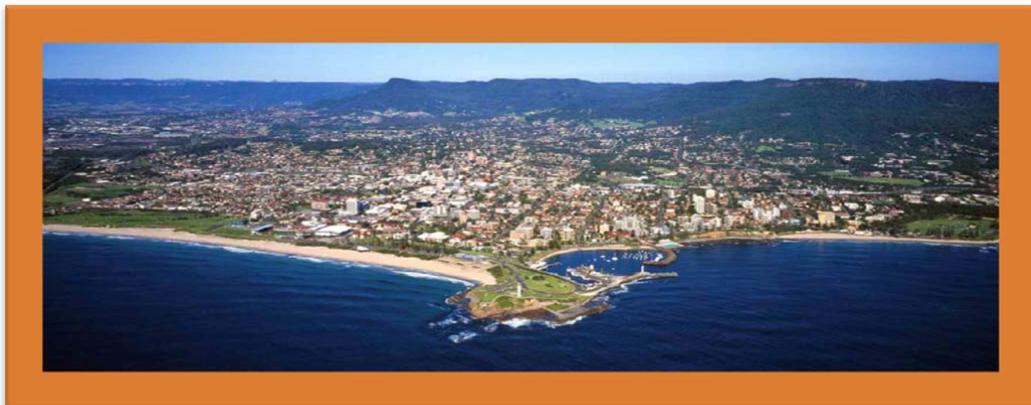
This section provides a profile of the region, highlighting some of the key economic and social issues including: constrained population growth; an ageing community; an economy in transition from traditional

heavy industry manufacturing to new knowledge-intensive industries; a large commuter workforce; and an unemployment rate that remains consistently above the state and national average. These issues should be kept in mind when considering the present and potential future role of the University.

1.6.1 Location

UOW's main campus and its technology park (the 'Innovation Campus') are located in the coastal city of Wollongong, just 80km south of the Sydney CBD. Wollongong is well positioned strategically, with over five million people living within a three hour drive from Sydney in the north to Canberra in the south-west. Being located in a zone holding nearly one-quarter of Australia's entire population (and the nation's political and financial capitals), UOW has access to world-class transport and logistical infrastructure. Wollongong's proximity to Sydney has also meant that UOW is not classified as a regional university, despite Greater Wollongong being a largely self-contained region. Within the context of Federal government regional higher education funding initiatives (such as the current Collaborative Research Networks program) this has left UOW at a disadvantage relative to other regionally-based universities in Australia.

Figure 1.14 Wollongong's spectacular geography presents natural barriers to growth



Source: ImageShack

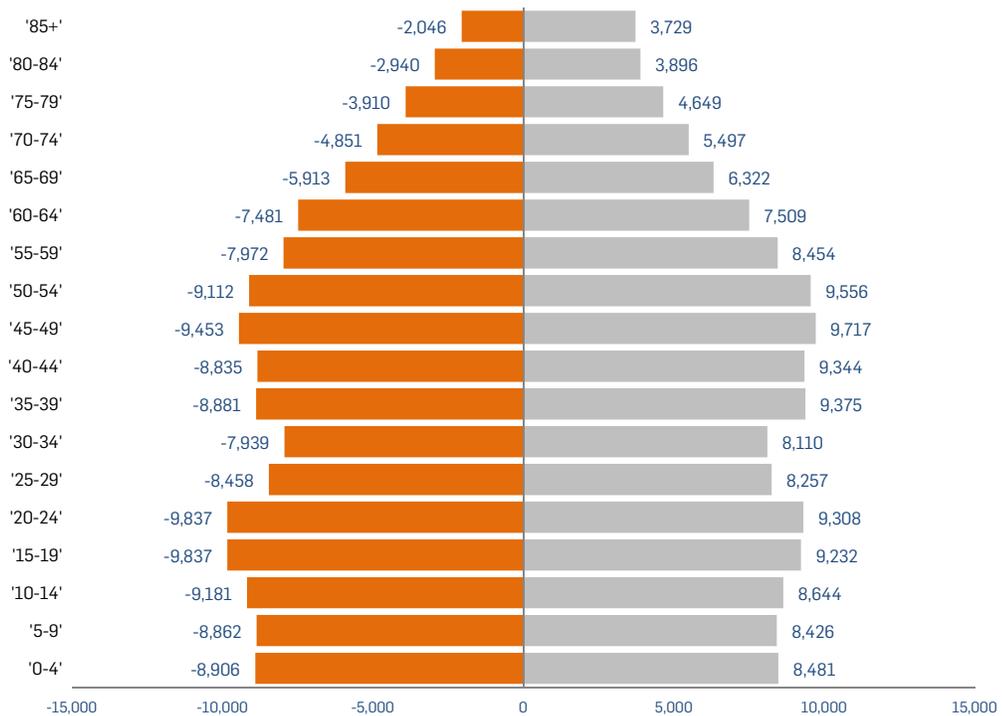
1.6.2 Strong, but ageing, population base

Wollongong is Australia's ninth largest city, with a population nearing 300,000 residents. The region's population is ageing and growth is relatively constrained by geography. As Figure 1.15 shows, the region has a large population nearing retirement age (aged 45-64yrs), and the population average age exceeds the state average.

The region's stunning beaches to the east and dense rainforest escarpment to the west act as a natural barrier to development, leaving the northern Wollongong area in particular with a relatively small geographic footprint for new dwellings. Although the Shellharbour and Kiama local government areas have significantly more available land for residential and commercial development than the Wollongong local government area, the projected population growth of the region as a whole is forecast to be at or slightly below the state average over the next 30 years (NSW Department of Planning, 2012).

Figure 1.15 Greater Wollongong Age Pyramid (2011)

Males (LHS) vs. Females (RHS)

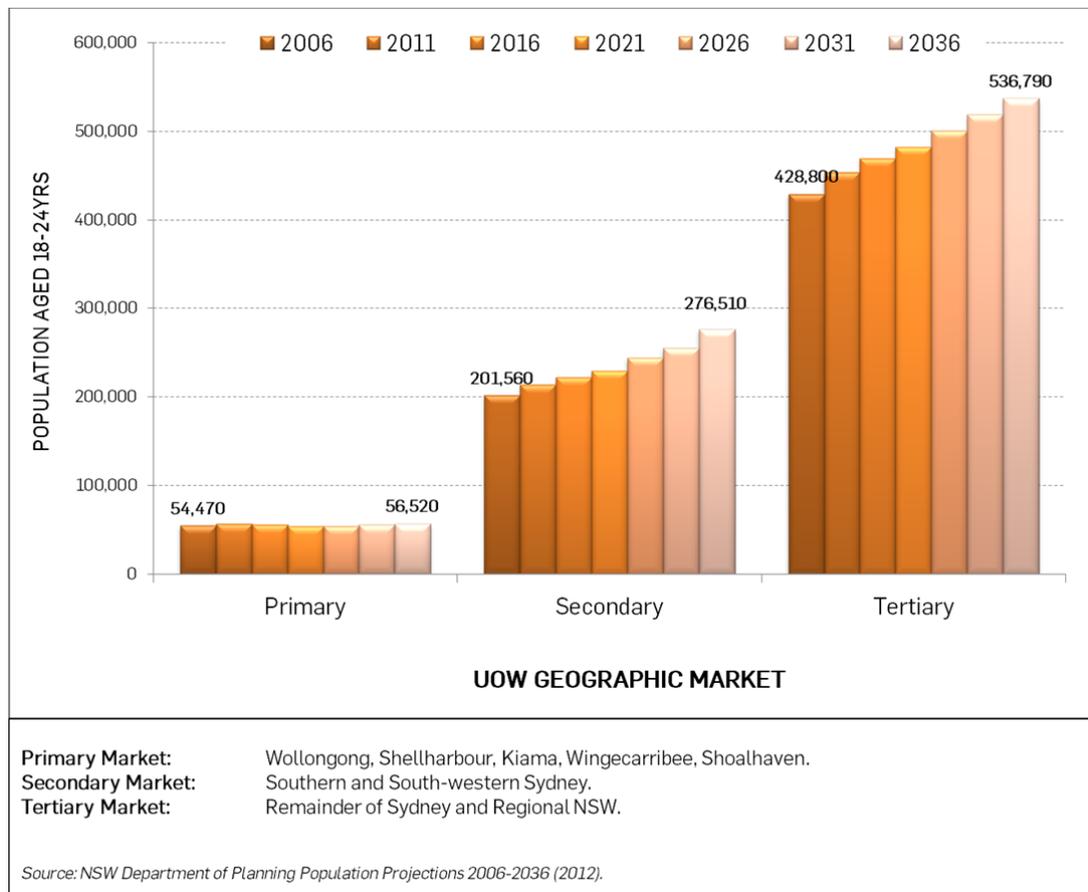


Source: ABS Census of population and Housing, 2011.

The implications of Greater Wollongong's limited population growth for UOW are magnified by the related trend highlighted in Figure 1.16, which shows the projected population growth of the 18-24 year age group to 2036. The virtual flat lining of growth for Wollongong's 18-24yr age group suggests there is little room for market growth within UOWs primary drawing area over the next 30 years.

Conversely, UOWs secondary markets of southern and southwestern Sydney, and tertiary markets of central, northern and northwestern Sydney are projected to grow strongly over the same period. This of course has longer term implications for UOW, with the importance of sourcing students from outside its traditional 'local' market to continue growing.⁵

Figure 1.16 Projected 18-24yr population growth in UOW market areas



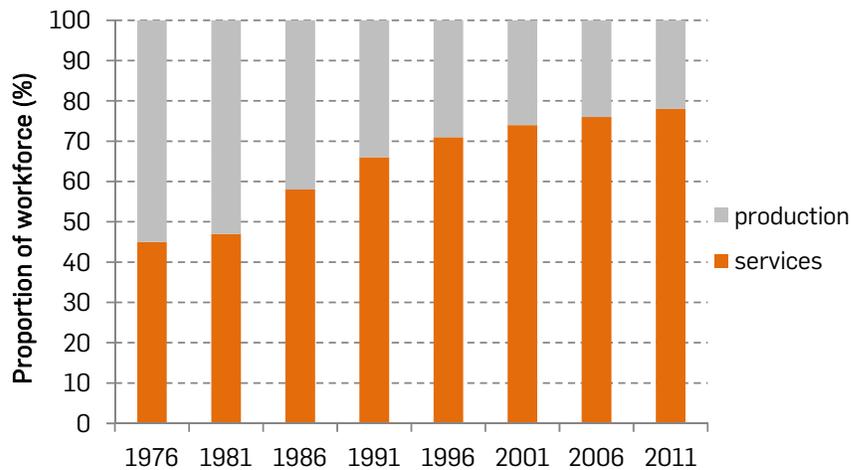
⁵ Although future population growth scenarios have not been furnished in the impact modelling within this report, the model developed for this study is suited to the task of simulating future growth scenarios and their economic impacts.

1.6.3 The shift from 'traditional' to 'new' industries

Greater Wollongong as a region has been economically dependent on coal mining and heavy industry manufacturing since the early 1900s. For decades these industries laid the economic, social and cultural foundations of Wollongong as a major regional Australian city. However, over the past three decades there has been a fundamental shift in the balance of international development and terms of trade that has put significant pressure on the region's traditional industries – particularly manufacturing. Over this period, the Greater Wollongong region has faced substantial economic development challenges, manifested in consistently high unemployment rates, particularly youth⁶, limited success in attracting new industries and investment, and low economic growth relative to the state as a whole.

The changing structure of employment in the region over the last 30 years clearly shows the growing importance of UOW's role as a developer of skilled human capital within the region. As Figure 1.17 and Figure 1.18 clearly illustrate, whilst traditional manufacturing industries, such as the Port Kembla steelworks, continue to be significant employers, there is a clear trend away from production-based employment and toward service-based employment. As the region's population has become more educated, the region's skills base has been increasingly able to meet the demands of new industry. Perceptions of Wollongong linger on past images of smoke stacks, pollution and working class fibro suburbs, but the reality is that the economic and social base of Wollongong has substantially broadened and is now more closely aligned with the structure of the national economy, with knowledge and other service industries becoming prominent employers (Braithwaite, 2006).

Figure 1.17 Greater Wollongong's shift from production to service industries (1976-2011)



Source: ABS Census data.

⁶ A 2008 report by Braithwaite et al investigating the long term employment challenges facing youth within the Illawarra region found several underlying issues of extreme disadvantage, not least of which were issues of entrenched intergenerational unemployment, educational participation and completion rates consistently well below the state average, and a severe lack of employer demand within the region for jobs suited to 18-24yr old school leavers.

Figure 1.18 International Export Comparison – Steel Production vs. Knowledge Production



Note: data on international steel exports from Port Kembla was not available for 2012, however, in late 2011 BlueScope Steel announced that it was ceasing its international steel export operations from Port Kembla. Hence, the dotted line represents the assumption that there was no steel exported from Port Kembla in 2012.
 Source: IRIS Illawarra Statistical Guides, UOW Performance Indicators database.

1.6.4 Employment growth remains a big issue

High unemployment relative to other Australian cities continues to haunt Wollongong. Figure 1.19 **Error! Reference source not found.** tracks Wollongong's long-run average unemployment rate over the five year period from 2008-2012. It shows that the region's unemployment rate has been consistently 1.5-2% above the state average, a statistic that is indicative of deep underlying structural unemployment problems. Table 1.1 shows that the unemployment issues are even greater for the region's youth (15-24yr olds), with both Wollongong (12.9%) and its immediate southern neighbour the Shoalhaven (20.9%) amongst the top four regions within NSW in terms of youth unemployment rate. The region's persistently high unemployment rate is symptomatic of an inability to address the complex labour market challenges that come with the competitive demands of an increasingly global economy. Like many regions, Greater Wollongong suffers from a latent 'structural mismatch', with employing sectors seeking new skills not often held by the displaced workforce. The workforce requires time, resources and significant training support to gain the necessary skills to compete in what is a vastly different employment landscape.

Figure 1.19 Unemployment Rate Trends – Greater Wollongong vs. NSW

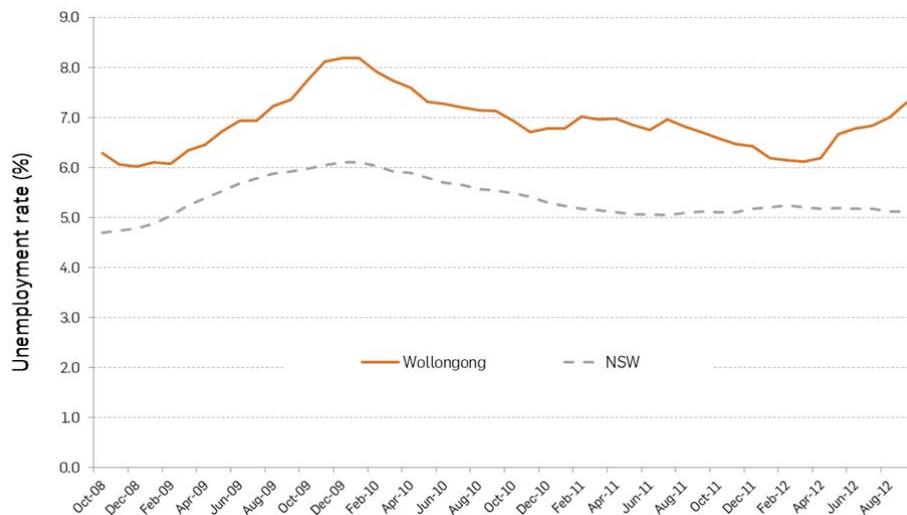


Table 1.1 Comparative youth (15-24yrs) unemployment rates (2012)

NSW Regions	Youth (15-24yrs) Unemployment Rate
<i>Shoalhaven</i>	<i>20.6%</i>
Canterbury-Bankstown	19.6%
Fairfield-Liverpool & South Western Sydney	14.2%
<i>Greater Wollongong</i>	<i>12.9%</i>
North Western Sydney	11.3%
South Eastern	10.8%
Lower Northern Sydney	10.3%
Inner Sydney and Inner West Sydney	9.6%
Northern Beaches	9.6%
St George-Sutherland	8.1%
Eastern Suburbs	7.5%

Source: ABS Labour Force Survey; 12-mth average of unemployment rate for 12mths to Sep 2012.

1.6.5 Large Commuter Workforce

One on the effects of the close proximity to Sydney is the impact on the region's labour dynamics. For instance, many Wollongong residents commute outside the region either because opportunities do not exist locally or are better elsewhere (particularly in Sydney). Figure 1.20 shows where Wollongong residents travel to work as at the 2011 Census, indicating that nearly 30,000 residents, or 28% of the workforce, travel outside the region for work. Over half of these commuters (17,150) travel to Sydney for work. Table 1.2 **Occupations of Wollongong's commuter workforce** gives the breakdown of commuters by broad occupation level, with Professionals (20%), Technicians and Trades Workers (20%) and Managers (11%) often traveling to work outside the region.

Figure 1.20 Where do Wollongong residents work?

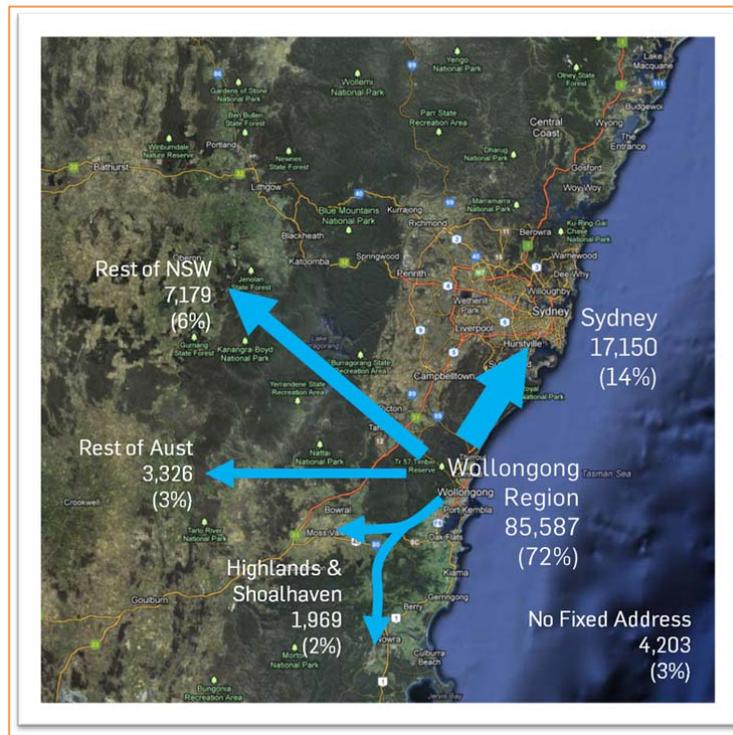


Table 1.2 Occupations of Wollongong's commuter workforce

Occupation	% of all Travelling Workers
Professionals	20%
Technicians and Trades Workers	20%
Managers	11%
Community & Personal Service Workers	11%
Labourers	11%
Clerical and Administrative Workers	10%
Machinery Operators and Drivers	9%
Sales Workers	7%

Note: Excludes workers whose place of work was not stated or inadequately described. Sources: 2011 Census of Population and Housing, Google Maps.

1.6.6 Summary - a region in need of economic leadership

The Greater Wollongong region has much to offer. It is well placed geographically to take advantage of Australia's economic capital (Sydney) and political capital (Canberra), has a large, diverse and increasingly skilled population, and a stunning natural setting. But it is also a region that has experienced a sustained period of major structural adjustment to its economic base leading to issues of structural unemployment, job creation and investment.

UOW's economic and broader contribution is of course closely tied to its role in the evolution of Wollongong from a steel city towards being a diverse, highly skilled and globally competitive city. UOW has been, and will continue to be, an active partner in creating a better economic future for Wollongong. As the remainder of this report will demonstrate via an analysis of the available evidence, UOW has, is and will continue to provide the Wollongong region with the local economic leadership it needs to grow and reach its full potential as a vibrant, prosperous and globally competitive city well into the future.

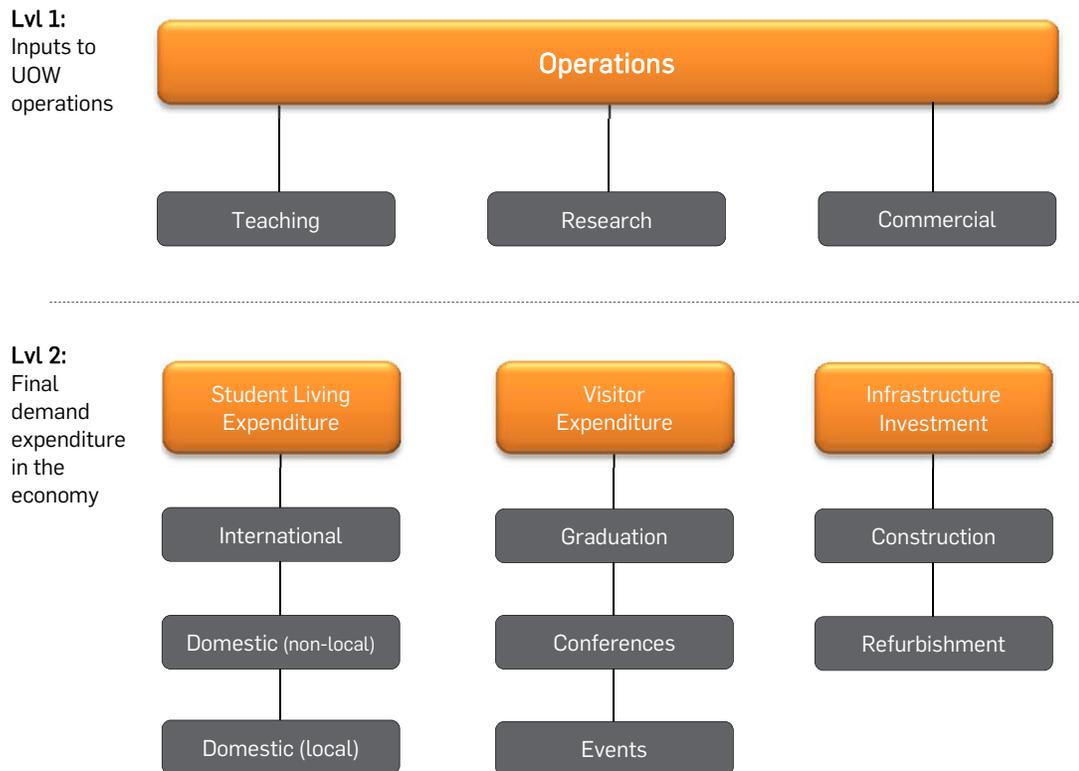
SECTION 2:

UOW'S ECONOMIC IMPACT

2.1 Expenditure-related Activities

In providing academic, research and infrastructure development, UOW is a direct employer, purchaser of goods and services, generator of student expenditure, and attractor of investment and visitation to its operating areas. UOW-related expenditure is a substantial contributor to the economic strength of its home region and beyond. Direct expenditure generates *indirect and induced* economic effects by stimulating further demand for goods and services, resulting in incremental employment, income and value added benefits for Greater Wollongong, NSW and Australia.

Figure 2.1 UOW-related Expenditure in the Economy



2.1.1 UOW Operations

2.1.1.1 Overview

The day-to-day operations of the University are vast and have a major direct, indirect and induced effect on the economy, particularly within its regions of operation. As an employer of over two thousand academic and professional staff, buyer of goods and services from a wide range of businesses, and a generator of local, state and federal tax revenue, UOW contributes significantly to the ongoing economic vitality of Greater Wollongong, NSW and Australia. This section addresses the direct, indirect and induced effects of UOW's day-to-day operations, which are summarised in Table 2.1.

Table 2.1 Summary of Operations-related Economic Activity Measures (2011)

Indicator	Greater Wollongong	Rest of NSW	NSW	Rest of Australia	Australia
Gross output (\$m)	742	101	843	106	950
Value Added (\$m)	383	118	501	67	568
Income (\$m)	269	61	331	26	357
Employment (FTEs)	2,738	640	3,378	423	3,801

Key findings:

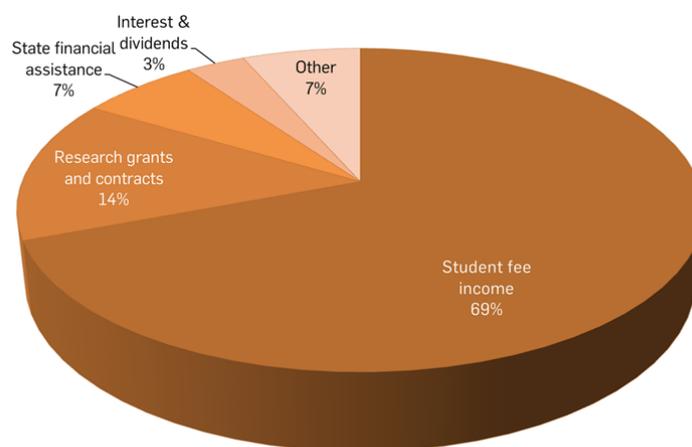
During 2011,

- Within the **Greater Wollongong** region, UOW operations generated direct, indirect and induced effects that included gross output of \$742 million, value added of \$383 million, local income of \$269 million, and 2,738 full-time equivalent jobs.
- Across the state of **NSW**, UOW operations generated direct, indirect and induced effects that included gross output of \$843 million, value added of \$501 million, income of \$331 million, and 3,378 full-time equivalent jobs.
- **Nationally**, UOW operations generated direct, indirect and induced effects that include gross output of \$950 million, value added of \$568 million, income of \$357 million, and 3,801 full-time equivalent jobs.

2.1.1.2 Direct Effects

UOW's revenues and expenditures are important factors in understanding its broader economic effect. In 2011, UOW's consolidated entity⁷ attracted \$512 million of revenue (excluding capital investment and student accommodation, which are accounted for elsewhere). As Figure 2.2 shows, this funding is drawn from direct (student) and indirect (federal government HECS/HELP/scholarship) fee income (69%), research grants and contracts (14%), state government assistance (7%), interest and dividends (3%) and other general revenue sources (7%). *Importantly, approximately 87% of this revenue comes from sources outside the Greater Wollongong region.*

Figure 2.2 Sources of UOW Revenue, 2011 (Total=\$512m)

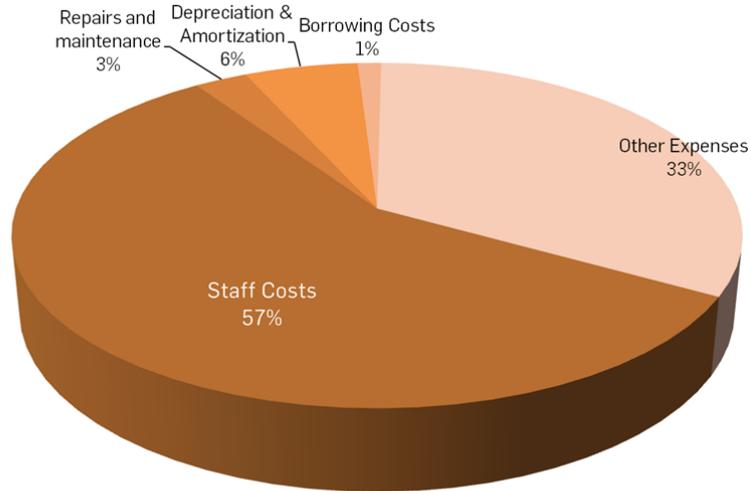


*Note: Excludes capital grants and student accommodation.
Sources: UOW Planning Services.*

UOW operating expenses in 2011 totaled \$432 million. As shown in Figure 2.3, the most significant proportion of UOW turnover was accounted for by staff wages and salaries of approximately \$250 million for its 2,096 on-shore employees across the consolidated entity. Purchases of goods and services totaled \$147 million, with the remainder of costs made up of repairs and maintenance, depreciation and amortization, and borrowing costs. *According to estimates provided by UOW Finance, approximately 70% of all expenditure occurs within the Greater Wollongong region.*

⁷ UOW's consolidated entity as at the time of the study includes Illawarra Technology Corporation, a separate commercial operation owned by UOW.

Figure 2.3 UOW Expenditure Profile, 2011 (Total=\$432m)



*Note: Excludes capital works.
Sources: UOW Planning Services.*

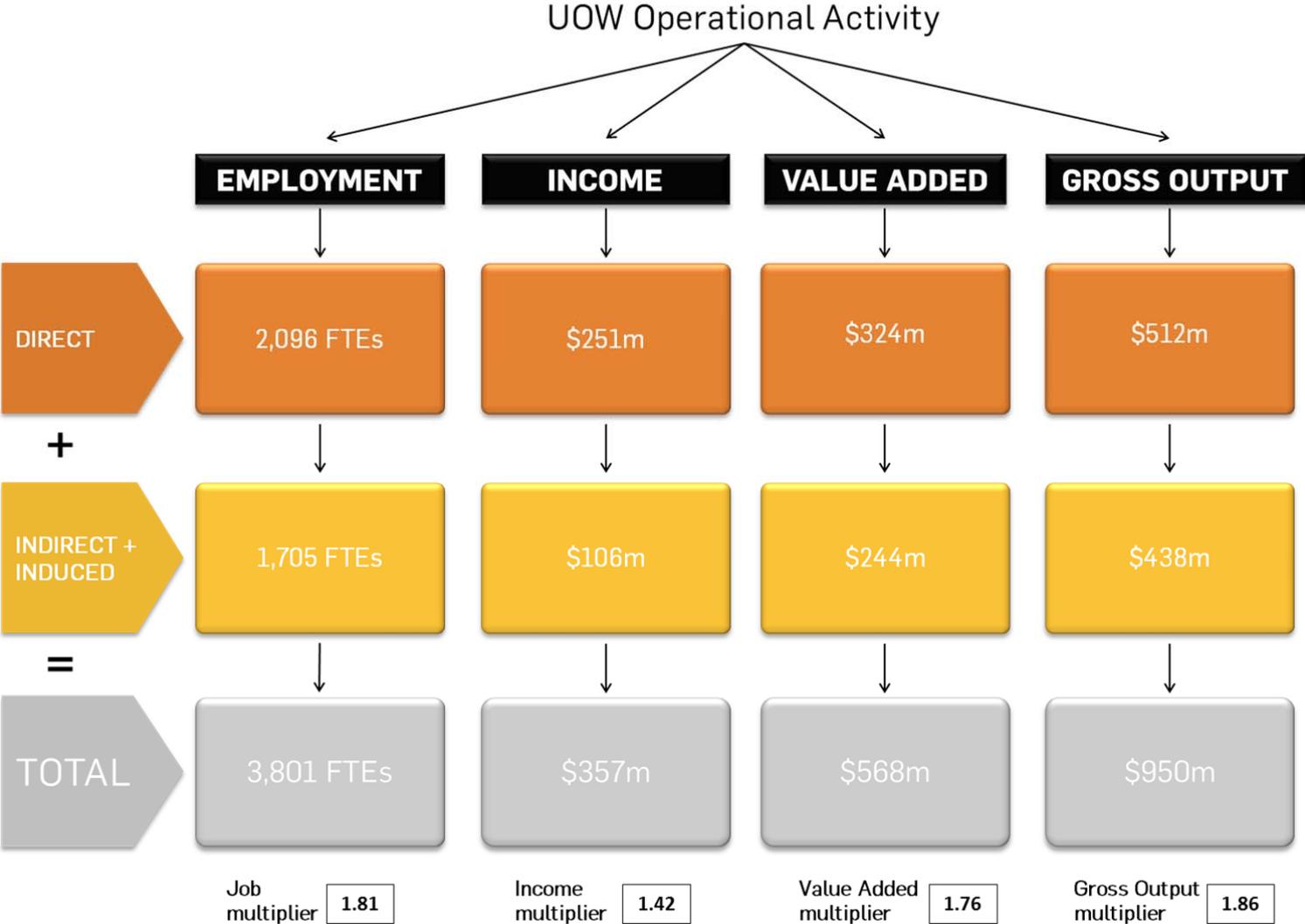
2.1.1.3 Indirect, Induced and Total Effects

Figure 2.4 provides an overview of the direct, indirect and induced effects of UOW's operational expenditure on compensation of employees and the purchase of goods and services. The \$512 million in initial UOW expenditure across its operations results in a further \$438 million in indirect and induced gross output through the economy, meaning that every dollar spent on UOW operations creates a further 86 cents of output elsewhere in the economy. Total output from UOW operations is approaching one billion dollars (\$950 million). The industry sectors most impacted in terms of gross output generated are *Ownership of Dwellings, Finance and Insurance, and Professional, Scientific and Technical Services*.

UOW's day-to-day operations do not just sustain the 2,096FTEs employed by the University. Its expenditure in the economy also creates a further 1,705FTEs in supporting industries, meaning that the total employment effect of UOW's operations equates to 3,801 FTEs sustained throughout the economy. Alternatively, for every 100 FTEs employed by UOW in its operations, a further 81 FTEs are employed by other businesses. The industry sectors benefiting most in terms of employment were *Retail, Accommodation and Food Services, Health and Social Services, and Financial Services*.

Beyond the \$251 million paid by UOW to its employees, its operations generate a further \$106 million in household income throughout the economy.

Figure 2.4 Direct, Indirect and Induced Impacts of UOW Operational Spending (2011)



2.1.2 Capital Investment

2.1.2.1 Overview

UOW's infrastructure investment, in the form of construction and refurbishment activities, also delivers significant benefits for the economy. During 2011, the University invested \$76 million in various construction and refurbishment projects. Over the decade from 2003 to 2012, UOW has directly invested nearly half a billion dollars (\$464m) in major construction and refurbishment projects, and has already committed at least a further \$193 million on infrastructure development and refurbishment projects between 2013 and 2017. Table 2.2 provides a summary.

Table 2.2 Summary of Capital Investment-related Economic Activity Measures (2011)

Indicator	Greater Wollongong		NSW	Rest of Australia	
	Wollongong	Rest of NSW		Australia	Australia
Gross output (\$m)	100	22	122	19	140
Value Added (\$m)	19	21	39	11	50
Income (\$m)	11	15	26	5	31
Employment (FTEs)	177	228	405	80	485

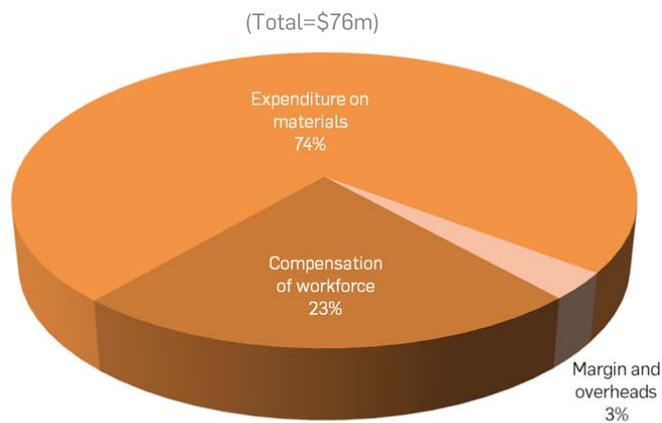
Key findings:

- Within the region of **Greater Wollongong**, UOW capital works during 2011 generated direct, indirect and induced effects that include gross output of \$100 million, value added of \$19 million, local income of \$11million, and 177 full-time equivalent jobs.
- Across the state of **NSW**, UOW capital works during 2011 generated direct, indirect and induced effects that include gross output of \$122 million, value added of \$39 million, income of \$26 million, and 405 full-time equivalent jobs.
- **Nationally**, UOW capital works for 2011 generated direct, indirect and induced effects that include gross output of \$140 million, value added of \$50 million, income of \$31 million, and 485 full-time equivalent jobs.
- Over the **past decade** (2003-2012) UOW construction and refurbishment programs have contributed over a billion dollars (\$1.16 billion) in gross output, \$417 million in value added, \$260 million in income and 4,188 FTE jobs.
- Over the **next five years** (2013-2017) UOW construction and refurbishment programs are projected to contribute at least \$482 million in gross output, \$172 million in value added, \$107 million in income and 1,726 FTE jobs.

2.1.2.2 Direct Effects

During the 2011 calendar year, UOW invested \$76 million across a range of capital works projects including the SMART Infrastructure Facility, a new commercial building (Enterprise 1) and the Australian Institute for Innovative Materials (AIIM) building at the Innovation Campus, the Metro Square development; a new Common Teaching Area building; and major refurbishment of UniCentre student facilities. Figure 2.5 Direct Capital Expenditure (2011 presents a summary of direct expenditure. These works directly employed 264 FTEs and paid over \$17 million (23%) in wages and salaries, whilst spending \$56 million (74%) on materials, equipment and contractors. Half of all expenditure went directly into the local economy (50%), with a further 31% spent throughout NSW.

Figure 2.5 Direct Capital Expenditure (2011)

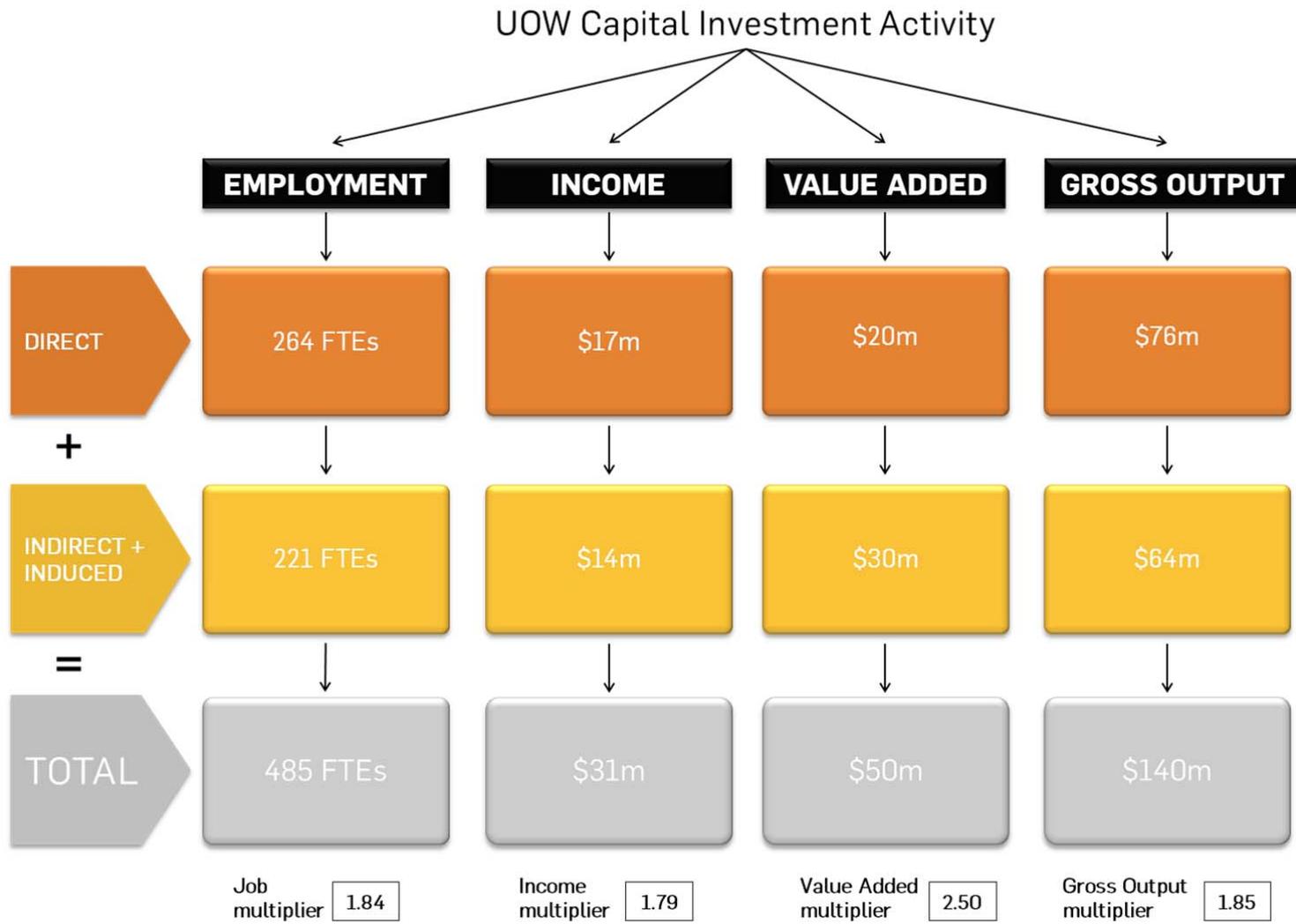


2.1.2.3 Indirect and induced effects

Figure 1.7 provides an overview of the direct, indirect and induced effects of UOW's capital expenditure on construction and refurbishment projects in 2011. The \$76 million in initial UOW expenditure results in a further \$64 million in indirect and induced gross output throughout the economy, meaning that every dollar spent on UOW operations creates a further 85 cents of output elsewhere in the economy. Gross output from UOW capital investment is \$140 million. The industry sectors benefiting most in terms of gross output generated are *Construction, Ownership of Dwellings, Non-Metal Product Manufacturing, and Metal Manufacturing and products*.

Apart from the 264 FTEs directly employed as a result of UOWs capital works, a further 221 FTEs are sustained in supporting industries by UOWs expenditure, meaning that the total employment effect of UOWs capital works in 2011 equated to 485 FTEs sustained throughout the economy. UOW capital works contributed direct value added of \$20 million, and led to a further \$30 million in value added through the rest of the economy.

Figure 2.6 Direct, Indirect and Induced Capital Expenditure Impacts (2011)



2.1.2.4 Longer Term Capital – 2003 to 2012

UOW has seen a decade of major infrastructure development between 2003 and 2012. Table 2.3 lists projects undertaken during this period. Of particular note has been the development of UOW's Innovation Campus in north Wollongong, the SMART Infrastructure facility and the Illawarra Health and Medical Research Building – significantly, all developments that increase the research capacity of UOW.

Table 2.3 Summary of Capital Works Projects (2003-2012)

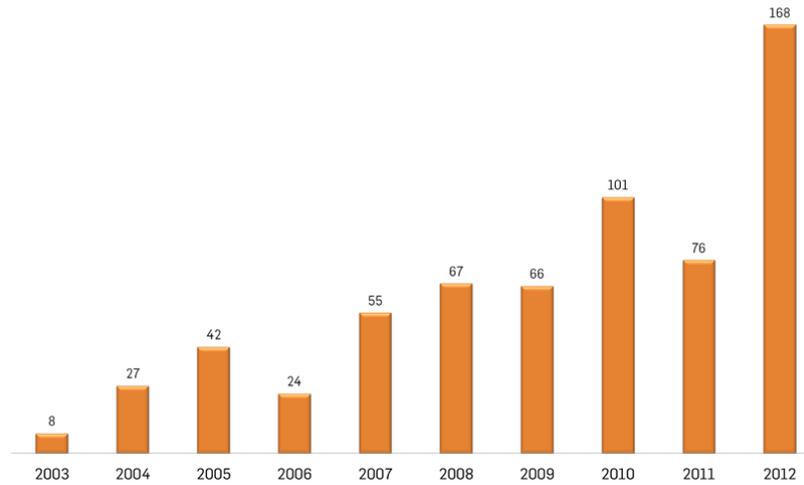
Year	Construction/Refurbishment Projects
2003	Biology / Science refurbishment; Sydney Centre establishment; Energy management initiatives
2004	Major refurbishments to buildings 15, 40 & 14
2005	New Halls Building iC; Energy management upgrades; Science Centre upgrade
2006	Medical School (Wollongong and Shoalhaven campuses); Building 20 upgrade
2007	Library expansion; Building 8 refurbishment; Anatomy Lab extension
2008	Future Materials building; iC Central; Centre for Transnational Crime Prevention; URAC multi-purpose facility; Ecological Research Centre
2009	Keira Court refurbishment; Hope Theatre refurbishment URAC sports fields
2010	Illawarra Health and Medical Research Building; TAFE multimedia facility
2011	SMART infrastructure facility; iC Enterprise 1; AIIM P&D building; Metro Square development; Common Teaching Area building; Unicentre student facilities
2012	Building 19 major refurbishment; ITS relocation to building 39; * Others unavailable at time of reporting

Source: UOW Finance.

As

Figure 2.7 shows, over the past six years there has been a major increase in capital works. UOW has spent \$632 million dollars on new facility construction and refurbishments from 2003 to 2012. Of this expenditure, \$146 million has been paid in compensation of employees, and \$467 million on purchases on construction materials and other goods and services. Furthermore, UOWs capital expenditure projects generated 2,348 FTEs either directly or via subcontractors.

Figure 2.7 UOW Capital Expenditure - 2003-2012 (\$m)



Sources: UOW Finance.

Table 2.4 summarises the total effects of UOW capital expenditure over the period from 2003 to 2012. It shows that UOWs capital expenditure has cumulatively had a billion dollar effect (\$1.169 billion) over the past decade, with \$632 million dollars of direct UOW investment leading to indirect and induced effects of \$537 million in gross output across the economy. Most of that activity has been contained within UOWs home region of Greater Wollongong, with \$833 million (or 71%) of gross output accounted within the local area. Over the same period this investment has also generated total value added of \$417 million, boosted household income by \$260 million, and created a total of 4,188 FTEs across the economy.

Table 2.4 Summary of economic activity from Past Capital Investment (2003-2012)

Indicator	Greater Wollongong	Rest of NSW	NSW	Rest of Aust	Australia
Gross Output (\$m)	833	181	1,014	155	1,169
Value Added (\$m)	155	171	326	91	417
Income (\$m)	95	124	219	41	260
Employment (FTEs)	1,507	2,005	3,512	676	4,188

2.1.2.5 Effect of UOW's Projected Developments – 2013 to 2017

UOW has a projected capital works budget (summarised in Table 2.5) for the next five years to 2017. This will contribute to significant economic activity. For instance, UOW was recently awarded a Federal government capital grant of \$31 million and a private donation of \$7 million towards the design and

construction of a \$44m Early Start Educational Research Facility. Such projects stimulate major regional economic activity for a prolonged period. It should be noted that, as the modeling team did not have access to this information, this project has *not* been included in Table 2.5.

Table 2.5 Budgeted Capital Expenditure (2013-2017)

Year	Capital Works (\$m)	Refurbishments (\$m)	Total (\$m)
2013	31.2	28.8	60.0
2014	13.0	27.9	41.0
2015	6.5	27.9	34.4
2016	0.05	28.8	28.9
2017	-	28.4	28.4
TOTAL	50.9	141.8	192.6

*Note: Capital works budgeted to date – excluding the recently announced \$44m Early Start project.
Source: UOW Finance.*

The above forecast expenditure was used to project the likely economic contribution of capital projects over the next five years. Table 2.6 Forecast Capital Expenditure impact on four key measures of economic activity (2013-2017) is a summary and indicates that UOW's capital works from 2013 to 2017 will generate nearly half a billion dollars (\$482m) in gross output, \$172 million in value added, \$107 in household income and will sustain 1,726 FTEs. Much of this impact will occur in the Greater Wollongong region, which will benefit from an extra \$343 million of gross output, \$64 million in regional value added, \$39 million in extra income, and the creation of 625 FTEs.

Table 2.6 Forecast Capital Expenditure impact on four key measures of economic activity (2013-2017)

Indicator	Greater Wollongong	Rest of NSW	NSW	Rest of Australia	Australia
Gross Output (\$m)	343	75	418	64	482
Value Added (\$m)	64	71	134	38	172
Income (\$m)	39	51	90	17	107
Employment (FTEs)	625	822	1,447	278	1,726

2.1.3 Student Expenditure

In addition to the economic effects generated by its day-to-day operational spending, UOW attracts a large number of students who spend a significant amount of money in these operating regions. We have modeled the *localised* spending effects of three separate student cohorts: (1) **international** students, who represent important export income not just to Wollongong and NSW, but to Australia; (2) domestic **'non-local'** students, who either live in, or travel to, UOWs operating regions and spend money in these regions, representing export income for these regions; and finally, (3) domestic **'local'** students, who live within UOWs operating regions, but whose education-linked expenditure has been isolated and modelled, as it is reasonable to expect that, had UOW not existed, many of them (and their expenditure) would have been lost to the region as they would have moved away to go to university (i.e. a genuine case of 'import substitution'). As discussed in the methodology section, the modelling was based on inputs derived from a comprehensive survey of UOW student income and expenditure conducted via email in October 2011.

2.1.3.1 Overview

UOW student living expenditure had almost as much impact on the economy as UOWs operations. As reviewed in Section 1, UOW has nearly 19,000 on-shore students, with some 5,000 of these coming from overseas and over 7,000 from beyond UOWs home region of Greater Wollongong. Table 2.7 provides an overview of the expenditure of international, non-local and local students.

Table 2.7 Summary of Student Expenditure-related Economic Activity Measures (2011)

Indicator	Greater Wollongong	Rest of NSW	NSW	Rest of Australia	Australia
Gross output (\$m)	519	158	677	264	941
Value Added (\$m)	251	82	333	150	483
Income (\$m)	110	37	147	64	211
Employment (FTEs)	1,922	585	2,507	1,045	3,553

Key findings:

- Within its home region of **Greater Wollongong**, UOW student expenditure during 2011 contributed direct, indirect and induced effects that include gross output of \$519 million, value added of \$251 million, local income of \$110 million, and 1,922 full-time equivalent jobs.
- Across the state of **NSW**, UOW student expenditure contributed total direct, indirect and induced effects that include gross output of \$677 million, value added of \$333 million, income of \$147 million, and 2,507 full-time equivalent jobs.

- **Nationally**, UOW student expenditure contributed total direct, indirect and induced effects that include gross output of \$941 million, value added of \$483 million, income of \$211 million, and 3,553 full-time equivalent jobs.
- **International students** spent approximately \$128 million on living expenses in 2011. The total final demand, industrial and private consumption effects of this expenditure were \$318 million in gross output, \$167 million in value added, \$68 million in household income, and 1,136 FTEs.
- **Non-local domestic students** spent approximately \$168 million on living expenses in 2011. The total final demand, industrial and private consumption effects of this expenditure were \$424 million in gross output, \$220 million in value added, \$93 million in household income, and 1,554 FTEs.
- **Local students** spent approximately \$68 million on university related expenses in 2011. The total final demand, industrial and private consumption effects of this expenditure were \$199 million in gross output, \$96 million in value added, \$50 million in household income, and 836 FTEs.

2.1.3.2 *Direct Effects*

Estimates of student expenditure were based on a survey of 1,400 UOW students conducted in October 2011. The survey asked students to carefully estimate various weekly, monthly, sessional and annual expenses, and sought to distinguish between 'local' (Wollongong) expenditure from money spent elsewhere (namely Rest of NSW and Rest of Australia).

Table 2.8 provides the average annual local expenditure by UOW international and domestic students. It shows that UOW international students spend significantly less per annum (\$20,905) in the Wollongong economy than non-local domestic students (\$24,876) ($SSM = 3.551$, $Df = 1$, $F = 12.233$, $sig. = .000$). Interestingly, this provides evidence to support the claims of Birrell and Smith, who contend that Australian universities have suffered a recent dramatic decline in enrolments from more affluent countries, replaced increasingly by a 'new wave' of value-seeking students from emerging economies (2010, p4). Average local student expenditure was substantially less (\$15,557), as a number of day-to-day expenditure items were excluded from the analysis, as discussed earlier.

It should be noted that, to avoid double counting, our analysis includes student accommodation costs under student expenditure (i.e. and not under UOW operations) but accounts for student tuition under the UOW operational analysis.

Table 2.8 Average Annual Expenditure by Domestic and International UOW Students (2011)

Category	International	Domestic		Total
		Non-local	Local	
On-shore student EFTSL in 2011	6,129	6,745	4,355	17,230
Groceries (fruit/veg, meat, dairy etc)	\$18,431,190	\$21,824,128	\$14,091,835	\$54,347,152
Takeaway / Fast food	\$7,854,300	\$6,796,794	\$4,388,688	\$19,039,782
Alcohol (inc. at social events)	\$2,723,558	\$6,952,270	\$4,489,080	\$14,164,908
Clothing	\$5,187,895	\$7,020,972	\$4,533,440	\$16,742,307
Stationary and peripherals	\$492,938	\$762,903	\$492,606	\$1,748,448
Photocopying and printing	\$359,109	\$318,799	\$205,849	\$883,757
Text books	\$2,399,453	\$3,979,477	\$2,569,547	\$8,948,477
Private vehicle fuel	\$3,273,067	\$10,238,377	\$6,610,917	\$20,122,361
Car (purchase)	\$12,621,310	\$17,547,986	\$11,330,731	\$41,500,027
Electrical equipment	\$3,204,607	\$4,992,482	n/a	\$8,197,089
Furniture	\$2,822,698	\$3,411,753	n/a	\$6,234,451
Kitchenware	\$1,734,230	\$1,403,230	n/a	\$3,137,460
Electricity	\$4,058,536	\$5,093,773	n/a	\$9,152,309
Household gas	\$739,430	\$1,092,670	n/a	\$1,832,101
Water	\$786,679	\$2,261,229	n/a	\$3,047,908
DVD / video rental	\$248,565	\$641,460	\$414,191	\$1,304,216
Private vehicle maintenance	\$1,692,682	\$2,772,512	\$1,790,211	\$6,255,405
Other entertainment	\$3,955,920	\$5,432,489	\$3,507,757	\$12,896,165
Travel/tour bookings	\$1,422,225	\$674,437	\$435,484	\$2,532,146
Phone (landline and mobile) charges	\$3,208,866	\$3,972,589	\$2,565,100	\$9,746,554
Internet charges	\$2,204,263	\$2,092,889	\$1,351,378	\$5,648,530
Private vehicle insurance	\$1,230,020	\$3,043,693	\$1,965,312	\$6,239,025
Health insurance	\$1,777,851	\$1,514,881	\$978,158	\$4,270,889
Home contents insurance	\$238,103	\$807,103	\$521,146	\$1,566,352
Rent / Mortgage	\$39,797,763	\$43,494,984	n/a	\$83,292,746
Private vehicle registration	\$1,511,194	\$2,816,244	\$1,818,448	\$6,145,886
Childcare / school fees	\$1,142,116	\$1,012,583	n/a	\$2,154,699
Health / medical	\$2,468,212	\$4,962,465	\$3,204,262	\$10,634,940
Other education expenses	\$541,619	\$856,529	\$553,061	\$1,951,209
ANNUAL UOW STUDENT EXPENDITURE	\$128,128,400	\$167,791,700	\$67,817,200	\$363,737,300
AVERAGE ANNUAL LIVING EXPENSES	\$20,905	\$24,876	\$15,571	\$20,450

Note: All expenditure has been converted to basic prices. Domestic survey respondents were non-local students. Local student expenditure was estimated using a range of references, including the non-local student results and the ABS Household Expenditure Survey 2003-04 (Cat. 6535.0) and inflated by CPI (ABS Cat. 6401.0).

Source: UOW Student Income and Expenditure Survey, Oct 2011.

2.1.3.3 Indirect, Induced and Total Effects

The level of student expenditure by origin, as reported in Table 2.9, shows that non-local students, who are drawn to the Greater Wollongong region mainly from southern and southwestern Sydney, are of greatest overall economic significance. This group accounts for about half of all UOW student expenditure. Overall, non-local student expenditure contributed \$424 million in gross output, \$220 in value added, \$93 million in household income and 1,554 FTEs. Expenditure by international students, who represent the purest form of “export income” for the entire economy, contributed \$318 million in gross output, \$167 million in value added, \$68 million in household income and supported 1,136 FTEs throughout the economy. Local student expenditure on university-related goods and services contributed gross output of \$199 million, value added of \$96 million, household income of \$50 million and supported 863 FTEs.

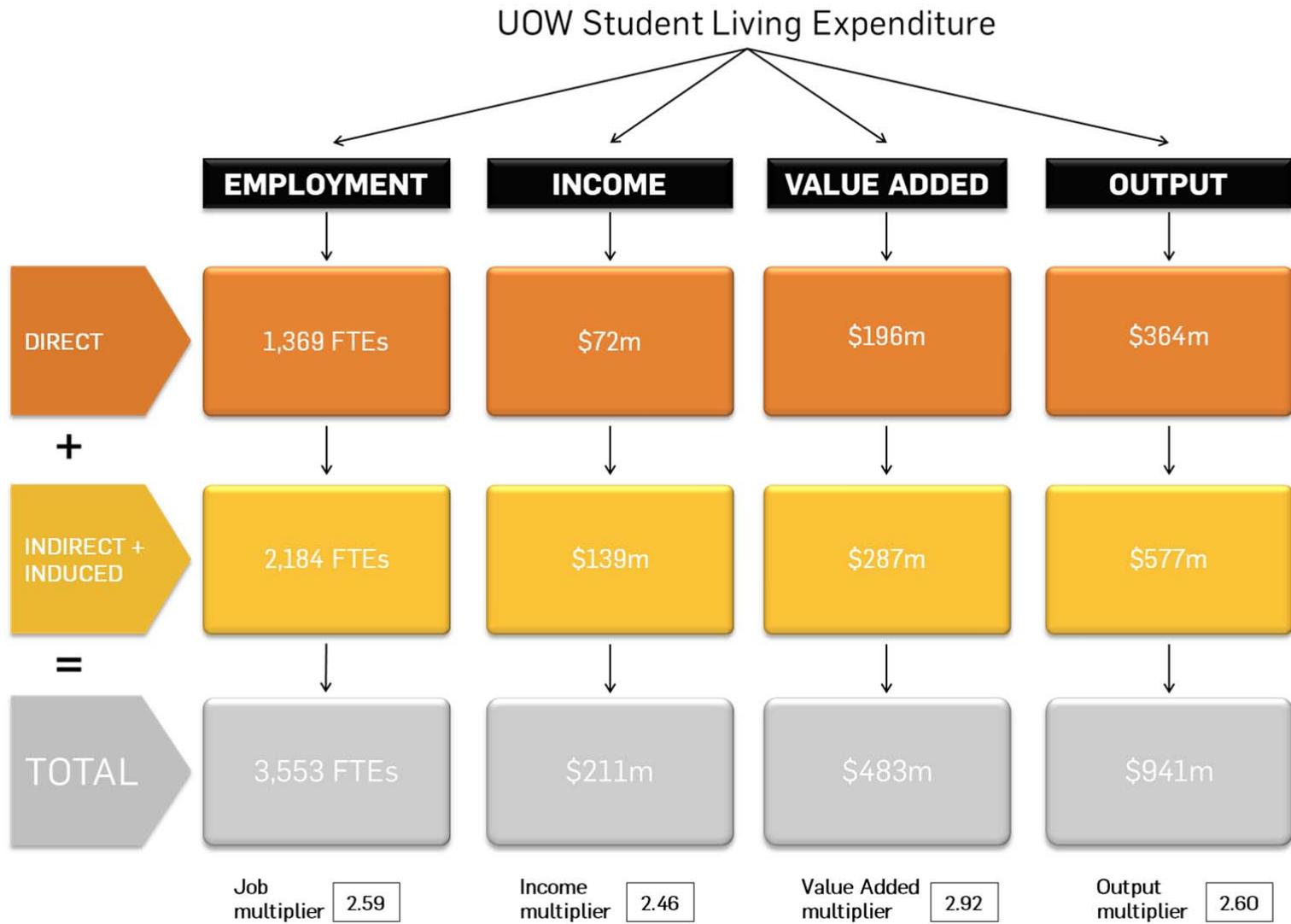
Table 2.9 Effects by Student Origin, 2011

Student Origin	Economic Effects		
International Students	Direct	Indirect and induced	TOTAL
Gross output (\$m)	128	190	318
Value Added (\$m)	73	94	167
Income (\$m)	22	46	68
Employment (FTEs)	424	712	1,136
Domestic Non-Local	Direct	Indirect and induced	TOTAL
Gross output (\$m)	168	257	424
Value Added (\$m)	92	128	220
Income (\$m)	31	62	93
Employment (FTEs)	591	963	1,554
Local	Direct	Indirect and induced	TOTAL
Gross output (\$m)	68	131	199
Value Added (\$m)	31	65	96
Income (\$m)	19	31	50
Employment (FTEs)	355	509	863

Note: "Indirect" effects include the industrial and private secondary consumption effects "induced" by the initial injection of student expenditure in the economy.

Figure 2.8 summarises the overall UOW student expenditure impacts. It shows that UOW student expenditure contributed gross output of \$941m, value added of \$483m, household income of \$211 million and sustained 3,553 FTEs in 2011.

Figure 2.8 Direct, Indirect and Induced Impacts of UOW Student Living Expenditure (2011)



2.1.4 Visitation Expenditure

2.1.4.1 Overview

The University of Wollongong is a catalyst for significant intrastate, interstate and international visitation. Graduation ceremonies, academic and industry conferences, special events (such as the Stumping Serious Disease Twenty20 cricket match), the UOW Science Centre, and visiting friends and relatives (VFR) travel relating to UOW staff and students all contribute significantly to regional tourism. Table 2.10 provides a summary of the total effects of UOW-related visitation for 2011.

Table 2.10 Summary of Visitor-related Economic Activity Measures (2011)

Indicator	Greater Wollongong	Rest of NSW	NSW	Rest of Australia	Australia
Gross output (\$m)	13	7	20	10	30
Value Added (\$m)	6	3	9	5	15
Income (\$m)	4	2	5	2	8
Employment (FTEs)	70	30	99	40	139

Key findings:

- Within its home region of **Greater Wollongong**, UOW visitation expenditure contributed gross output of \$13 million, value added of \$6 million, local income of \$4 million, and helped sustain 70 full-time equivalent jobs.
- Across the entire state of **NSW**, UOW visitation expenditure contributed gross output of \$20 million, value added of \$9 million, income of \$5 million, and helped sustain 99 full-time equivalent jobs.
- **Nationally**, UOW visitation expenditure contributed gross output of \$30 million, value added of \$15 million, income of \$8 million, and 139 full-time equivalent jobs.

2.1.4.2 *Direct Effects*

Table 2.11 provides calculations of the estimation of direct UOW-related visitation and expenditure in 2011. In total, we estimated visitation expenditure from all sources to be approximately \$13 million. The details of visitation and expenditure for each visitation category are provided below.

Graduation Visitation

Over 6,000 UOW students attended graduation ceremonies at UOW during 2011. It is estimated that these ceremonies attracted approximately 8,000 non-local visitors. Based on the proportion of international students graduating, we estimated that about 30% (or 2,270) of all graduation visitors were international family and friends of graduands, who spent an average of ten days in Australia and spent an average of \$192 per day (based on estimates taken from the Tourism Research Australia International Visitor Survey, 2012). We also estimated that there were approximately 6,000 visitors from elsewhere in NSW or Australia, spending on average about \$180 on the day on travel, meals and graduation related retail. In total, we estimated graduation-related visitation expenditure to be approximately \$5.4 million.

Conference Visitation

During 2011, UOW hosted 22 academic conferences and workshops attended by delegates from elsewhere in NSW, interstate and from around the world. We estimate that UOW hosted approximately 3,160 non-local conference and workshop delegates during 2011. On average these delegates spent three days in Wollongong and spent approximately \$1,300 on travel, accommodation, registration, meals, shopping and other ancillary expenses. We estimate that UOW-related conference visitors spent approximately \$4.1 million in 2011.

Science Centre

The Science Centre received nearly 60,000 visitors in 2011, of which 35,414 were local and therefore not included in this analysis. However, of these 20,920 visitors were from the rest of NSW, 1,243 from interstate and 1,447 from overseas. Based on this data and tourism expenditure estimates from the Tourism Research Australia Regional Tourism Profile 2011/12, we estimate that Science Centre visitors spent approximately \$2.7 million in 2011.

2.1.4.3 *Direct, Indirect, Induced and Total Effects*

Figure 2.9 provides an overview of the direct, indirect and induced effects of UOW-related visitation in 2011. Direct UOW-related visitor expenditure of approximately \$13 million creates a multiplier effect through the economy that eventually contributes a total of \$30 million in gross output, \$15 million in value added, \$8 million in household income and sustains 140 FTEs.

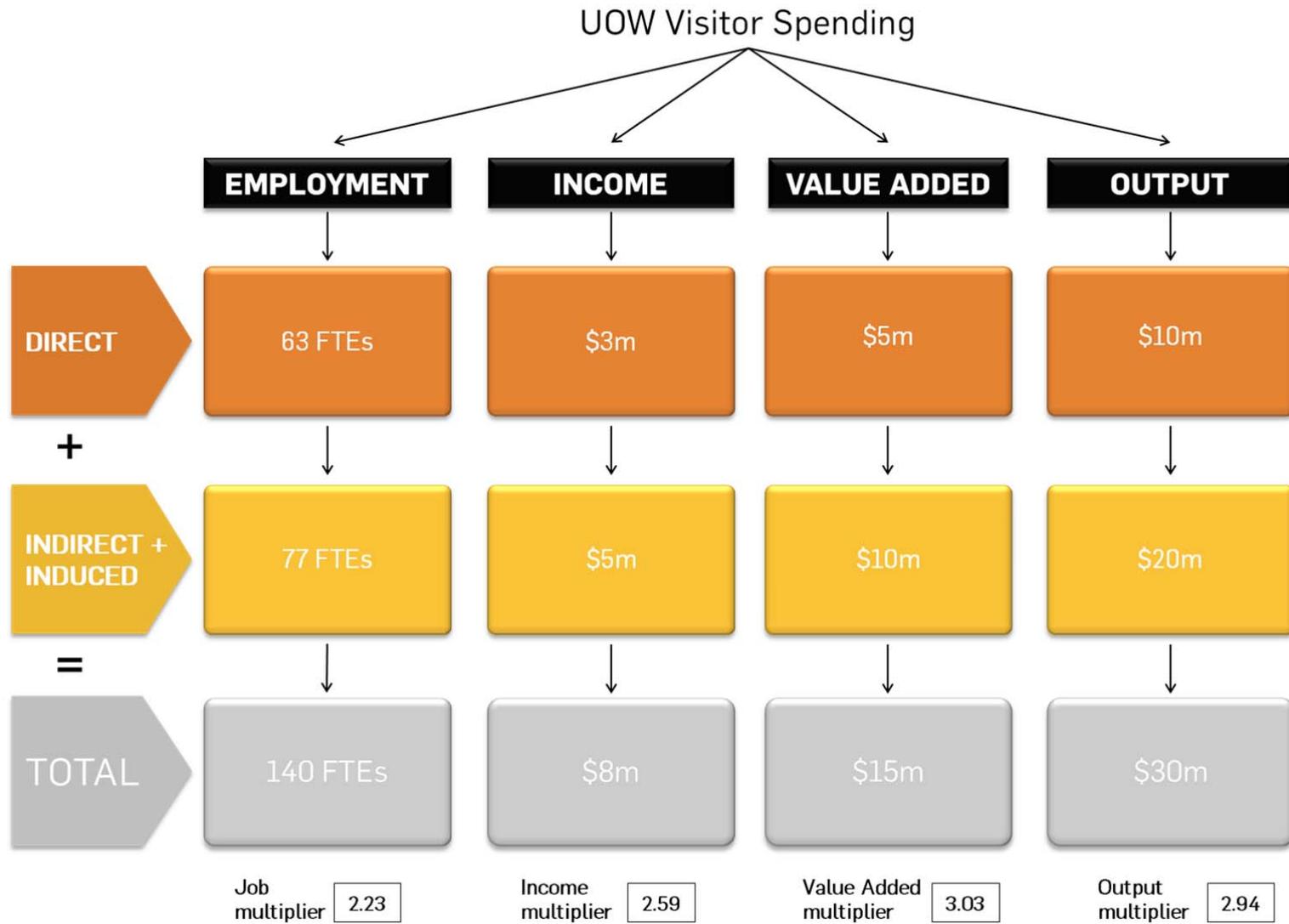
Table 2.11 UOW Visitation and Expenditure Estimates (2011)

EVENT TYPE	VISITOR ORIGIN				Total
	Local	Rest of NSW	Rest of Australia	International	
Graduation¹					
2011 Graduation Visitor Attendance	4,927	5,720	91	2,267	13,005
Ave. nights spent in region and elsewhere	N/A	1	2	10	
Total non-local visitor days spent in region and elsewhere	N/A	5,720	181	22,670	28,571
Ave. daily spend	N/A	\$183	\$240	\$192	
Total spend	N/A	\$1,048,710	\$43,416	\$4,352,640	\$5,444,766
Conferences²					
2011 Conference Delegate Attendance Estimates	770	840	848	702	3,160
Ave. nights spent in region and elsewhere	N/A	3	4	10	
Total non-local delegate days spent in region and elsewhere	N/A	2,520	3,392	7,020	12,932
Ave. daily spend	N/A	347	320	312	
Total spend	N/A	\$873,600	\$1,085,440	\$2,190,240	\$4,149,280
Science Centre³					
2011 Science Centre Visitor Attendance	35,414	20,920	1,243	1,447	59,024
Ave. nights spent in region	N/A	1	2	3	
Total non-local visitor days spent in region and elsewhere	N/A	20,920	2,486	4,341	27,747
Ave. daily spend	N/A	\$97	\$97	\$92	
Total spend [#]	N/A	\$2,029,201	\$241,142	\$399,372	\$2,663,149
Special Events⁴					
2011 event visitor numbers	2,100	720	130	10	2,960
Ave. nights spent in region	N/A	2	3	4	
Total non-local visitor days spent in region and elsewhere	N/A	1,440	390	40	1,870
Ave. daily spend	N/A	250	350	280	
Total spend	N/A	\$360,000	\$136,500	\$11,200	\$507,700
TOTAL EXPENDITURE (ALL VISITATION)		\$4,311,511	\$1,506,498	\$6,953,452	\$12,764,895

Sources:

1. UOW Planning Services, Unicentre, Business Solutions.
 2. Unicentre, ConferenceOnline.com.au, Tourism Research Australia (Regional Tourism Profiles 2011/12).
 3. Science Centre management, Tourism Research Australia (Regional Tourism Profiles 2011/12).
 4. UOW Office of Community and Partnerships (Stumping Serious Disease Twenty20), Tourism Research Australia (Regional Tourism Profiles 2011/12).
- [#] Total spend reduced by \$6567 to account for international leakage.

Figure 2.9 Direct, Indirect and Induced Impacts of UOW Visitor Expenditure (2011)



2.1.5 UOW's effect on export earnings

A significant component of UOW's activities contributes regional, state or national export earnings. In fact, from a regional perspective, UOW is the third largest exporter after coal and steel manufacturing. Nearly 90% of the University's revenues are derived from federal, state and private sources outside the Wollongong region. An important fact to note is that the majority of the revenue brought in to the region remains in the region, with approximately 75% of the budget of the consolidated UOW entity spent within its home region on salaries, purchases of goods and services and construction projects. The value of exports goes well beyond just University revenues and can be estimated by looking at both University and non-University revenues generated by:

1. **Tuition fees** from international and domestic non-local students– with the former counting as export income for Australia, NSW and Wollongong, and the latter only counting as export income for the Wollongong region;
2. **Grants and contracts** from federal and state sources – with the former counting as export income for NSW and Wollongong, and the latter only counting as export income for the Wollongong region;
3. **Living expenditure** of international and domestic non-local students – with the former counting as export income for Australia, NSW and Wollongong, and the latter only counting as export income for the Wollongong region; and
4. **Visitor expenditure** of international and domestic non-local visitors – with the former counting as export income for Australia, NSW and Wollongong, and the latter counting mainly as export income for the Wollongong region.

Table 2.12 Estimated value of UOW's export earnings effect (2011)

Source	Export Earnings by Region		
	Greater Wollongong ¹	NSW ²	Australia ³
Tuition fees from International students	\$142,506,360	\$154,898,217	\$154,898,217
Spend expenditure of International students	\$102,502,720	\$121,721,980	\$128,128,400
Spend by International visitors	\$5,910,434	\$6,605,779	\$6,953,452
International grants and contracts	\$2,971,584	\$2,971,584	\$2,971,584
Federal grants and contracts	\$114,373,084	\$114,373,084	
Spend by Domestic non-local visitors	\$5,818,009	\$1,506,498	
Tuition fees from Domestic 'Non-local' students	\$113,496,935		
Spend of Domestic 'Non-local' students	\$167,791,700		
State grants and contracts	\$18,127,171		
Total 'export' earnings effect	\$673,497,997	\$402,077,142	\$292,951,653

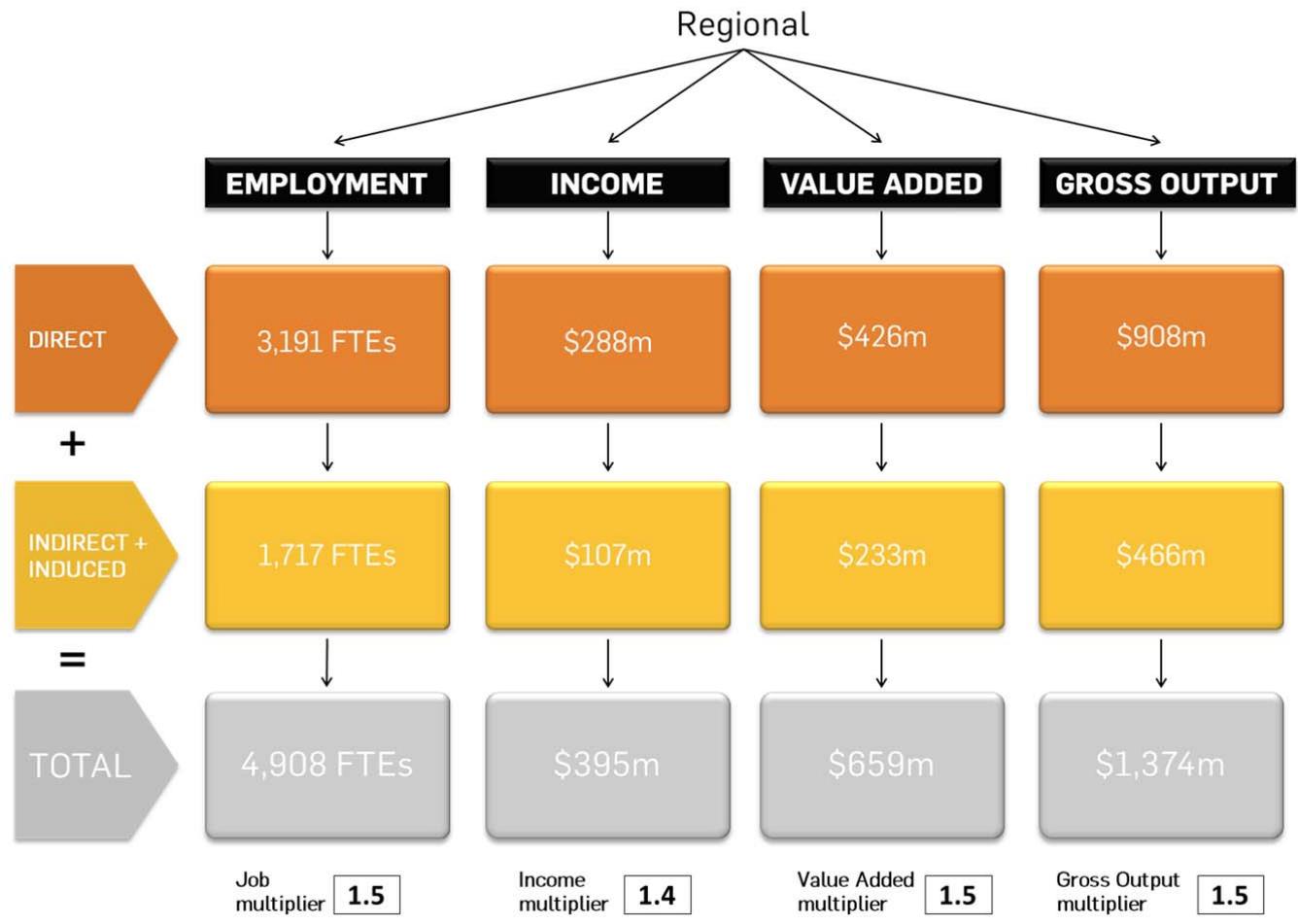
Notes:

1. *Greater Wollongong export earnings include any UOW-related revenue from sources outside the region.*
2. *NSW export earnings include any UOW-related revenue received from sources outside the state.*
3. *Australian export earnings include any UOW-related revenue received from sources outside the country.*

2.1.6 Summary of Geographic Economic Activity

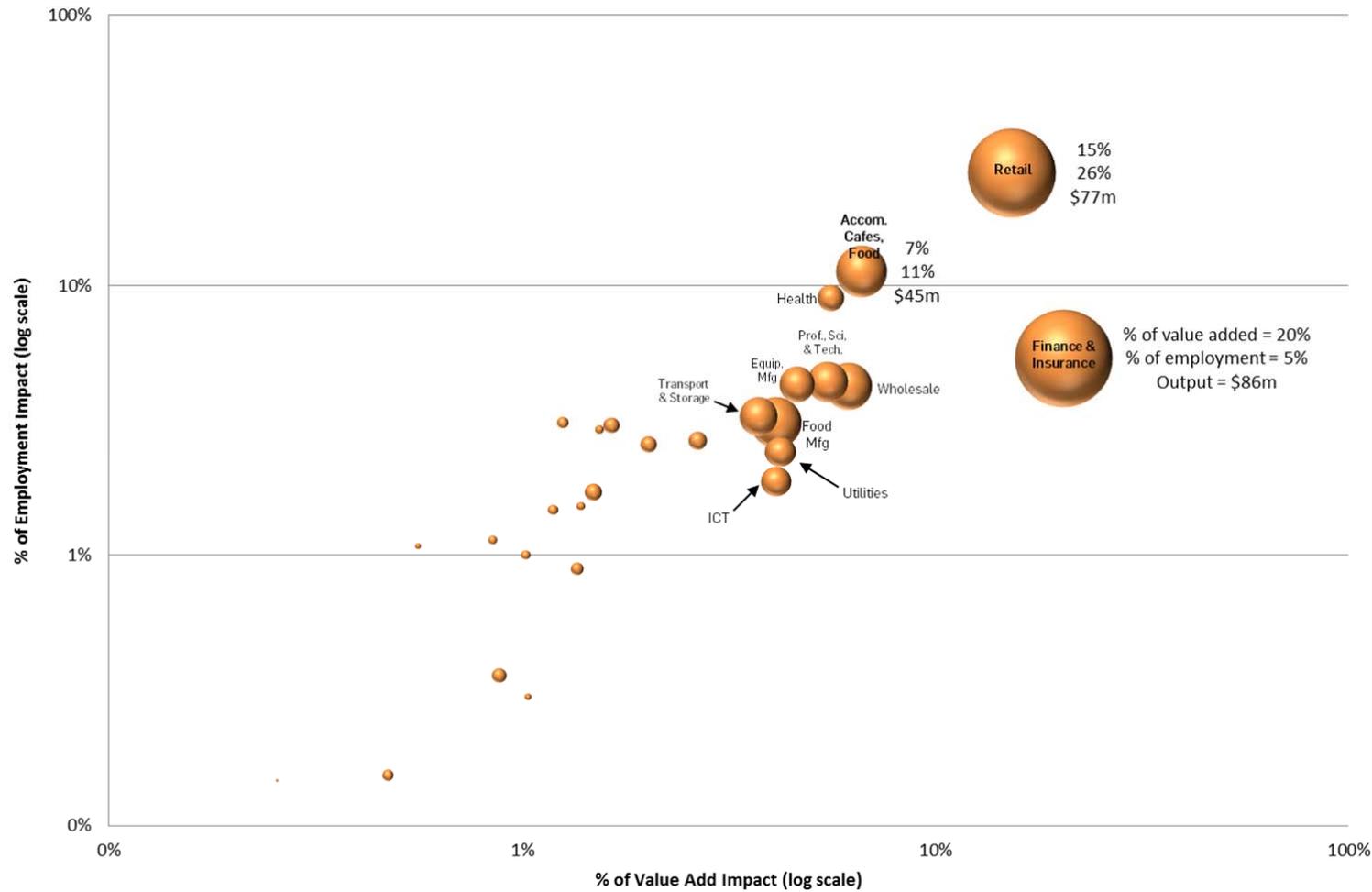
Figures 2.10 to 2.13 provide an overview of UOW's total direct, indirect and induced impacts at the regional, state and national levels.

Figure 2.10 Summary Direct, Indirect and Induced Impacts on Greater Wollongong (2011)



Relative Impact:
 Within its home region of Wollongong, accounts for 4.6% to Gross Regional Product, 5.7% of total household income, and 4.8% of total full-time equivalent (FTE) employment, when both direct and indirect impacts are taken into account.

Figure 2.11 Key Sector Effects (Greater Wollongong Region - 2011)



Key Sector Impacts:
 Within UOWs home region of Wollongong, the sectors most significantly impacted during 2011 were 'Finance and Insurance', which benefited from \$86m in output, received 20% of the local value added, and 5% of all employment generated by UOW expenditure. Similarly, 'Retail' benefited from \$77m in output, accounted for 15% of local value added, and 26% of all employment generated by UOW expenditure. Other sectors significantly impacted included 'Accommodation, Cafes and Food', 'Food manufacturing', 'Wholesale Trade', 'Health and Social Services', 'Professional, Scientific and Technical Services', 'Transport and Storage', 'Utilities' and 'ICT'.

Figure 2.12 Summary Direct, Indirect and Induced Impacts on NSW (2011)

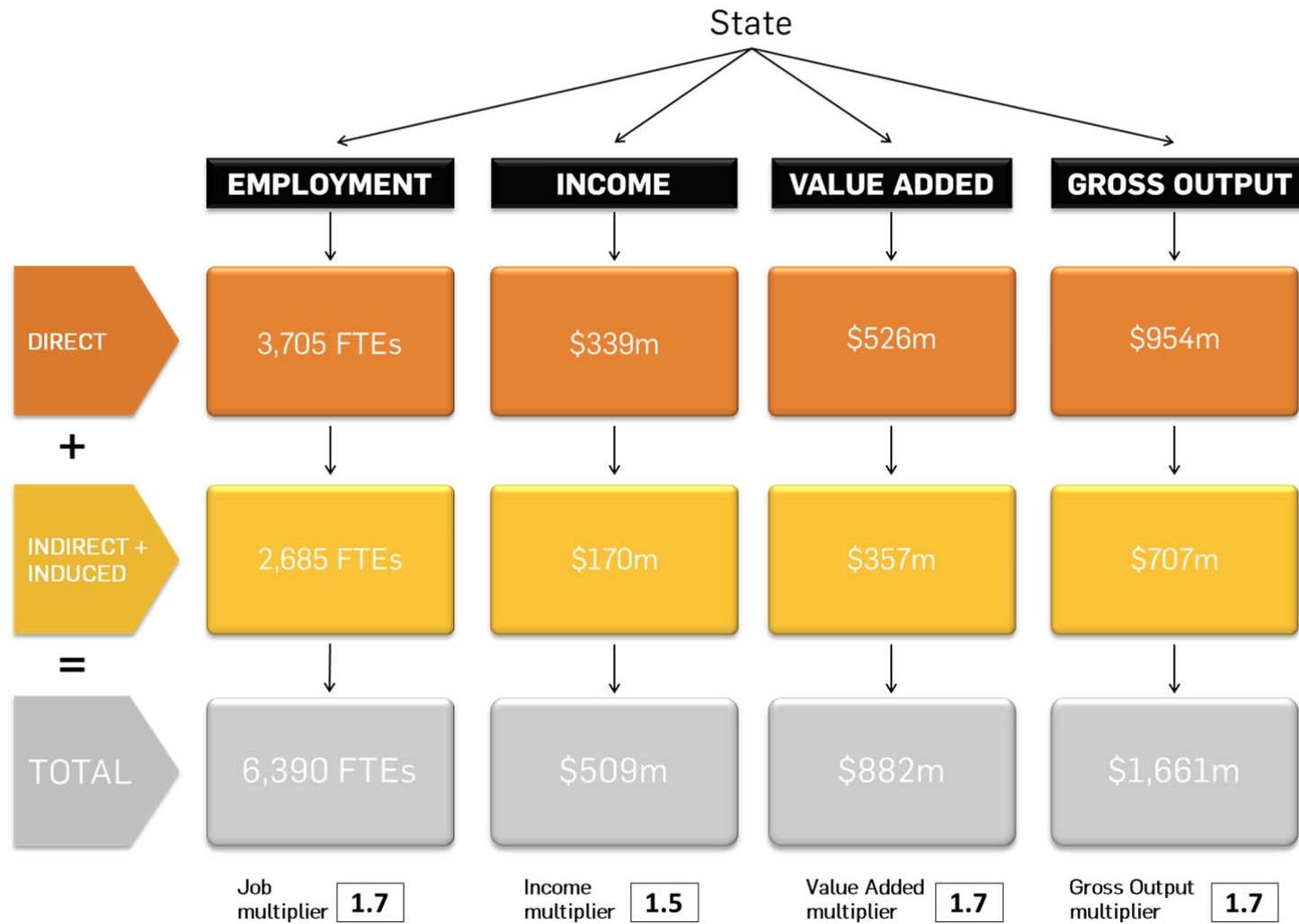
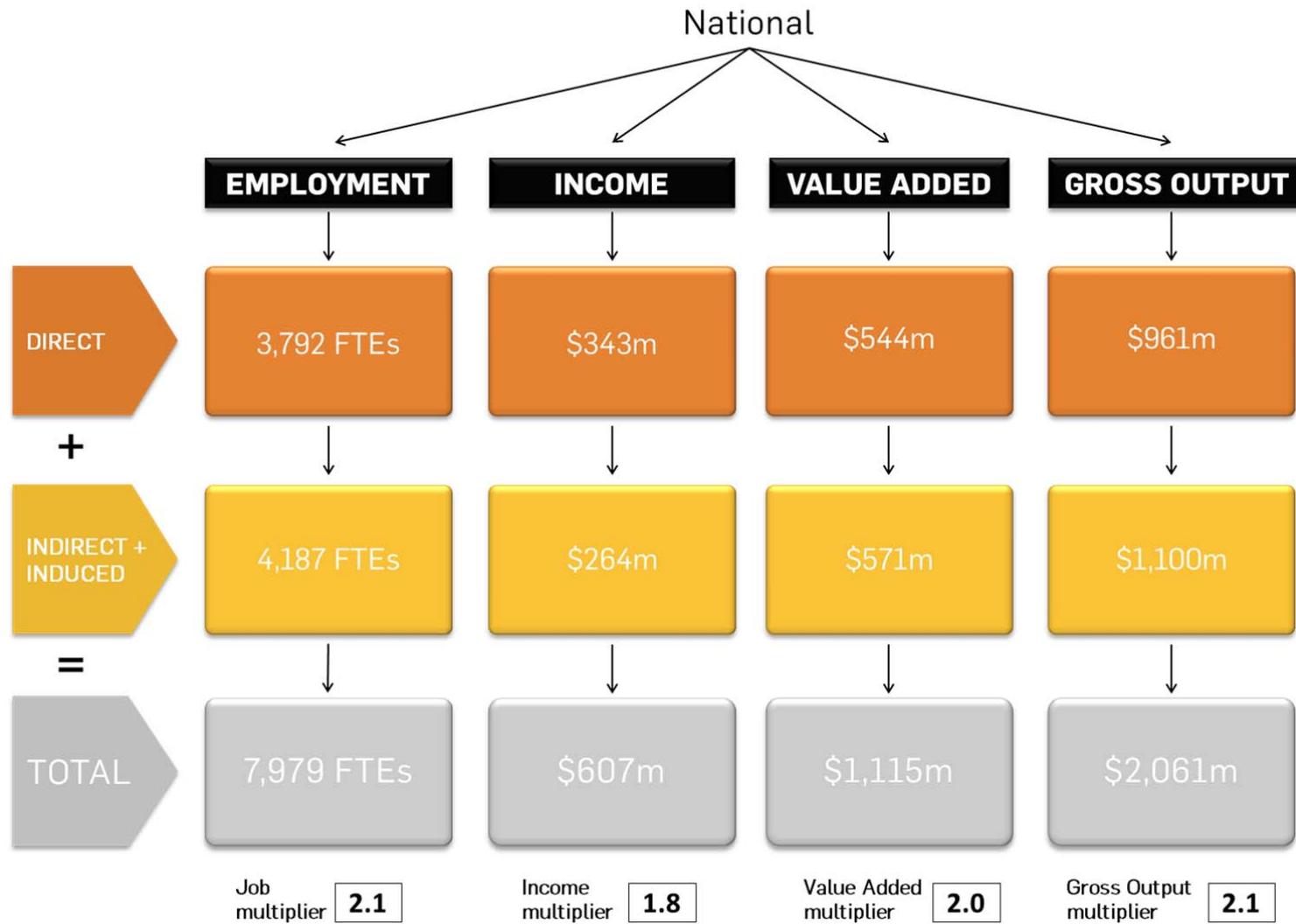


Figure 2.13 Direct, Indirect and Induced Impacts on Australia (2011)



2.2 Knowledge-related Activities

The tangible and immediate economic activity associated with a university, such as those measured in the previous section for UOW, are the sorts of economic effects that most typically come to mind. However, this is not the entire story in terms of UOWs broader economic influence. For the communities within which it operates, UOW also plays a vital role as a producer of highly skilled and productive graduates who will produce both private and public returns as a result of their UOW education. Moreover, UOW *creates* knowledge and innovation that supports the wider economic growth and development of its communities. In this section, we estimate the longer-run economic effects of UOWs development of human capital and creation of new knowledge and innovations that produce positive externalities that benefit industry and society.

2.2.1 Human Capital Development

For a region such as Greater Wollongong, which has traditionally had a large proportion of its population classified in lower socio-economic categories, there is evidence to suggest that the financial benefits of obtaining a university education are even greater than for people in higher socio-economic areas (see Blundell et al. 2005 for an overview). The private returns on a university degree are established in the literature. Recent studies within the Australian context suggest that individuals who gain a degree can expect to earn 40-50% more than someone who completed high school but does not hold a degree (Leigh, 2008, Daly, et al, 2012). This 'premium' level is consistent with the international experience within developed economies (OECD, 2012). According to the most recent evidence of graduate wage premiums presented by the by the Organisation for Economic Cooperation and Development (OECD, 2012), within member countries over the past decade the graduate wage premium has remained high notwithstanding increased overall tertiary attainment levels:

Despite an increase in the proportion of 25-64 year-olds with tertiary attainment from 21% in 2000 to 30% in 2010, the earnings premium for those with a tertiary education held firm over the same period. (OECD, 2012, p141)

UOW provides a significant endowment to its graduates, who head out into the workforce confident of not just getting a good job, but earning significantly more than their high school graduate counterparts. Drawing on recent approaches to the reliable measurement of lifetime graduate premiums and returns to higher education, we have attempted to quantify the returns, to individuals and to society at large, of a degree from the University of Wollongong. Following the work of Australian economists such as Michael (1996), Borland et al. (2000), Larkins (2001), Borland (2002) and Daly et al. (2012) on the internal rates of return to Australian higher education, we calculate the individual and public costs, benefits and internal rates of return on a UOW degree. Table 2.13 provides an overview of the results and Appendix B provides a detailed technical overview of the important assumptions underlying our calculations.

2.2.1.1 UOW Graduate Earnings Premium

When compared to their Year 12 completion counterparts, UOW degree graduates gain a significant annual and lifetime earnings premium. Based on unpublished 2011 Census income data for *full-time working* Wollongong residents whose highest qualification attained is a bachelor degree, median male income was \$75,504 and median female income was \$47,008.

Applying an estimated earnings differential of 45%, as recommended in a 2008 Australian study by Leigh (who conveniently accounts in this estimate for the well-known issue of ability bias with a 10% discount factor), the resultant average gross annual earnings premium for UOW degree graduates relative to Year 12 graduates is \$23,432 per annum for males and \$14,589 for females. This means that for the average male UOW bachelor degree graduate who has a working life of 40 years, he can expect to earn nearly one million dollars (\$937,291) more over his working life than a male counterpart who finished his education at Year 12. Likewise, the average female UOW bachelor degree graduate who has a working life of 38 years (to account for time out of the workforce for some women), she can expect to earn over half a million dollars (\$554,370) more over her working life than a female counterpart who finished her education at Year 12.

However, gross earnings premiums should be adjusted down to account for the costs (both direct and indirect) of gaining a degree and for the time value of money. As Table 2.13 shows, the net present value (NPV) of lifetime earnings premiums (discounted at 3%) is \$541,632 for male UOW degree holders and \$328,136 for females. After accounting for earnings forgone, the direct costs of study and tax paid on earnings, the NPV to the UOW graduate of their lifetime earnings premium is estimated to be **\$312,763** for males and **\$174,825** for females.

2.2.1.2 Individual and Public Returns to a UOW Degree

The estimates of NPV of earnings premiums described above are a precursor to calculating the internal rate of return. The internal rate of return is a useful measure of the pecuniary benefits received by individuals and society from the completion of a degree.

Table 2.13 shows the estimated private rate of return to a UOW bachelor degree for males and females and suggest that there is significant motivation for individuals to attain a UOW degree. Male UOW bachelor degree holders receive a private rate of return of 20% and have a payback period of approximately five years post degree to recoup the private investment costs of their education. Female UOW bachelor degree holders receive a private rate of return of 12% and have a payback period of nine years. *The overall average private rate of return to UOW bachelor degree holders is 16%.*

Table 13 also shows the estimated social rates of return to a UOW degree, based on an assessment of the public costs and benefits of individuals attaining a UOW degree. The public rate of return is 17% for male bachelor graduates, with a payback period of six years on government costs. The public rate of return is 10% for female degree holders, with a payback period of ten years. *The average public rate of return to a UOW bachelor degree is 14%.*

These results provide evidence to reinforce the fact that a UOW degree is a good investment for both individuals and the government.

Table 2.13 The Private and Public Rates of Return to a UOW Degree

1. COST ANALYSIS: Total Costs per UOW Completion for Bachelor's Degrees		Females	Males	Persons
A	Average HECS costs	\$18,683	\$18,683	\$18,683
B	Estimated earnings foregone ¹	\$15,280	\$16,114	\$15,697
C	Direct education costs	\$4,500	\$4,500	\$4,500
D	Total private costs for a UOW degree (A + B + C)	\$38,464	\$39,297	\$38,880
E	Total public costs per UOW degree (i.e. Govt contributions, based on UOW income received in 2011)	\$30,538	\$30,538	\$30,538
2. BENEFIT ANALYSIS: Economic Benefits of a UOW Bachelor's Degree		Females	Males	Persons
F	Gross graduate annual premium ²	\$14,589	\$23,432	\$19,010
G	Gross graduate lifetime premium (F multiplied by 38yrs for females, 40 yrs for males)	\$554,370	\$937,291	\$741,409
H	NPV of graduate lifetime premium (at 3% discount rate)	\$328,136	\$541,632	\$434,884
I	NPV in excess of total private and public costs (H - (D + E))	\$259,134	\$511,094	\$385,114
J	NPV of income tax payable on gross graduate premium (H multiplied by marginal tax rate of 0.35)	\$114,847	\$189,571	\$152,209
K	NPV to individual of income premium after tax and costs (H - D - J)	\$174,825	\$312,763	\$243,794
L	Government revenue from investment in UOW (A + J + (0.1 x K))	\$151,013	\$239,531	\$195,272
3. INTERNAL RATE OF RETURN ON A UOW DEGREE		Females	Males	Persons
M	Private Rate of Return	12%	20%	16%
	<i>Approximate Payback Period</i>	<i>9yrs</i>	<i>5yrs</i>	
N	Public (Federal Government) Rate of Return	10%	17%	14%
	<i>Approximate Payback Period</i>	<i>10yrs</i>	<i>6yrs</i>	

Notes: See Appendix C for detailed methodology and calculations.

Sources: UOW Finance &, Office of Advancement; ATO; ABS 2011 Census, unpublished; Borland et al (2000), Larkins (2001), Leigh (2008), Daly et al (2012).

2.2.1.3 *Sizing the Economic Footprint of UOW Human Capital Development*

There are additional earnings that accrue to the region, the state and the nation as a result of the enhanced productive capacity and earning capabilities of UOW alumni.

Table 2.14 presents the aggregate private earnings premiums of UOW Alumni and their commensurate impact of government tax revenue in both annual and 'working life' terms. It shows that the total earnings premiums accrued to UOW alumni each year is nearly one billion dollars (\$992m), with much of this extra income (\$447m) generated by alumni in the local area. Moreover, the annual contribution of UOW alumni earnings premiums on government revenue (via taxes) is \$347 million.

Assuming an average 40 year working life, the estimated effects of aggregated UOW alumni lifetime earnings premium (NPV discounted at 3%) is approximately \$39 billion, with this extra income also generating government revenue through extra taxes of about \$18 billion.

Table 2.14 Summarizing the Private and Public Benefits of a UOW Bachelor Degree

	W'gong	<i>Rest of NSW</i>	NSW	<i>Rest of Australia</i>	Australia
UOW Alumni	41,123	44,693	85,816	5,442	91,258
Estimated Annual Effects					
<u>Private:</u> Annual earnings premium of UOW alumni	\$447 M	\$ 486 M	\$933 M	\$59 M	\$992 M
<u>Public:</u> Annual contribution of UOW alumni earnings premium on govt. revenue	\$156 M	\$170 M	\$327 M	\$21 M	\$347 M
Total Annual Effects	\$604 M	\$656 M	\$1,260 M	\$80 M	\$1,339 M

2.2.2 UOW Research Effects of Productivity

Much of the current study has focused upon measuring what can be described as the static economic effects of UOW expenditure on the Greater Wollongong region, as well as that at the state and national levels. Of potentially greater economic significance are the dynamic economic effects arising from UOW research activities. As a research intensive university UOW plays an important role in its region by creating and disseminating knowledge and in developing new technology. The Productivity Commission has summed up the role and contribution of universities as follows:

Universities' core role remains the provision of teaching and the generation of high quality, openly disseminated, basic research. Even where universities undertake research that has practical applications, it is the transfer, diffusion and utilisation of such knowledge and technology that matters in terms of community wellbeing. Commercialisation is just one way of achieving this. The policy framework for universities should encourage them to select the transfer pathway that maximises the overall community benefits, which will only sometimes favour commercialisation for financial gains. (Productivity Commission, 2007)

UOW contributes to regional innovation where firms, government and others deliberately and productively incorporate knowledge generated from its research activity into their activities and outcomes so as to improve or develop new products (goods and services), processes and organisational forms (Rogers, 1998). Such innovation is a critical ingredient to future regional growth, competitiveness, wealth and prosperity and in providing the capacity, and associated adaptability, for the region to tackle emerging economic, social and environmental challenges.

UOW research can be usefully categorised into three types, each of which contributes to innovation but differ in terms of their timing and mode of effect. First is *basic research*, which is aimed at acquiring new knowledge but with no specific application in mind. It often plays the most crucial role in supporting successful innovation over the medium to longer term (Productivity Commission, 2007). Second is *applied research*, which is also aimed at acquiring new or original knowledge but with a specific application in mind. It is likely to generate more immediate innovation outcomes. Third is *experimental research*, which draws on existing knowledge gained from research and/or practical experience, with the aim of producing new materials, products or devices. This form of research is also aimed at generating innovation. These research activities and the knowledge and innovation they generate result in spillover effects (human capital development and diffusion of new ideas), which provide an important rationale for the public funding of research at universities. Spillover effects or benefits arise from innovation when they cannot be captured by the innovator and cannot be realised without support. They may be ideas that can be used, mimicked or adapted cheaply by firms or others without payment to the originator. The magnitude of such spillover effects from UOW research, particularly to the regional economy, critically depends upon the quality of the research being conducted as well as on how effectively knowledge generated is managed and disseminated. Such spillover effects have the potential to be highly significant to the regional economy, but because these effects can be intangible they are difficult to quantify and measure.

A number of studies of North American Universities can be found in the literature aimed at measuring the impact of university research (spillovers) on regional development, by attempting to measure the dynamic effects of human capital development, innovation and diffusion of knowledge to firms and others. Some studies have attempted to capture the dynamic effects by using measures such as licensing activity⁸. Others, such as that for four universities in Canada - University of British Columbia (Sudmant, 2009), Simon Fraser University (Sun and Lee, 2011), University of Ottawa (Diaz, Mercier and Duarte, 2012) and the University of Alberta (Briggs and Jennings, 2012) estimate the link between university R&D spending and regional total factor productivity (TFP)⁹. All of which were found to be more significant than the static effects. Other studies have gone further using survey data and include the entrepreneurial impact studies at the Massachusetts Institute of Technology (Roberts and Eesley, 2009), Iowa State University (Jolly, Yu and Orazem, 2009), Tsinghua University (Eesley, Roberts and Yang, 2010) and Stanford University (Eesley and Miller, 2012). The total factor productivity approach for the Canadian universities primarily adopted a top down approach to the calculation of the impact of university research on productivity, applying data for the impact of the university sector as a whole to calculate the TFP contribution for each individual university (Martin, 1998). In this study we propose adopting a bottom up approach to quantifying the contribution of UOW's research to regional (Greater Wollongong) total factor productivity, by using an econometric approach based entirely on regional data.

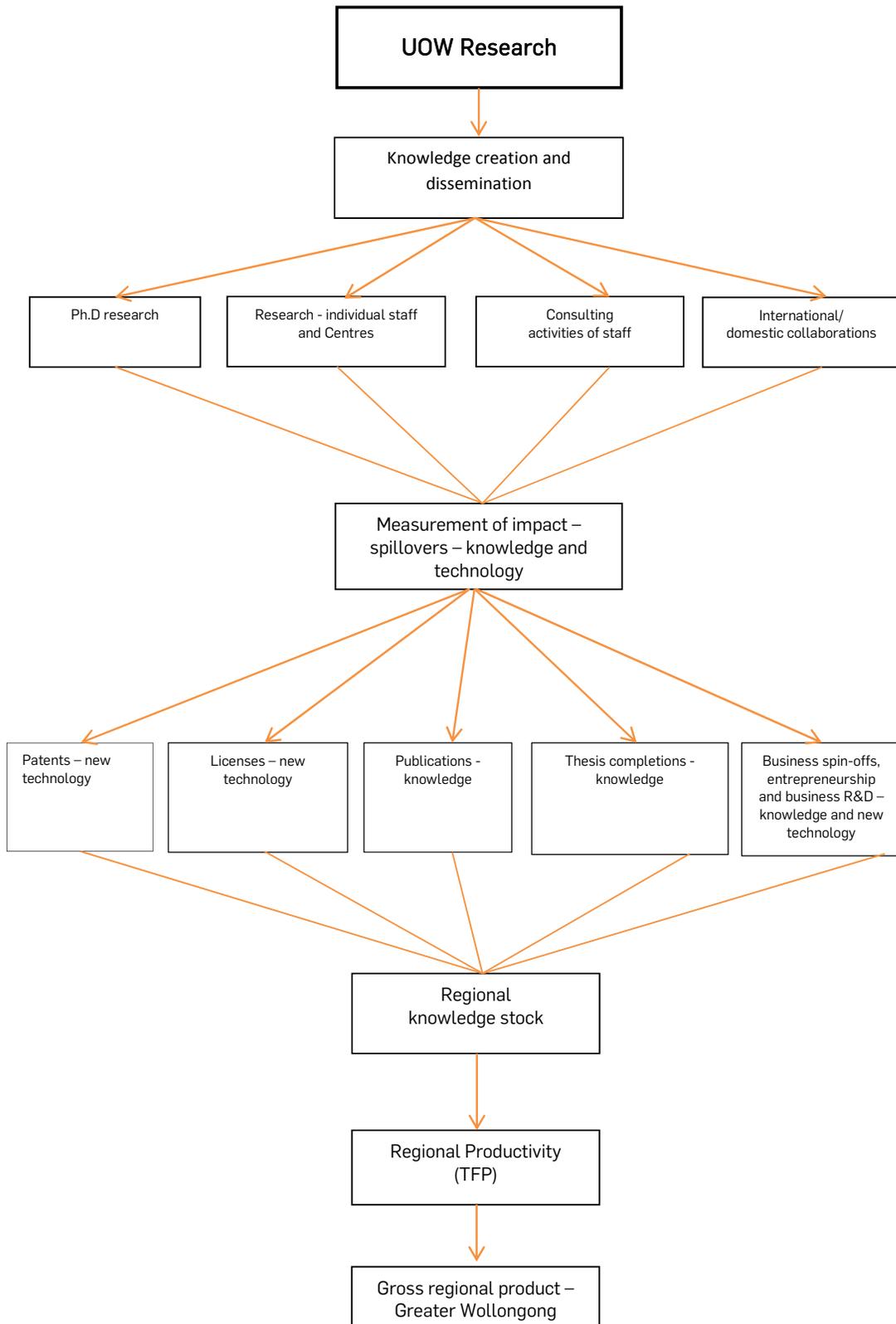
2.2.2.1 *Proposed framework*

Figure 2.14 encapsulates the dynamic aspects of UOW research and its potential impact on the Greater Wollongong economy. UOW knowledge creation and dissemination is assumed to take place through – Ph.D research, research conducted by individual academic staff members as well as through research centres, consulting activities by academic staff and knowledge obtained through collaborative research activity with other domestic and international universities and research institutions. The impact of this in the form of knowledge spillovers and new technology can be measured in a number of ways – patents, licenses, academic publications, successful doctoral thesis completions, business spin-offs, entrepreneurship and business R&D. These activities add to what we can call the regional knowledge stock (see, for example, Khan and Luintel (2006)), which consists of knowledge/innovation generated from the R&D activities of firms, government agencies, foreign firms, external regional trade and UOW. This knowledge stock contributes to regional productivity (as measured by total or multi-factor productivity). Improvements in regional productivity in turn enhances regional production/output growth. While the literature suggests that there is an important link between R&D (research), innovation and productivity (TFP) (Productivity Commission, 2007), identifying and quantifying the dynamic and spillover effects arising from UOW research is by no means easy to quantify.

⁸ Jaffe (1989), for example, found a significant effect of university research on corporate patents. In addition, university research was found to have an indirect effect on local innovation by inducing R&D spending.

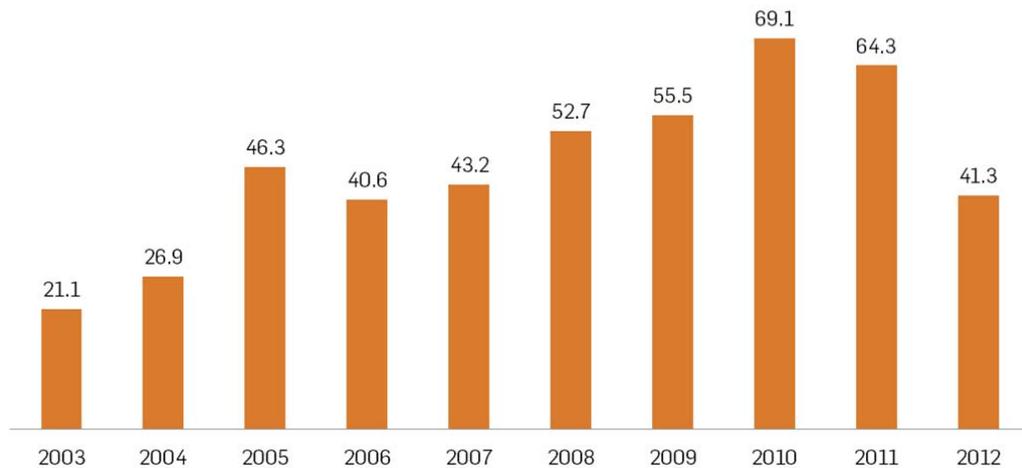
⁹ Also referred to as multi factor productivity.

Figure 2.14 UOW Research Activities and Effects on Productivity



Over the decade to 2011, UOW has attracted more than \$431 million in research and innovation income. Figure 2.15 shows the strong growth in research and innovation income from a variety of government and industry sources.

Figure 2.15 UOW Research and Innovation Income – 2002-2011 (\$m)



The transmission of university research and development into commercial and applied outcomes takes considerable time. Evidence is emerging of a strong innovation and commercialisation culture (Table 2.15). This culture will be vital to the future economic prospects of the Greater Wollongong region, as it seeks to renew economic fortunes through the development of enterprises which take advantage of the burgeoning global knowledge economy. CSBRR is currently looking to develop robust estimates of the economic effects of this activity. Appendix C provides a discussion of our proposed approach to this task.

Table 2.15 UOW Research and Innovation Activity & Outcomes (2003-2011)

UOW Commercialisation Statistics	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012 (YTD)	Total
Disclosures	4	6	25	30	35	27	58	48	35	7	275
Patents - Provisional	4	5	7	9	11	7	7	8	10	4	72
Patents - Granted	0	1	0	2	4	8	4	16	15	10	60
Licence Agreements Executed	2	1	1	1	1	6	9	3	2	0	26
Licence Agreements Active	2	3	3	3	3	5	6	6	8	10	49
Start-up Companies (Spin-offs)	0	0	1	0	0	0	1	0	0	1	3

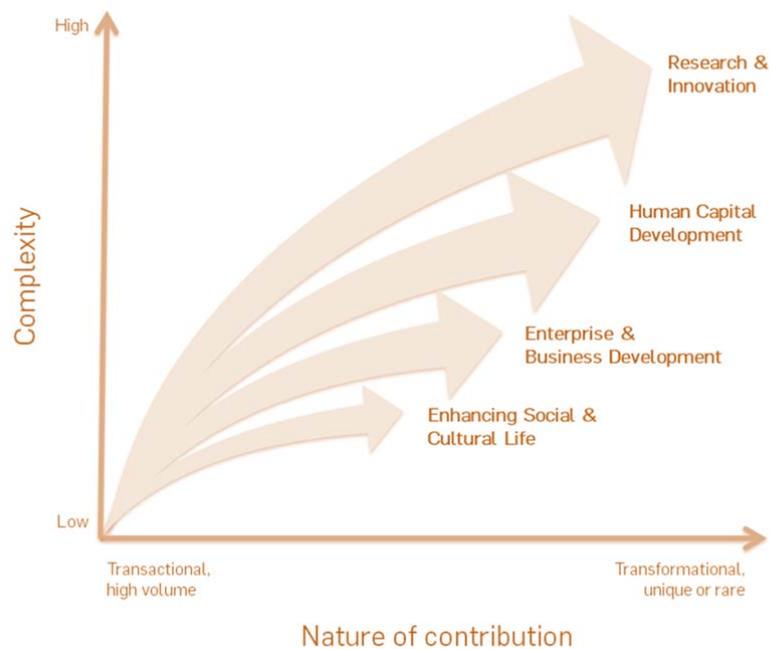
Source: UOW Office of Commercialisation and Technology Transfer

**SECTION 3:
UOW'S BROADER
CONTRIBUTION**

3.1 Introduction

A conclusive assessment of the University of Wollongong's economic impacts has been made. However, there are many benefits that are not easily measured in pecuniary terms. For example, UOW is an incubator and catalyst for new business ideas and innovation, provides advice to industry and government, attracts and retains creative knowledge workers, is a catalyst for accessing regional infrastructure development; a promoter of regional pride and identity, is a portal for promoting its home location and connecting the people and industry of its communities to the rest of the world, and is heavily involved in social and cultural engagement activities. This section addresses each of these benefits in detail.

Figure 3.1 Framework for assessing the broad university contribution



3.2 Research and Innovation

3.2.1 Industry Research Partnerships

3.2.1.1 *World-leading Medical Bionics*

The University of Wollongong's Australian Laureate Fellow Professor Gordon Wallace is leading a \$4.7 million medical bionics research program working with Melbourne's St Vincent's Hospital and other universities around Australia to develop ways to regenerate damaged nerves and muscles and groundbreaking brain implants for epilepsy patients. Professor Wallace Leads the ARC Centre of Excellence for Electromaterials Science located in the Australian Institute for Innovative Materials (AIIM) at UOW's Innovation Campus. He also heads UOW's Intelligent Polymer Research Institute at AIIM, which has a long history of partnerships with other research institutes and industry partners in Australia, the United Kingdom, the United States, Ireland, China, Japan and Korea. Professor Wallace's team is recognised as a world leader in the field of materials and bionics, by creating specialised three-dimensional structures made from 'smart' materials which are accepted by the human body and can enable regrowth of damaged nerves and muscles.

"In the last couple of decades a whole new area has been developed in organic materials that conduct electricity," Professor Wallace said. He said the pioneering research that developed cochlear ear implants to help people overcome hearing loss had sparked interest among clinicians, who had started looking for new applications for the electrodes. He said the new research program will focus on building better organic materials to conduct electricity through the body, to "improve lines of communication" between electronics and biology to stimulate nerve, muscle and bone regeneration. "Cochlear implants stimulated the imagination of researchers, and now the challenge is to make 3-D structures that can be a muscle regeneration platform to facilitate and stimulate re-growth," Professor Wallace said. "We will also be developing the machinery to put these three-dimensional structures together."

The epilepsy project with Professor Cook at St Vincent's aims to develop nanostructured materials that can be implanted in the brains of epilepsy sufferers to monitor electrical signals. The device would pre-empt an epileptic seizure and then release medication to reduce or eliminate the effects of the seizure. Professor Wallace said the research program was a multi-disciplinary, high collaboration effort. His team of researchers and PhD students are working with other faculties at UOW and researchers at the University of Tasmania and Deakin and Monash Universities in Victoria, as well as the clinicians at St Vincent's and researchers overseas. "This is a rare alignment of the planets, where we have the funding (from his Laureate Fellowship), a cracking research team and cracking people involved (from partner organisations)," Professor Wallace said. Professor Cook said St Vincent's Melbourne greatly valued its strong relationship with Professor Wallace and his team. He paid tribute to the team's ability to produce the 3-D bionic materials needed for their clinical research at short notice.

The ARC Centre of Excellence for Electromaterials Sciences (ACES) has also forged a strategic relationship with Irish wearable sensor company, Shimmer Research, to develop wearable bionic devices to be used post-operatively to improve patient recovery times. Patients undergoing treatments such as orthopaedic surgery will be able to reduce their stay in hospital by wearing sensors strapped to their bodies which will

feed vital rehabilitation information back (via a software program) to the patient and hospital. The collaboration brings together the new materials and fabrication expertise at ACES with Shimmer Research's wearable wireless communication technology. With input from ACES members (including world renowned orthopaedic clinicians from St Vincent's Hospital Melbourne) the partnership will foster work on building bionics devices that will improve the quality of life for a large number of elderly people and those recovering from injury.

3.2.1.2 Centre for Medical Radiation Physics

UOW's Centre for Medical Radiation Physics (CMRP) has partnerships with major organisations around the world, working on projects ranging from measuring the effect of cosmic radiation on NASA astronauts to developing new methods for treating prostate cancer. The CMRP team has joined a major European project developing medical physics radiation detection technology. It previously had been part of a team that won a prestigious research grant from the US National Space Biomedical Research Institute at NASA to develop space qualified instrumentation for assessment of radiobiological effects on humans during long-term space missions.

The Advanced Radiation Dosimetry European Network Training (ARDENT) invited CMRP to join seven full European and five associate international partners working in the field of radiation detectors development and their application in different areas of radiation science and medicine. The project, which is being coordinated by the European Organisation for Nuclear Research (CERN), also enables three UOW PhD students to be seconded to overseas institutions for specific research training. Under founding director Professor Anatoly Rozenfeld, CMRP has developed strong research partnerships and collaborations with around 15 Australian organisations including ANSTO, the CSIRO and major hospitals and cancer research centres. It also has partnerships and collaborations with more than 25 research organisations, institutes and hospitals around the world.

3.2.1.3 BlueScope Steel Metallurgy Centre

The University of Wollongong's partnership with Blue Scope Steel and its predecessors Australian Iron and Steel (AI&S) and BHP Steel dates back to its very earliest days. UOW grew out of a divisional college of the then NSW University of Technology (later UNSW) that was established in Wollongong in 1951 primarily to train metallurgists and industrial chemists for the local steel industry. In 1959 BHP, AI&S and other local industries led a community campaign for the divisional college to become a University College with a wider range of courses. The industries donated £138,000, which was pooled with £50,000 in community donations and £178,000 from the Federal and NSW Governments to establish Wollongong University College which opened on its current campus site in 1962. BHP also donated substantial amounts of land and building materials, while also funding the salary of the College's first Professor of Metallurgy. Since then the steel industry and the University, which became an autonomous institution in 1975, have maintained a close relationship through research partnerships, traineeships, scholarships and collaboration on a wide range of industry and community projects.

The BlueScope Steel Metallurgy Centre (BSMC) in the Faculty of Engineering at UOW was established in 2004, evolving out of the previous BHP Institute for Steel Processing and Products, which had been operating since 1995. BSMC has built up specialised equipment infrastructure that is shared by the University and company employees in a unique arrangement. It is a true partnership, providing opportunities for academic staff to assist industry while enhancing the opportunities for industry staff to make a contribution to fundamental research and education. One UOW-BlueScope research project has been at the heart of the development of BlueScope Steel's flagship range of COLOR BOND® steel painted products.

Over the past decade a research team led by Dr Phil Barker from BlueScope Steel Research at Port Kembla and Professor Stephen Blanksby from UOW's School of Chemistry have been developing a better understanding of the chemical processes which underpin the durability of the paints used in the COLORBOND® range. The team has developed new technologies based on state-of-the art mass spectrometry (a technique for identifying molecules by their individual masses) to monitor chemical processes within the paint at a molecular level. The work has attracted national attention, with the Wollongong research team invited to join the national Centre of Excellence in Free Radical Chemistry and Biotechnology. "We have made great advances in the understanding of chemical factors important to the durability of our pre-painted products," Dr Barker said. "The work with Professor Blanksby has enabled us to design new highly-specialised, anti-oxidant molecules to soak up harmful free-radicals which can form in the paint. The outcomes will help make COLORBOND® steel products even more durable in the future."

3.2.1.4 Castrol Global Mining Team Partnership

Innovation is at the heart of one of UOW's most recent industry partnerships with international lubricants manufacturer CASTROL. The partnership has a strong focus on innovation between UOW researchers and CASTROL's Global Mining Team, particularly developing products and services that help reduce total operating costs and risk for mining companies across the world. The partnership will also focus on developing scholarships, internships and graduate programs for UOW students. UOW Ambassador and former champion cricketer Adam Gilchrist played a key role in bringing the University and CASTROL together, as he works closely with both organisations and considered the partnership would be of mutual benefit. He has represented the University as an Ambassador since 2008, and has been a CASTROL Brand Ambassador for nine years. Mr Gilchrist said his intimate knowledge of both organisations led to him suggesting the two organisations should talk about areas of common interest, such as research and development, that would be positive for both. "Both are wonderful organisations, highly respected in their areas of expertise," he said. "The opportunities (for collaboration) in the research and development area are very exciting, but the partnership is also about broadening horizons for students and providing opportunities for graduates."

CASTROL Global Mining Manager Dave Collings said: "CASTROL is accelerating its global mining program, and we were looking to develop a relationship with a tertiary institution that is strongly focused on the mining industry and related engineering disciplines. Not only does it have a very positive reputation in the Australian mining industry, but it also has a strong commercial focus." Mr Collings said CASTROL was looking forward to working with UOW researchers who had a strong understanding of the needs of the mining industry to develop better engineering solutions to current and future mining challenges.

3.2.2 Developing a Regional Innovation Ecosystem

3.2.2.1 *Innovation Campus*

The Innovation Campus (iC) epitomises the University of Wollongong's commitment to partnerships that connect its researchers with corporations and other institutions. UOW established the research and commercial precinct on a 33-hectare site in North Wollongong, a few kilometres from UOW's main campus, to drive partnerships and collaboration between its researchers and innovative corporations. iC provides opportunities for commercial tenants like international mining engineering corporation Joy Global to co-locate with some of the University's leading research organisations in state-of-the-art facilities, tapping into their research expertise and benefitting from access to UOW's graduate talent pool. Joy Global's motivation for re-locating to the Innovation Campus is typical of the attraction the campus has for commercial tenants. When the company announced its move to iC Enterprise 1 in April 2012, it cited the opportunity to collaborate with the University's engineering researchers as a key reason for the move.

Joy Australasia Managing Director Brad Neilson said the Innovation Campus provides the ideal combination of state-of-the-art commercial office space and the competitive advantage of collaboration with the University. "We were looking for premises that would allow us to consolidate a number of existing offices and undertake R&D, and the Innovation Campus presented the ideal solution," Mr Neilson said. "In addition to fantastic office space, it gives us the opportunity to align with one of the most progressive schools of engineering and mining in the country, presenting opportunities for R&D as well as internships and scholarships." UOW opened the first buildings on the Innovation Campus in 2008. There are now seven, containing some of UOW's leading research institutes and commercial tenants ranging from major international corporations to specialist banking and IT companies. The iC Masterplan provides for another 18 buildings to be developed over the next decade, including an international hotel and conference centre.

The latest is the Sustainable Buildings Research Centre, a \$25 million federally-funded facility with key partnerships with TAFE NSW Illawarra Institute, BlueScope Steel and Housing NSW, where researchers can develop and test systems for making new and existing buildings more environmentally sustainable.

3.2.2.2 *iAccelerate*

The University of Wollongong's iAccelerate business incubator initiative has been designed to fast-track development of high-tech industries in Wollongong. iAccelerate is the essential cog of the Illawarra Innovation Ecosystem, which has been developed to take advantage of UOW having one of the largest IT undergraduate training and postgraduate research programs in Australia to expand Wollongong's growing technology-based sector into a high-tech industry cluster that will help drive regional development. iAccelerate is designed to increase the productive capacity of the Illawarra by up skilling and supporting start-up companies working in technology fields. It will deliver a 'broadband economy' by marrying UOW's IT graduates with the National Broadband Network (NBN) rollout and by leveraging technology into the region's manufacturing and health industry base.

3.2.2.3 *StartPad*

UOW has collaborated with key partners to establish StartPad, an office space in Wollongong designed to help technology-focused entrepreneurs to grow and develop ideas into successful businesses. StartPad is a joint initiative between the University, Wollongong City Council, NSW Trade & Investment, Enterprise Connect and Regional Development Australia (RDA) Illawarra. It is also a key component of UOW's iAccelerate initiative. With direct funding of \$50,000 from NSW Trade & Investment and Wollongong Council providing the office space in the CBD, StartPad provides start-up entrepreneurs with low-cost office accommodation, mentoring support, peer support and access to networks of people with ideas they would like to see developed into businesses.

3.2.2.4 *ICTI*

UOW is a key member and supporter of ICT Illawarra (ICTI), a Wollongong-based cluster that represents the region's burgeoning ICT sector. UOW joined forces with State Government agency NSW Trade & Investment in 2009 to establish ICTI and help develop the sector in the region. ICTI members range from professionals working in large multinational firms with offices in Wollongong, through to smaller start-up and locally grown companies. And with the growing importance of ICT in many organisations, ICTI is attracting professionals working in a diverse range of industries.

3.2.3 **Technology Transfer**

The University of Wollongong is establishing its own technology transfer operation to facilitate commercialisation of work undertaken by its researchers, in a move which underlines the increasing importance of the University's research output. The new operation replaces the seven-year commercial arrangement UOW had with UniQuest, a technology transfer company established by the University of Queensland. UOW decided to reorganise its approach after a review of its strategies for commercialisation, intellectual property and knowledge exchange between its researchers and commercial organisations. This reflects UOW's growth, as well as the increasing importance the University is placing on helping its researchers test the commercial potential of their discoveries. The case studies below give a few examples of the commercialisation successes of UOW research.

3.2.3.1 *Research-led Invention: The "Spectronus" Greenhouse Gas Analyser*

A University of Wollongong invention will help governments around the world measure greenhouse gases following the University's decision to commercialise its greenhouse gas analyser- the Spectronus - in partnership with Australian environmental monitoring solutions manufacturer, Ecotech. The partnership comes at a critical time in Australia with the carbon price arrangements coming into effect on 1 July 2012. Worldwide, there is an increasing need for governments to accurately measure greenhouse gases in their environments. To meet growing demand, Ecotech will manufacture the analyser in Australia and distribute it via its worldwide network under a licensing agreement with the University of Wollongong. First

developed in 2002 by the University of Wollongong's School of Chemistry, the greenhouse gas analyser is already in use with Australian governments and organisations including:

- Queensland Department of Agriculture, Forestry and Fisheries
- Victoria's Department of Sustainability and Environment
- Australian Nuclear Science & Technology Organisation (ANSTO).

Internationally, the analyser is currently used by government organisations and universities in Germany, France, China, South Korea and New Zealand. The Spectronus leads the market in its ability to deliver a high-precision, real-time analysis of the major greenhouse gases including carbon dioxide, methane, nitrous oxide, carbon monoxide and water vapour. The analyser's hardware is complemented by powerful operating software which provides a flexible, fully-automated system that can be remotely controlled.

Professor David Griffith, head of the University of Wollongong Research Team, said: "Policy decisions based on climate change research demand highly accurate and repeatable data for all greenhouse gases, not just CO₂. In a world first, the Spectronus simultaneously measures important greenhouse gases, making it highly sought after by governments and their agencies. We are excited by the opportunity to meet global demand for this Australian invention through our partnership with Ecotech."

3.2.3.2 Research-led Solutions: "BulkSim" Bulk Materials Handling Simulation Software

With consistently high levels of demand for their commodities, mining industries such as iron ore, gold, copper and coal, are under increasing pressure to deliver more in less time. As UOW researcher, Professor Peter Wypych, an expert in bulk materials handling says, "Bulk commodities are a huge part of the Australian economy. To meet increasing demand, products need to be handled harder, faster and safer than ever before."

Understanding where and how to upgrade large-capacity systems and thereby bolster efficiency has been a major challenge for these businesses. Being able to predict the behaviour and movement of bulk commodities as they make their passage from the point of extraction, through transfers, chutes, conveyors, processing plants, bins, stockpiles, trucks and trains up to their final dispatch can help companies identify which elements of their complex systems need improvement. No traditional computer modelling system has had the multi-variable ability to accurately simulate the journey of raw materials through the supply chain. "Traditional models need to make too many assumptions and cannot factor in the complexities of the ore materials and various processing and handling operations," Professor Wypych said.

To solve this problem, University of Wollongong (UOW) BMEA engineers, led by Professor Wypych, teamed up with UK-based simulation software provider DEM Solutions Ltd (DEM_{SL}). This has resulted in the development of unique validated material model calibration technology that includes dynamic testing and full-scale DEM simulations of material properties and flow. This technology revolutionises design for the reliable and safe handling and supply of bulk commodities. Professor Wypych used a gold mine case study in the USA to illustrate the technology's advanced capabilities. The new technology platform calibrates real products and scenarios, using mathematical equations and the principles of physics to simulate properties and behaviour down to particle-level. Because all relevant particle and bulk variables are factored into the

simulation, the new *EDEM BulkSim* code is capable of more accurately predicting system shortfalls and identifying why certain materials are getting stuck in critical parts of the handling and processing operation.

"With the new technology and collaborations, we are assisting industry globally in the design and improvement of handling and processing plants, including sustainable ports, export terminals and mine expansions," Professor Wypych explained. The team is already deploying *EDEM BulkSim* for some of the world's biggest mining players. "The group is currently working with companies in Australia, Africa, USA and Canada on some major mining and export terminal projects." Professor Wypych said.

3.2.3.3 Research-led Commercialisation: "AquaHydrex" iC's first spin out tenent

The ARC Centre of Excellence for Electromaterials Science (ACES) has secured venture capital investment from True North Venture Partners in a spin out company named 'AquaHydrex'. AquaHydrex technologies are the culmination of years of research that has taken place within the University of Wollongong (UOW) and Monash University nodes of ACES as well other Australian Research Council (ARC) supported projects at Monash University. According to ACES Energy Program leader Professor Doug MacFarlane, the research teams have developed new electrochemical systems for splitting water, with and without the use of sunlight. "Broadly, the technologies involve novel catalytic processes that enhance the efficient electrolysis of water to produce hydrogen," Professor MacFarlane said. A second set of technologies are inspired by photosynthesis to assist the production of oxygen gas from water under sunlight.

ACES Director Professor Gordon Wallace said the investment fulfilled the Centre's strategy by meeting the needs of society. "This new investment adds in a material and very substantial way to the investment that the ARC has made in ACES. It holds the future promise of a major technological and social impact, with accompanying benefits to Australia. We aim to build the skills and infrastructure required to translate our research into commercially viable opportunities," he said.

UniQuest, one of Australia's leading technology transfer companies, partnered with UOW and Monash University to develop the business plan and raise capital for AquaHydrex. According to UniQuest Managing Director David Henderson, the investment highlights the strength of Australian university inventions. "AquaHydrex is a great example of a university technology that has been developed to an investable opportunity. It is really a credit to the expertise and determination of the research teams at UOW and Monash," Mr Henderson said.

True North Venture Partners leads a \$300 million venture capital fund that seeks to identify disruptive innovations and work with management teams to build companies for the long-term in the areas of energy, water, waste, and agriculture. "AquaHydrex is an example of the interesting and globally relevant innovation in Australia and we look forward to partnering with the AquaHydrex team," according to Steve Kloos, Partner at True North Venture Partners.

3.3 Contributing to the development of human capital and skills

UOW does not just “produce graduates” that contribute economic benefits. The benefits for both graduate and society go beyond those to which numerical estimates can be attached. UOW adds to the prosperity of society at large and individuals through the knowledge and skills embodied in its graduates. It supports the development of skills and knowledge that increase the opportunities available to the workforce; helps improve the mobility of staff and students as they gain the skills and connections that increase their employability; and it attracts and retains global talent to Australia and its region of Wollongong. This section provides an overview of the ways that UOW contributes in these areas.

3.3.1 Enabling Access to Quality Higher Education in Regional NSW

UOW has a network of education centres across south-eastern NSW and southern Sydney designed to bring a UOW education to students who may not be able to come to Wollongong. The regional centres are located in the Shoalhaven at West Nowra, at Batemans Bay and Bega on the South Coast, and at Moss Vale in the Southern Highlands. Each is a joint education initiative with TAFE NSW Illawarra Institute, while UOW Southern Sydney at Loftus is a joint initiative with the Sydney Institute of TAFE.

UOW opened in the Shoalhaven in 1993, followed by Batemans Bay and Bega in 2000, Moss Vale in 2002 and Loftus in 2003. The first degrees offered were from the Arts and Commerce faculties. These have been expanded to include Education and Nursing. Since 2007, UOW's Shoalhaven Campus has offered Medicine through an arm of the Graduate School of Medicine. There are now more than 1200 students studying across the five centres, which play crucial roles in their communities.

Eurobodalla Shire Council is a partner in the Batemans Bay centre. At the opening of a \$2.5 million extension in May 2012, Eurobodalla Shire Council Mayor Councillor Fergus Thompson summed up the value of the regional centres. He said they gave residents the opportunity to enhance their skills and earning capacity without having to leave the area to study in Wollongong, Canberra or Sydney. “Education at any level is important,” Cr Thompson said. “From the point of view of this community, this (centre) creates employment opportunities or enhances employment opportunities. Not only is it good now, but it will continue to grow and be great for our community.”

3.3.2 Social Equity and Tertiary Participation

UOW has a history of delivering accessible higher education in one of Australia's working-class cities. UOW has become a catalyst for the Wollongong region's transition from employment in low-skilled production sectors to high-skilled knowledge sectors. Over many decades, UOW has been providing opportunities for “first generation” students to become the first members of their families to undertake university studies. Moreover, beyond UOW's success in engaging students from lower social economic groups in higher education, it has become a national standard-bearer for the successful support of these students once at university. Three leading edge UOW engagement and transition support programs, *In2Uni*, *AIME*, and *Staying Connected* are described below that put it at the forefront of the sector in delivering the Federal Government's social equity policy objectives.

3.3.2.1 In2Uni: Engaging and inspiring underrepresented students

In2Uni targets cohorts of students who are underrepresented in tertiary education and encouraging them to aspire to university studies. Specially trained UOW students work with around 1,500 school students at 20 high schools across the Illawarra and South Coast.

Reinforcing the message that higher education is achievable, In2Uni ambassadors like SBS Television news presenter Ricardo Goncalves, himself a first generation university graduate from the UOW Business Faculty, feature in videos encouraging students to persevere with their studies and assuring them that their efforts will bring rewards. The program has developed from a unique partnership between UOW and the Department of Education and Communities, Illawarra and South East Region and is designed to lift educational aspirations and give school students a better understanding of the opportunities that higher education can provide.

In2Uni's programs include academic mentoring, leadership and transition workshops, campus experiences and online activities for students, parents and teachers. It ranges from a specially targeted program for Year 6 primary school students through to Year 12. The student mentors visit schools throughout the Illawarra and South Coast regions of NSW, working with Year 7 to 10 students and helping them develop the skills to strive for excellence and set goals for their future. The student mentors continue with Year 11 and 12 students in leadership and transition workshops where they work on study skills, career options and activities that facilitate their transition into higher education.

3.3.2.2 AIME: Indigenous Mentoring

The Australian Indigenous Mentoring Experience (AIME) at UOW was established in 2008 to help redress imbalance in high school completion rates between Indigenous and non-Indigenous students. UOW's AIME program pairs student mentors one-on-one with more than 300 Indigenous high school students for an hour a week for 15 weeks, while others are involved as tutors at afternoon learning sessions at the Aboriginal Corporation Centre in Wollongong and as members of tutor squads which go out to schools during school hours to help the students.

AIME also runs an Outreach Program where high school students located within two to three hours of the UOW campus visit for a full day, three times a year, in a program designed to break down the barriers between them and the University. AIME's UOW Program Manager Nadia Neal says there is clear evidence that participating in AIME gives Indigenous high school students the skills, opportunities and confidence to not only complete high school but to then transition to university, TAFE or other tertiary education.

3.3.2.3 Staying Connected: a first year student support and attrition aversion initiative

The University of Wollongong takes its responsibility to new students seriously. First year undergraduate students are undergoing a major life transition, and UOW is continually seeking new and innovative ways to

assist in this transition. One such initiative - conceived of by the UOW Client Service team and first trailed in the Faculty of Informatics in 2009 - is *Staying Connected*, a program aimed at calling all UOW first year students within their first six weeks on campus to undertake what could be described as "an early transition health check".

The primary aim is to make new students feel welcome at a potentially vulnerable time, and to identify any issues and seek support for those students who may need help in adjusting to university life. After the successful trail in 2009, the initiative was endorsed by the Deputy Vice Chancellor Academic and rolled out to the entire on-shore first year student cohort in 2010, with a total of 3,332 students contacted. By 2011, *Staying Connected* was attempting contact with all commencing UOW on-shore students, with approximately 75% of all on-shore first year students completing the welcome interview within their first six weeks of arriving at UOW.

Staying Connected has had a positive influence on the student experience at UOW in a number of areas:

- Increased awareness and utilization of student support services
- Reduction in failure rates (particularly in difficult courses)
- Increased course retention rates
- Increased overall student satisfaction with the UOW student experience

3.4 Promoting enterprise, business development and growth

3.4.1 Global Linkages and Industry Connections

3.4.1.1 Chinese Connections

One of UOW's key researchers Professor Shi Xue Dou personifies the University's close links with China, collaborating closely with major Chinese corporations and leading universities. Professor Dou came to Australia from China in 1986 as a visiting professor of chemistry on sabbatical leave from the Northeastern University in Shenyang. Now he is an internationally acclaimed scientist who is one of Australia's leading authorities on electronic materials, superconductivity, energy storage and new generation battery technology. Professor Dou is the Director of the Institute for Superconducting and Electronic Materials (ISEM), a flagship UOW research institute located in the Australian Institute for Innovative Materials at the University's Innovation Campus. Professor Dou maintains many close connections with China. His Institute attracts postgraduate students from around the world, but at least 30 percent of them are traditionally from China. Professor Dou has supervised a large number of Chinese postgraduate research students over the years- many of whom have returned to China to take senior posts in research, at universities and in industry.

Professor Dou has also fostered many research collaborations with Chinese partner institutions and corporations. Projects include an energy recovery program with BAD Steel to capture heat from the company's steel production processes and transfer it into usable energy, a long-standing research collaboration with one of China's largest battery companies, DLG, and a partnership with Ningbo Jan Sen to develop next generation MRIs using superconductor technology. His latest collaborations involve development of electric vehicle power systems, where he and his researchers are involved in joint Australia-China programs with a number of Chinese universities including institutions in Beijing and Shanghai. Professor Dou has a number of honorary academic appointments with prestigious Chinese institutions including the Chinese Academy of Science, the Chinese Institute of Physics and Shanghai University. Professor Dou says personal contact is the key to strong relationships with China. "In China personal contact is vital. We have maintained close personal contact with many Chinese academics, and that is why we have so many excellent postgraduate students coming here from China," he said. "The study environment is very good, and we produce great academic outcomes for the students." ISEM also has many other connections and collaborations with leading institutes around the world.

3.4.1.2 Indian Connections

The University of Wollongong and India's premier industrial research and development organisation, the Council of Scientific and Industrial Research (CSIR), are working together to advance research collaborations and establish a dedicated CSIR Research and Development Centre at UOW's Innovation Campus. CSIR was established in 1942 and is India's largest research and development organisation with nearly 40 laboratories and 50 field stations throughout India. It has a collective staff of more than 17,000. Under an arrangement announced in May, 2012, UOW and CSIR will pursue research and development

collaborations in areas including advanced steel metallurgy, lithium-ion batteries, super capacitors and polymer-based nano-composites.

Both organisations will also work towards the establishment of a CSIRO Research and Development Centre on the Innovation Campus to work closely with the University's research groups housed in the Australian Institute for Innovative Materials and to develop an academic exchange program for staff and students. UOW Vice-Chancellor Professor Paul Wellings believes that the relationship between the University and CSIR will make a substantial contribution to the future success of both organisations. CSIR Director-General Professor Samir K Brahmachari said the partnership with UOW, with a focus on innovation, would contribute to CSIR's long standing vision to provide affordable health, low cost energy solutions and sustainable development for millions of people in India and around the world who need affordable science and technology solutions. "We strive for global scientific impact and an important part of that is the development of a CSIR presence in the Asia-Pacific region.

3.5 Enhancing social and cultural life

3.5.1 Community Health

3.5.1.1 *IHMRI: improving regional health through community-based medical research*

The Illawarra Health and Medical Research Institute (IHMRI) is a collaborative venture between UOW and the Illawarra Shoalhaven Local Health District dedicated to excellence and innovation in health and medical research that will lead to better health services and a healthier local community. Based at a \$30 million research facility with purpose-built clinical trials facilities and sophisticated laboratories on the UOW campus, IHMRI was established to bring the University's best health and medical researchers together with the region's best clinicians.

More than 100 scientists are now based at IHMRI, with a further 180 using the facilities on a regular basis. In addition, the Institute has fostered the IHMRI Research Network – a community of academic researchers, clinicians and other health professionals with a common interest in advancing health and medical research in the region. By early 2012 the network had 715 members.

IHMRI's research program is based on population health, with four core research themes:

- Diagnostics and Therapeutics
- Neuroscience and Mental Health
- Ageing and Chronic Conditions
- Health Care Delivery

Research programs are community-based, with a strong focus on early intervention, preventative health care and investigation through clinical trials. IHMRI encourages the region's clinicians and the wider Wollongong community to become involved in these clinical trials aimed at contributing to a better understanding of disease, looking at options for reducing the risk of disease and developing better treatments. The benefits of this research will flow back to the Wollongong community and, ultimately, benefit patients around Australia and around the world.

IHMRI opened in July 2010, and the first commercial trials began in the Clinical Research and Trials Unit (CRTU) in January 2011. Commercial trials already undertaken in the unit include a shingles vaccination, blood lipid control medication and a cold sore treatment, with others planned for treatments for gout, asthma and osteoporosis.

IHMRI researchers have also undertaken investigator-initiated trials such as dietary approaches to weight management, dietary interventions and dementia. The CRTU is also introducing research clinics focusing on researching and providing health care in areas of need that currently are unmet in the region. Initial priorities include the fields of hypertension, obesity and chronic disease management.

UOW's Pro Vice-Chancellor (Health) Professor Don Iverson is IHMRI's Executive Director. He believes the Institute makes a significant contribution to the economic prosperity of the Wollongong region as well as to improving the health and well-being of its citizens. "The continued development of IHMRI ... is not only

creating opportunities for residents to access new treatment options but bring new money to the region," Professor Iverson said. "A health-based economy can be a primary driver of the region's evolutionary growth. Apart from improving the scope and quality of health and medical services that residents can access, a health-based economy will create a range of new companies and jobs."

3.5.1.2 Northfields Clinic: supporting mental health in the community

Northfields Clinic has provided low-cost, high-quality psychological services to the Wollongong community for more than 30 years, while also providing a superb training facility for clinical practitioners. UOW's School of Psychology operates the clinic, which was established in 1981 to provide psychological assessment and treatment services to the community and an advanced clinical training setting for post-graduate psychology interns. These interns, who have completed a four-year degree in psychology, work under the supervision of senior clinical psychologists.

Since 1981 more than 4300 interns have graduated from Northfields Clinic as clinical psychologists with Masters, Doctorate and PhD qualifications, making it one of the most successful clinical training facilities of its type in Australia. Many graduates – like Lifeline South Coast Director Grahame Gould – stayed on and practice in the region.

In its 50 years, Northfields Clinic has treated more than 10,000 children and adults for a range of issues including anxiety and phobias, depression, drug and alcohol problems, obsessive compulsive disorder, stress management, sleeping disorders, assertiveness, self-esteem building, anger management, learning disabilities and child behavioural problems.

Mr Gould says Lifeline regularly refers people to the clinic. "We trust Northfields, we know the quality of the treatment there and we have a strong, established relationship," he said. "I trained as a psychologist at Northfields Clinic and use the skills I learned there in my job every day."

Psychology Professor Brin Grenyer describes Northfields Clinic as a "community gem". "High quality, low cost mental health care is very difficult to find," Professor Grenyer said. "Northfields has always catered to a very large and varied group of clients who would have trouble accessing help anywhere else in the region. The clinic has such a broad outreach and emphasises preventative treatment and early intervention."

In assisting so many people, Northfields Clinic has touched the lives of many more – family, friends and colleagues of the people who have been successfully treated.

3.5.1.3 Bra Guide: enhancing women's health and sporting performance

Researchers at UOW's Breast Research Australia (BRA) are helping women around Australia play sport and exercise in more safety and comfort. BRA researchers located within UOW's Biomechanics Research Laboratory have been studying bra design and effectiveness for more than a decade, including pioneering work on designing better sports bras. Their expertise was recognised when Sports Medicine Australia commissioned BRA to produce a brochure for national distribution to help women choose the right bra for

sport or exercising. This was in response to research showing that few women wore the correct bra to exercise, with the potential to cause physical problems as well as affect performance.

The BRA team produced a free do-it-yourself guide called *Exercise and Breast Support*, launched in 2012. It provides easy to follow explanations on why correct bra fit and support is important for women of all ages when they play sport or exercise, as well as information about the potential for ill-fitting bras to contribute to neck, back and arm pain, especially in women with large breasts. It contains a practical table that helps women make the right choice of bra based on age, bra cup size and the type of physical activity being undertaken and advice on the type of bands, straps, cup, underwire and material, three easy steps to correct bra fit and a bra fit checklist.

BRA team researcher Dr Deirdre McGhee said the information in the brochure was prepared from evidence-based research, and is a valuable guide for women of all ages. "One of our recent studies found that 88 percent of female adolescents wore a bra during sport that didn't fit properly, while 85 percent failed a simple knowledge test on bras and bra fit," Dr McGhee said. "At the same time the vast majority of women, 75 percent in the younger age group and 67 percent among older women, do not choose to use the bra-fitting services that some bra retailers provide. "So clearly there is a problem, and we are delighted that Sports Medicine Australia has partnered with us to produce this brochure to help women who want to be active – whether it is very physical activities like playing hockey, netball, football, jogging or gym workouts, or more passive activities like walking."

3.5.1.4 *CHECK IT: helping to promote men's health*

University of Wollongong student volunteers have played a major role in the success of the annual Check It Illawarra men's health event at the WIN Entertainment Centre since it started in 2010. Around 120 medical, nursing, exercise science and medical and health science students work as volunteer clinical assistants at the event, providing free health assessments for almost 1,000 men. Check It is organised by Healthier Illawarra Men (HIM) - a committee of business, community, medical and UOW representatives formed to promote greater awareness of health issues among the region's male population. The event has been run under the auspices of the Illawarra Division of General Practice, with UOW one of the major sponsors.

The students conduct a series of tests on each "patient", including taking blood for cholesterol and blood sugar readings, taking blood pressure, and measuring height and weight for a Body Mass Index (BMI) assessment. People with high readings are advised to consult their doctor, while those with dangerously high readings are encouraged to speak to the doctors on duty at the event.

UOW Pro Vice-Chancellor (Health) Professor Don Iverson, who is on the organising committee, says the event has been a great success from a public health perspective, while also providing invaluable training for the students. HIM committee chairman Mark McDonald paid tribute to the students' contribution, declaring the event could not have been possible without their input. "They have been absolutely brilliant," he said. "We were really pleased with the response from the public – having almost 1000 men attend for the first two years – and we simply couldn't have managed these numbers without the enthusiasm and hard work of our student volunteers."

UOW Vice-Principal (Administration) Chris Grange says the University has been delighted to be involved with Check It, as sponsors and supporters and through the students' involvement. "This is exactly the kind of event that is consistent with the University's commitment to improving medical infrastructure and services in the Illawarra, through our medical school and our medical and health research programs," Mr Grange said. "It is also terrific training for our students to have the experience of meeting and interacting with so many people."

3.5.2 Sustainability

The rising cost of energy is one of the biggest budget issues for Australian businesses and households. At the same time, our use of buildings contributes between a quarter and a half of all greenhouse gas emissions generated in Australia.

Two research centres at the University of Wollongong are collaborating in research and training projects designed to make Australian buildings more environmentally and economically sustainable, while also looking at the social and cultural side of energy consumption. It is a shining example of the interdisciplinary partnerships that characterize much of UOW's research. Australian Laureate Fellow Professor Lesley Head leads the Australian Centre for Cultural Environmental Research (AUSCCER), which was established in 2010 to undertake in-depth analysis of important Australian environmental issues by exploring how humans interact with and understand the environment. It was established with Australian Research Council (ARC) support to provide evidence-based information to help governments determine the best policies to protect the environment.

Professor Paul Cooper heads the Sustainable Buildings Research Centre (SBRC), which has a major focus on reducing the carbon footprint of existing buildings, while developing technologies that will make Australia's future buildings more environmentally sustainable. SBRC researchers' projects include developing sustainable building technologies for residential and commercial applications, analysing and improving thermal design for buildings to reduce the need for using energy for heating and cooling, and developing control and sensor technology to improve building performance.

The Federal Government has provided a \$25.1 m grant to build the SBRC headquarters at UOW's Innovation Campus, while the centre also has a key industry partnership agreement with BlueScope Steel. Its other partners include Housing NSW, TAFE Illawarra Institute, Regional Development Australia Illawarra and Green Jobs Illawarra. AUSCCER was established with funding from UOW and the ARC through Professor Head's five-year Australian Laureate Fellowship (2009-2014) and human geographer Professor Chris Gibson's ARC Future Fellowship (2010-2013). It also receives support from government departments and local government organisations. AUSCCER and SBRC are currently collaborating on a project to examine how Australian households heat and cool their homes.

"The SBRC looks at the technical side of sustainability, while AUSCCER looks at the human side, which is equally if not more important," Professor Cooper said. "Households use a lot of energy keeping warm and keeping cool, and (as part of this research) Paul's group is monitoring temperature and humidity in existing buildings to identify both barriers and opportunities to lower energy consumption," Professor Head said. "Professor Gordon Waitt is leading the project from our end, looking to see how people use their space, and

what could be changed to help them use less energy. This would benefit both consumers and the environment. "People do undertake a range of sustainability practices, even if they are not really focused on sustainability issues," Professor Head said. "It may simply be because they have a low income and want to save money on their energy bills. These practices are resources we can all learn from."

The two centres' collaborations include NSW Government-funded professional development courses that SBRC runs throughout the year for engineers and other professionals to train them on the latest energy-saving technologies and innovations for retro-fitting existing buildings and making sure new buildings are as sustainable as possible. "Our joint research informs the training courses, and Lesley has developed training materials focussing on the human factors involved in sustainability in buildings and industry," Professor Cooper said.

3.5.3 State-of-the-art Sports and Recreation Facilities

Many high profile Australian and international sporting teams have used UOW superb sporting facilities as training bases – from the United States and Australian national swimming squads to the Wallabies rugby union team and the St George Illawarra Dragons in the National Rugby League. But just as importantly, UOW makes its world-class facilities available for all kinds of community groups – from learn-to-swim classes to local primary and high schools staging their swimming carnivals in the international-standard 50 metre pool, to junior coaching clinics, junior sports squads that train and play on the sports fields and people attending fitness classes at Wollongong's best-equipped gymnasium.

Other facilities at the University Recreation and Aquatic Centre (URAC) include high quality cricket fields, a field for rugby and AFL, a championship-standard hockey field with artificial surface, tennis courts, physiotherapy centre, indoor courts for basketball and volleyball and a sports hall (called the Sports Hub) with three courts for sports like basketball, volleyball, futsal and netball.

UOW teams competing in local competitions in sports like men and women's hockey, AFL, rugby union, rugby league and cricket, host visiting teams at the campus for matches. URAC also houses the headquarters of the Illawarra Academy of Sport - a regional junior sports academy that has produced Australian representatives in many sports, from cricketers Brett and Shane Lee, rugby league stars Brett Stewart, Craig Fitzgibbon and Shawn Timmins to Olympian hockey star Casey Eastham, Commonwealth games gold medal-winning cyclist Rochelle Gilmore and international surfing star Sally Fitzgibbons. As part of this support of junior sport in the region, URAC also accommodates regional development officers for NSW-ACT AFL, NSW Rugby Union and NSW Tennis.

In April 2012 URAC was the headquarters for the NSW Academy Games, hosted by the Illawarra Academy of Sport. More than 700 emerging athletes took part in the Games, which will be hosted in Wollongong until 2014.

3.5.4 Community Support

3.5.4.1 *UOW Cares: Workplace giving program*

The University of Wollongong's commitment to community has proven an example to its staff, who have contributed almost \$300,000 to community organisations through the UOW Cares workplace giving program since it was established in 2007. The funds are raised through a pre-tax payroll deduction scheme and other fund-raising activities such as an annual coffee week (when a percentage of every coffee sold at participating outlets on campus goes to UOW Cares) and Christmas card sales.

Workplace giving is a simple and effective way for staff to regularly donate to a community group with a deductible gift recipient status (DGR) through automated payroll deductions. Staff are able to pledge a nominated amount which is sent to their chosen organisation each pay. All money goes towards vital financial assistance for groups working in areas such as conservation, medical and disability support, health and medical research, UOW student support, humanitarian programs and community assistance.

Organisations that have received support through UOW Cares include:

- **The Smith Family** (social disadvantage)
- **Cancer Council NSW** (medical research and education)
- **The Fred Hollows Foundation** (ending avoidable blindness and improving Indigenous health)
- **Autism Spectrum Australia** (Aspect) South Coast School
- **Australian Conservation Foundation** (conservation/environment)
- **Oxfam Australia** (humanitarian and emergency aid)
- **Indigo foundation** (community development)
- **RSPCA** (animal welfare)
- **UOW Equity Fund** (educational disadvantage)
- **Para Meadows School** (Wollongong-based organisation helping children with disabilities)
- **SCARF Inc** (Strategic Community Assistance to Refugee Families)
- **Careflight** (rapid response critical care helicopter service)
- **Tanna Island Hospital Relief Fund** (established by UOW medical students' Health Over Wealth collective to help a small island community in Vanuatu)

3.5.4.2 *CEGS: connecting UOW expertise with community needs*

UOW also directly supports community projects through the Community Engagement Grant Scheme (CEGS) and the Chancellor's Awards for Voluntary Contribution. CEGS was introduced in 2005 to encourage and support collaborative University-community projects which have mutually beneficial outcomes and has distributed nearly \$300,000 to 40 separate projects (see Table 3.1).

Over the years projects that have received CEGS funding have ranged from a collaboration with the Salvation Army and the Police Citizens Youth Clubs to provide children from disadvantaged backgrounds free access to UOW's Science Centre weekend family program, to a two-year "economic gardening" project that helped businesses in the Shellharbour City Council area with an advanced entrepreneurship program that included specialised information and operational assistance including business planning, identifying target markets, intellectual property management and leadership skills.

Table 3.1 UOW Community Engagement Grants (2005-2012)

Community Project	UOW Funding
1. Disabled Children's Services in Illawarra – A Needs Assessment	\$6,429
2. Aunty Jean's Good Health Team – A Living Legacy	\$9,919
3. Web-cast Water Testing and Weather Station	\$10,000
4. Growing up on the South Coast	\$3,752
5. Learning and Teaching Creatively	\$9,750
6. Community Support Program – Science Centre	\$3,000
7. Guides in Engineering and Science Saturday	\$1,650
8. Towards a UOW Webcasting Service	\$8,300
9. New ways to engage the community and prioritise economic development	\$9,000
10. Developing community language resources: Community schools in the Illawarra	\$8,300
11. Linking with Illawarra Association of Private Psychologists	\$5,670
12. Empowering the Community to Respond to Inappropriate Alcohol Marketing	\$9,550
13. Impacts of Climate Change and Community Based Strategic Response in the Illawarra	\$7,600
14. Multimedia Youth Legal Resources	\$5,000
15. Capacity Building Among Members of the Clubhouse for People with Mental Illness	\$8,600
16. Voices of Children: A Sense of Community	\$7,600
17. Bringing International Experience to Illawarra High Schools	\$5,980
18. Patient Volunteer Programs for medical education at the GSM in W'gong and Shoalhaven.	\$9,990
19. Supporting children with cerebral palsy: a DVD resource kit	\$9,940
20. Young people and the impact of government fines	\$10,000
21. Blakwriters Symposium	\$7,840
22. Kids Guernica: 15 years of peace	\$3,932
23. iHouse and the Strategic Community Alliance to Refugee Families	\$8,795
24. Art for Country: contemporary Aboriginal arts from the South Coast (a publication)	\$9,969
25. Developing Ecological Awareness among youth in the Illawarra	\$5,000
26. Health Workers Advisory Committee for Experts Patient Program in Clinical Skills	\$9,063
27. Acknowledgement of Dharawal Country (a film)	\$6,500
28. Reducing the Incidence of Cancer in People with Mild Intellectual Disabilities	\$5,775
29. Improving the nutritional status of clients of Meals on Wheels services	\$9,840
30. Opening doors between families and schools	\$4,267
31. Illawarra Science on Show – enriching community understanding of science	\$9,990
32. AIME – Connecting to Success	\$2,000
33. An educational resource for peers of students with Autism Spectrum Disorders	\$10,000
34. GreenCONNECT, a social enterprise founded by SCARF	\$10,000
35. Beating Breast Bounce: an educational resource on breast support	\$10,000
36. Creativity & Expertise: documenting & publishing the life and work of the late Janet Cosh	\$10,000
37. Engaging Smart Kids in Univeristy: A pilot program for high school students	\$8,533
38. Dementia Online Illawarra: Innovative approaches to supporting the information needs	\$9,742
39. UOWTV/Vibewire: Shoalhaven Media Makers	\$10,000
40. Sustainable Community Garden Education Project	\$5,000
Total grants funding awarded	\$296,336

Source: UOW Office of Advancement

3.5.4.3 Community Sponsorship

In addition to building productive community partnerships and engaging the community in the life of the University, the Office of Advancement (OA) administers several community sponsorships which demonstrate strong community values and advance our community engagement objectives. The Office of Advancement administers a Community Partnerships Sponsorships Fund, which provides limited funding (and/or in-kind support) for community events, projects and activities, and aims to achieve a balance between educational, social, cultural and environmental programs that benefit UOW and the broader community (Table 3.2). In addition, the Office makes recommendations to the Vice-Chancellor's Office on sponsorship requests that require approval from the Vice-Chancellor and are not funded by the Community Partnerships Sponsorships Fund or the Office.

Table 3.2 Summary of Community Partner Sponsorships (2012)

Organisation	Activity
Welcome to Wollongong Working Group (partnership with TAFE & Wollongong Council)	Biannual Civic Reception and welcome festival for new students to the City of Wollongong
Centre for Student Engagement	Student 4 Student National Leadership Conference
RDA Illawarra	Illawarra Innovation Festival
Futureworld Ecotechnology Centre	Fundraising Dinner
PCYC	Time 4 Kids Fundraiser
International Women's Day Committee	Illawarra International Women's Day Luncheon
Woilyungah Indigenous Centre	Reconciliation Week
Port Kembla Port Corp	Port Kembla Maritime Community Day
Illawarra Cancer Carers	Banquet at the Beach fundraiser
Lions Club of Woonona	Christmas Variety Show for special needs children and carers
Rotary Club of Fairy Meadow	Christmas Magic Show for special needs children and adults
KidzWish Foundation	KidzWish Christmas Party for sick, disabled & disadvantaged children
UOW community engagement subject	HIST280 Community, Power & the Common Good subject

Source: UOW Office of Advancement

3.5.5 Cultural Engagement

3.5.5.1 Wollongong Conservatorium of Music

UOW is a major supporter of the Wollongong Conservatorium of Music, which is the largest regional conservatorium in New South Wales and caters for around 1500 students a week. Its programs range from early childhood music courses and musical instrument beginner classes to high level musical training and performance in its 21 ensembles, orchestras, choirs and jazz bands. The Conservatorium teaches around 950 students at its home at Gleniffer Brae, in the Wollongong Botanic Garden adjacent to the University of Wollongong. It also runs a schools program for 500 children at 27 primary and high schools throughout the region.

Conservatorium Chief Executive Officer Andrew Snell stresses that its programs are about inclusivity. "We offer opportunities to anyone who wants to learn about music, from absolute beginners to people who have ambitions to play professionally," he said. "And our early childhood program is the longest –running in the country." With graduates including Australian Chamber Orchestra Artistic Director Richard Tognetti, international musical theatre star Anthony Warlow and the 2012 ABC Symphony Australia Young Performer of the Year, saxophonist Nick Russoniello, Wollongong Conservatorium of Music has a proud record of achievement since it was established in 1972.

The University of Wollongong has played a major role in its development since 1984, when the Conservatorium amalgamated with the University. These days it is an incorporated body, but UOW continues to be a major supporter, providing a six-figure annual grant to assist with the Conservatorium's operating expenses. "The University of Wollongong is a fabulous supporter and partner," Mr Snell said. "Its support over the years has literally ensured our survival, and it continues to provide us with a substantial annual grant. "Obviously the money the University has contributed over the years has been very important, but there is a lot more to its support than just dollars. Mr. Snell said the University often invited Conservatorium musical ensembles to perform at its major corporate events. "This gives our young musicians an invaluable opportunity to perform at significant events, like the opening of the Innovation Campus," he said. "It's a great relationship on many levels."

3.5.5.2 The Science Centre: mixing fun with education

The University of Wollongong Science Centre makes a significant contribution to the region's tourism industry, attracting visitors from around NSW, interstate and overseas. Around 60,000 people visit the University's Science Centre and Planetarium at the Innovation Campus every year, making its hands-on exhibitions, science shows, planetarium and observatory with a research-quality telescope one of Wollongong's most popular indoor tourist attractions. The visitors include around 600 school groups, many from outside the area. The Science Centre also plays an important community role in promoting greater awareness of the sciences.

3.5.5.3 UOW events and visitation: a tourism catalyst for Wollongong

Tourism Wollongong figures also show visitors to UOW for conferences, graduation ceremonies and visiting friends or family members who are working or studying at the University are an important and growing element of the region's tourism industry. "Education" is the third top purpose for people visiting the region, representing 17.1% of visitors compared to the NSW average of 6.1%. Visiting an educational institution is also in the top three purposes for international visitors who book accommodation in Wollongong, representing 15.5% of nights compared to the NSW average of 3.6%.

Tourism Wollongong says Wollongong's biggest source of visitors is people who are visiting friends and relatives (VFRs) – 59% compared to the NSW average of 47%. "We see a significant boost into the tourism economy during graduation periods at the University, and regard this as an important source of VFRs," a spokesperson said. "We see UOW as being the major reason Wollongong's VFR numbers are higher than the state average." Walter Immoos, General Manager of the city's major hotel, the Novotel Northbeach, agreed and added that conferences at UOW are also becoming increasingly important. "We see a big spike in our bookings from overseas visitors during graduation periods, and this flows through to our restaurant and other facilities. The two graduation weeks (in July and December) are now an important part of our calendar," Mr Immoos said. "We have also seen a big growth in visitors attending academic conferences at the University and at the Innovation Campus in recent years. The University's impact on our business just keeps getting bigger and bigger."

APPENDICIES

APPENDIX A: Methodology for Measuring Expenditure Impacts

A1. INTRODUCTION

The University of Wollongong will have an economic impact on the local, state and national economies in a number of different ways. The operational and construction activities will have linkages with other regional firms through the purchases of goods and services as inputs into their operations, and through the employment of workers who will in turn spend most of their wages in the local economy. Similarly, students attending the university will have an impact on the local economy through the consumption of locally purchased goods and services. The most common way to measure these effects is through estimation of the effects of the activity on key economic indicators, namely on the addition to the gross regional/state/national product through value-adding, household income earned in the form of wages and salaries, and level of employment.

A2. SOME DEFINITIONS

The term economic impact refers to the effects of an economic activity (e.g. the day-to-day operations of the University) on an economic system such as a regional, state or national economy. These effects are measured in terms of monetary units and employment.

The effects are measured on four key economic indicators:

- I. **Value added.** Gross expenditure measures are susceptible to multiple counting because they sum all the intermediate transactions over all stages of production during the production process. Consequentially, they can substantially overstate the contribution to economic activity. A preferred measure of the contribution to economic growth is value added. This is technically defined as wages and salaries and supplements paid to labour plus gross operating surplus plus indirect taxes on products and production less subsidies, but for practical purposes measures payments to factors of production (labour and capital), including net taxes on production. The sum of all industry value added is equal to gross regional product (GRP), so value added impacts refer to the contribution to GRP (or gross state product (GSP) at the state level and gross domestic product (GDP) at the national level). This is the accepted economic measure of what an economy produces.
- II. **Gross Output:** is the value of goods and services produced by an economic entity (such as UOW). Output is equal to total revenue plus internal consumption as a result of intermediate production.
- III. **Income.** This is the income earned by employees (or compensation of employees (COE)) as part of the normal operations of the economy.
- IV. **Employment.** The number of full-time equivalent jobs generated.

Economic effects are considered in terms of:

- Initial or direct effects which are the impact of the industry per se associated with direct purchases and employment by organizations supplying goods or services to the University, and represent the initial round of value adding, income and employment generated by the activity. For example, the University purchases inputs (eg, materials) from local suppliers. This is the first round impact.
- Indirect and induced effects which extend beyond the initial round of purchases and employment, and represent the additional value adding, income and employment generated resulting from second, third, and subsequent-round purchases flowing throughout the regional economy. For

example, local suppliers to the University in turn purchase goods and services from other local firms who in turn purchase goods and services from other local firms, and so on, as part of the chain of production. Similarly, households receive income as employees of these firms and spend some of their income on local goods and services. These purchases result in additional local jobs. Some of the income from these additional employees is in turn spent on local goods and services, thereby creating further jobs and income for local households.

- Total impact, which is the sum of the direct, indirect and induced effects.

As a result of the successive rounds of re-spending, the total impact on the economy exceeds the initial round of output, income and employment generated by the initial operation. However, each successive round of re-spending is smaller than the preceding round as some of the spending is on goods and services that are produced outside the region. The money which leaves the region is termed a leakage and will eventually limit the number of rounds of re-spending.

As a consequence, the extent of the ripple effects of second, third, and subsequent-round purchases depends on the regional boundaries of the local economy. For example, the size of the indirect and induced effects of a particular activity will generally be smaller in the local (regional) economy than in the state economy, which will in turn be smaller than in the national economy as a result of the different levels of leakage.

The impacts resulting from the University operations were estimated using an augmented input-output approach. Inter-industry modelling is the most widely accepted procedure for measuring indirect or flow on effects of industrial activity on regional economies. The model used in this study is described in more detail in the following sections.

It must be noted that this study is not intended to constitute an evaluation or feasibility study of the University, which would involve benefit cost analysis (BCA). The current study only measures the contributions of the University on the Wollongong, New South Wales and national economies in terms of the direct and indirect effects of its operations.

A3. MODEL SPECIFICATION

Economic modelling at the regional and small area level is restricted by model and data availability. Often, resource and time limitations preclude the construction of complex models such as computable general equilibrium (CGE) models, and in fact there are arguments to suggest that building a CGE model for a small region, while not invalid, may not be a very efficient use of resources in the context of the tradeoff between increased complexity and increased data 'fuzziness'.

Input-output (IO)¹⁰ has traditionally been used in such cases since it really provides the only practical option for planners. The assumptions of the input-output model are concerned almost entirely with the nature of production. Inter-industry models are based on the premise that it is possible to divide all productive activities in an economy into sectors or industries whose inter-relations can be meaningfully expressed as a set of equations. The crucial assumption in the IO model is that the money value of goods and services

¹⁰ Both CGE and IO are special cases of inter-industry analysis. Inter-industry economics encompasses any methodology which takes into account the interdependence among the productive units of the economy.

delivered by an industry to other producing sectors is a linear and homogeneous function of the output level of the purchasing industry with supply being infinitely elastic.

This linearity assumption clearly lays simple IO models open to valid criticism. It implies a strict proportional relationship between input coefficients and output; for example, income coefficients are average propensities and employment coefficients reflect average labor productivity rates. In impact studies, this property can lead to an overestimation of the indirect and induced (multiplier) effects, particularly if the initial effects are relatively modest. For example, many industries can increase output in the short term without corresponding proportional increases in wage costs and employment, particularly if there is slack capacity.

The model used in this study combines input-output with econometric relationships. These types of models are often referred to as integrated models. The replacing of some of the linear equations in the IO model with non-linear (or more specifically log-linear) equations overcomes some of the criticisms of the simple IO model. In addition, this allows both the demand-side IO model and the IO price model to be integrated into a single modelling framework. Consequently, the resulting model is effectively a non-linear price responsive inter-industry model, and should provide a more realistic view of economic reality.

Because the model shares much of the structure of the conventional IO demand model, it is convenient to follow the standard input-output notation. The transactions flows in the input-output table can be expressed in matrix equation form as:

$$\mathbf{T}(\mathbf{I}^{-1})\mathbf{X} + \mathbf{Y} = \mathbf{X} \quad (1)$$

where $\mathbf{T} = (n \times n)$ matrix of industry transactions, $\mathbf{X} = (n \times 1)$ vector of industry gross outputs, and $\mathbf{Y} = (n \times 1)$ vector of industry final demands. n is the number of industries, and the caret denotes a diagonal matrix.

The input-output tables \mathbf{T} , \mathbf{X} and \mathbf{Y} for this study were derived from the Australian Bureau of Statistics (ABS) 2008-09 National Input-Output Accounts (ABS cat no. 5209.0) and updated to 2010-11 using detailed ABS National Income and Expenditure (ABS cat no. 5206.0) and Labour Force (ABS cat no. 5291.0) data. The national tables were adjusted to derive the New South Wales and Wollongong tables used in this study, using the Generation of Regional Input-Output Tables (GRIT) technique developed at the University of Queensland, and using detailed ABS data from the 2010-11 State Accounts (ABS cat no. 5220.0), the 2011 Census and quarterly data on employment by industry sector (ABS cat. no. 6291.0.55.003). In addition, local specific information collected from local sources (via sector business activity surveys and other secondary data sources) was incorporated into the Wollongong region tables.

Equation (1) simply states that, for each industry, total industry sales equals intermediate sales to other industries for further processing, plus sales to final users. This can be rewritten as

$$\mathbf{A}\mathbf{X} + \mathbf{Y} = \mathbf{X} \quad (2)$$

where $\mathbf{A} = [a_{ij}]$ is the matrix of direct requirements coefficients which represents the amounts of inputs required from sector i per unit of output of sector j . Thus, for a given direct coefficient matrix, it is possible to solve the set of simultaneous equations to find the new sector production levels \mathbf{X} which will be required to satisfy a potential or actual change in the levels of sector final demands \mathbf{Y} . By rearranging and converting to differences, this equation can be rewritten as:

$$\Delta\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1} \Delta\mathbf{Y} \quad (3)$$

where $(\mathbf{I} - \mathbf{A})^{-1}$ is termed the total requirements table or Leontief inverse matrix, and represents the direct and indirect change in the output of each sector in response to a change in the final demand of each sector. ΔY can incorporate any element of final demand expenditure, including household expenditure, government expenditure, capital expenditure or exports.

Thus far, we have a linear model in which the matrix A represents a (constant) matrix of average input propensities. In many applications, the A matrix endogenizes the household sector, such that household income varies with the level of intersectoral activity, and household consumption induced effects can be measured. This is referred to as the type II input-output model; the alternative type I model is where households are treated as exogenous to local economic activity. Generally speaking, consumption induced effects are the largest contributors to the total multipliers. This is because consumer driven consumption (and income) tends to dominate local economic activity.

Total inputs are equal to intermediate inputs plus primary inputs (labour and capital). In the conventional input-output model, the inputs purchased by each sector are a function only of the level of output of that sector. The input function is assumed linear and homogeneous of degree one, which implies constant returns to scale and no substitution between inputs.

The model used in this study departs here from the conventional input-output model by a number of steps that a) replace sets of average propensities with corresponding marginal propensities (elasticities) within the model's major linkages, and b) provide for changes in intermediate input coefficients as a function of relative price changes. There is room for variation between models and applications in the implementation and specifications of these linkages, but the generic structure is described below and in Figure 1.

A4. PRIMARY INPUTS

The first step is to allow for non-constant returns to scale and substitution between primary input factors. Value added at factor cost is calculated based on marginal changes in output by industry:

$$\Delta V = \hat{X}_0^{-1} (\Delta \hat{X}) \hat{U} V_0 \quad (4)$$

where $U = (n \times 1)$ vector of industry value added elasticities w.r.t. output, and $V = (n \times 1)$ vector of value added by industry. The zero subscript denotes the base level value. The value added elasticities are estimated econometrically for industry i using time-series data assuming a long-run equilibrium relationship between real value added at factor cost and total production,

$$V_{it} = k_i X_{it} \quad \text{or} \quad \ln V_{it} = \ln k_i + \ln X_{it} \quad (5)$$

with a short-run non-equilibrium relationship

$$\ln V_{it} = \beta_{i0} + \beta_{i1} \ln V_{it-1} + \beta_{i2} \ln X_{it} + \beta_{i3} \ln X_{it-1} \quad (6)$$

To ensure consistency between the long-run and short-run relationships, the constraint

$$(\beta_2 + \beta_3)/(1 - \beta_1) = 1 \quad (7)$$

should be satisfied which gives a long-run elasticity equal to unity.

The shares of wage (compensation of employees) and non-wage (gross operating surplus and mixed income) contributions to factor costs are assumed to be based on the same long-run relationship as that for total value added, i.e.

$$W_{ijt} = r_{ij} V_{ijt} \quad (8)$$

with a short-run relationship

$$W_{ijt} = \beta_{ij0} + \beta_{ij1}W_{ijt-1} + \beta_{ij2}V_{ijt} + \beta_{ij3}V_{ijt-1} \quad (9)$$

for $j = 1, 2$. The restrictions

$$\beta_{j0} = 0, (\beta_{j2} + \beta_{j3}) / (1 - \beta_{j1}) = r_{j\bar{}} \quad \sum r_{j\bar{}} = 1 \quad (10)$$

should be satisfied, which implies the relative proportions of labour to capital in total primary inputs should remain constant in the long-run but that the short-term proportions can vary, as will the proportion of total value added in total demand. The long-run set of equations in (8) were estimated as

$$W_{ij} = \beta_{ij0} + \beta_{ij1}V_{ij} \quad (11)$$

with the elasticities calculated at the mean.

The change in wage cost is then calculated from the marginal change in the share of wage costs in total factor costs

$$\Delta \mathbf{W} = \hat{\mathbf{V}}_0^{-1} (\Delta \hat{\mathbf{V}}) \hat{\mathbf{R}} \mathbf{W}_0 \quad (12)$$

where $\mathbf{R} = (n \times 1)$ vector of industry wage income elasticities with respect to total primary inputs at factor cost, and $\mathbf{W} = (n \times 1)$ vector of wage cost by industry. Gross operating surplus plus mixed income is calculated as the residual. The change in employment is calculated based on the average wage rate in each industry times the change in wages.

A5. HOUSEHOLD CONSUMPTION EXPENDITURE

In a similar manner to primary inputs, total household consumption expenditure is assumed to follow a Friedman-type long-run equilibrium relationship between real consumption (CX) and income (Y), i.e.

$$CX_t = k Y_t \text{ or } \ln CX_t = \ln k + \ln Y_t \quad (13)$$

with a short-run non-equilibrium relationship

$$\ln CX_t = \beta_0 + \beta_1 \ln CX_{t-1} + \beta_2 \ln Y_t + \beta_3 \ln Y_{t-1} \quad (14)$$

Ideally, consumption expenditure should be a function of disposable income and the function should also include variables such as wealth, etc. In this simplified version of the model, income is taken as wage income, i.e. $W_t = Y_t$.

To ensure consistency between the long-run and short-run relationships, the constraint

$$(\beta_2 + \beta_3)/(1 - \beta_1) = 1 \quad (15)$$

should be satisfied which gives a long-run elasticity equal to unity. The estimated short-run elasticity of consumption with respect to wage income is 0.926.

Individual commodity expenditures (Ci) are expressed in terms of total expenditure and are assumed to be based on the same long-run relationship as that for total expenditure, i.e.

$$C_{it} = s_i CX_{it} \quad (16)$$

with a short-run relationship

$$C_{it} = \beta_{i0} + \beta_{i1} C_{it-1} + \beta_{i2} CX_{it} + \beta_{i3} CX_{it-1} \quad (17)$$

for $i = 1, \dots, n$. In this version of the model, the number of industries and commodities are taken to be the same. The restrictions

$$\beta_{i0} = 0, \quad (\beta_{i2} + \beta_{i3})/(1 - \beta_{i1}) = s_i, \quad \sum s_i = 1 \quad (18)$$

should be satisfied, which implies the budget shares for each commodity should remain constant in the long-run but that the short-term fluctuations are possible as income changes.

The long-run set of equations in (16) were estimated as

$$C_i = \beta_{i0} + \beta_{i1} C_i \quad (19)$$

with the elasticities calculated at the mean. Change in household commodity expenditures are then given by

$$\Delta C = \hat{C}_0 S (i' \Delta CX) (i' C X_0)^{-1} \quad (20)$$

where $S = (n \times 1)$ vector of commodity household demand elasticities with respect to total household expenditure, and $C = (n \times 1)$ vector of household expenditures by commodity. i is an $(n \times 1)$ vector of ones. Industry sourced non-wage household income is included in the other value added component of primary inputs.

The value added elasticities, household income elasticities and household demand elasticities were estimated for the national level using detailed ABS time-series data (ABS cat no. 5204, 6401 and 5209). As similar data are not available at the state and regional levels, the national elasticities are also used for the NSW and Wollongong models.

A6. INTERMEDIATE INPUTS

Intermediate input coefficients can vary because of substitution effects caused by relative price changes, or through changes in technology. Technology change is generally regarded as a long run phenomenon. Hence, in short run impact situations, price effects will be the major source of change.

Under constant technology, the IO relationship

$$\Delta a_{ij}^t = a_{ij,0}^t \frac{\Delta p_i}{\Delta p_j} \quad (21)$$

applies, which states that the change in regional technology coefficient (RTC) from industry i to industry j after a policy change or impact is equal to the technology coefficient before the change times the ratio of change in industry output prices. Similarly, the change in regional purchase coefficient (RPC) (or regional direct requirements coefficient) from industry i to industry j after a policy change or impact is equal to the RPC before the change times the ratio of change in industry local prices, i.e.

$$\Delta a_{ij}^l = a_{ij,0}^l \frac{\Delta p_i^l}{\Delta p_j^l} \quad (22)$$

The regional technology coefficient is the sum of the regional purchase coefficient and the regional import coefficient:

$$a_{ij}^t = a_{ij}^l + a_{ij}^m \quad (23)$$

and industry output prices are a weighted average of industry local and import prices. Note that the regional direct requirements coefficients can change, even when industry technology is fixed, as a result of relative price changes.

The change in industry prices can be calculated using the conventional IO price model:

$$\Delta \mathbf{P} = (\mathbf{I} - \mathbf{A}')^{-1} \Delta \mathbf{V} \quad (24)$$

where $\mathbf{V} = (n \times 1)$ vector of primary inputs per unit output by industry. Note that, in this instance, it is only possible to integrate both the demand and price models because of the non-linear relationship between \mathbf{V} and \mathbf{X} derived through econometric estimation. The prices refer to industry output prices in the case of the \mathbf{A} matrix containing regional technology flow coefficients (that is, with indirect allocation of imports) and local industry prices in the case of the \mathbf{A} matrix containing regional purchase coefficients (that is, the flow matrix is recorded with direct allocation of imports). In the former case, the competitive imports are allocated to the intermediate coefficients, so that:

$$\Delta \mathbf{V} = (\Delta \widehat{\mathbf{W}} + \Delta \widehat{\mathbf{O}})(\widehat{\mathbf{X}}_0^{-1}) \mathbf{i} \quad (25)$$

In the latter case, the primary inputs vector contains competitive imports:

$$\Delta \mathbf{V} = (\Delta \mathbf{W} + \Delta \mathbf{O} + \Delta \mathbf{M})(\mathbf{X}_0^{-1})\mathbf{i} \quad (26)$$

where $\mathbf{M} = (n \times 1)$ vector of competitive imports by industry and \mathbf{O} represents other value added. These terms can then be used to update the regional technology coefficients and regional purchase coefficients in (21) and (22) respectively.

A7. IMPORT SUBSTITUTION

The price model can also be used to adjust the regional purchase coefficients by calculating the substitution effect between locally produced and imported purchases. If we define the measure of the elasticity of substitution between locally produced and imported inputs of product i as:¹¹

$$\sigma_i = \frac{\Delta(a_{ij}^l/a_{ij}^m)}{(a_{ij,0}^l/a_{ij,0}^m)} \bigg/ \frac{\Delta(p_i^m/p_i^l)}{(p_{i,0}^m/p_{i,0}^l)} \quad (27)$$

then after a policy change or impact the new RPCs are given by:

$$a_{ij,1}^l = \frac{a_{ij,0}^l a_{ij,1}^m (1 + \Delta p_i^l) + \sigma_i (\Delta p_i^m - \Delta p_i^l)}{a_{ij,0}^l (1 + \Delta p_i^l) + \sigma_i a_{ij,0}^m (\Delta p_i^m - \Delta p_i^l)} \quad (28)$$

where $p_{i,0}^l = p_{i,0}^m = p_{i,0} = 1$ and σ_i is normalised to lie between 0 and 1 with 0 denoting no substitution and 1 denoting perfect substitution between local and imported goods.

In most impact situations at the regional level, it can be assumed that changes in local production will have no or negligible effect on import prices, so we can set $\Delta p_i^m = 0$. Specifying values for σ_i is more problematic because no data are available for estimation. Consequently, in this model, values for σ_i are imposed using best guess estimates, namely 0 for most service sectors and either 0.5 or 0.8 for the tradable sectors. The Trade Weighted Index provides the base level differential between the local and import price levels.

In addition, when adjusting the regional purchase coefficients, a penalty function is applied as a surrogate for capacity limitations in the case where the local price decreases relative to the import price thus resulting in increased demand for the local product. The constraint takes the form of a logarithmic function which becomes tighter as $a_{ij,1}^l$ approaches $a_{ij,1}^m$.

¹¹ Note this is different to the usually defined elasticity of substitution $\sigma_i = \frac{\Delta(x_{ij}^l/x_{ij}^m)}{(x_{ij,0}^l/x_{ij,0}^m)} \bigg/ \frac{\Delta(p_i^m/p_i^l)}{(p_{i,0}^m/p_{i,0}^l)}$ where $x_{ij,k}^l$ = local physical input from i to j in period k , $x_{ij,k}^m$ = imported physical input from i to j in period k , and the RPC is defined as $a_{ij}^l = \frac{p_i^l x_{ij}^l}{p_j x_j}$.

As a final step, the import row in the direct allocation table will have to be updated by the amount of the additional imports (positive or negative) due to the change in allocation of the regional flows into local and imported inputs.

A8. MODEL SOLUTION

The structural equations in this type of model cannot be solved analytically, because the input coefficients vary with the endogenous variables and thus also become endogenous. Hence, the solution procedure requires the use of an iterative recursive algorithm, such as the Gauss-Seidel method. The model is solved twice, with and without the activity of interest and the economic contribution of that activity on the local economy is calculated as the difference the two solutions.

The operational performance of the model, compared to the conventional input-output model, is determined in part by the productivity gains, both labour and capital, experienced by industries as they expand. This results in reduced unit factor costs and local product prices. If import prices are assumed to be unaffected by local production, then the reduction in local prices relative to import prices will see a shift towards locally produced inputs, thus further stimulating local production. The extent of these additional indirect and induced effects will not only depend on the relative shifts in local and import prices, but also the elasticity of substitution between local and imported inputs.

This has implications for the results of this type of model, particularly if compared with those from the conventional input-output model. If price effects are ignored, then we would expect that, while the output multipliers and effects may not be significantly different, income and employment effects should be smaller because of the marginal coefficients associated with labour productivity. This is because many industries, especially those that are more capital intensive and can implement further productivity gains, can increase output, particularly in the short run, without corresponding proportional increases in employment and hence income payments. However, when price effects are incorporated into the model, the direction of change becomes less clear, since these potentially can generate compounding or offsetting changes. If the import substitution elasticities are inelastic, then this will reinforce the downward effects on multipliers, but if the elasticities are large (elastic) then the price effects offset the productivity gains.

A9. LIMITATIONS

Empirical economic analysis is inevitably accompanied by some limitations on the interpretation of results. One limitation results from the nature of the data used in the model. These data, while drawn from the best estimates of the level and structure of the various types of economic activity making up the model, are in many instances representative rather than exact in nature. High levels of accuracy in terms of exactness cannot be guaranteed in an analysis of this type.

APPENDIX B: Methodology for Measuring Human Capital Effects

UOW graduates gain significant financial advantages over their non-graduate counterparts over their working lifetime. The question of how large this earnings 'premium' is, and to what extent the broader community also benefits from the individual's increased earning capacity, is an important element of a comprehensive assessment of UOW's economic impact.

Measuring the size of pecuniary returns to a UOW degree has been considered within the context of two measures:

- (1) Lifetime graduate premium relative to high school completion;
- (2) Return on a UOW degree (for graduates and the government).

B1. CALCULATING THE UOW GRADUATE EARNINGS PREMIUM

The first step in calculating the earnings premium of UOW graduates is to establish the *gross* income differential between degree qualified and Year 12 qualified workers within UOW's main operational area. Table B 1 provides a summary of the median gross income differential between degree qualified and Year 12 qualified males and females in the Wollongong region. We use unpublished 2011 Census data on median income of full-time workers in the Wollongong Statistical Region (including the local government areas of Wollongong, Shellharbour and Kiama) as the proxy as, although many UOW graduates leave the region for work and may settle in cities such as Sydney where incomes are higher than in Wollongong, (a) approximately 40% of graduates remain in Wollongong, and (b) it can be reasonably assumed that UOW graduates living in areas with higher earnings profiles will also incur higher general living expenses.

Our approach compares the median incomes of Wollongong residents employed *full-time* at the time of the 2011 Census. We used full-time employment as a selection filter to reduce the potential overstatement of the income. We took median income of full-time employed degree qualified residents of Wollongong. According to estimates derived from unpublished 2011 Census data, male degree holders residing in the Wollongong region and working full-time received a median annual income of \$75,504, with their female counterparts receiving a median annual income of \$47,008.

However, the commensurate median income of full-time Year 12 graduates in Wollongong was viewed as an unreliable estimate for our purposes, as it was about 70% lower than the degree qualified population. Instead, we apply derived an estimate of median annual income for full-time workers whose highest level of education is Year 12 completion using an assumed inter-group earnings differential of 45% between this group and degree holders. This differential is based on an Australian study by Leigh (2008), which estimated returns to a bachelor degree of around 40% (ability-adjusted), and is also consistent with other credible empirical findings internationally that estimate that degree holders earn between 45-55% more than their high school graduate counterparts in developed countries (OECD, 2012). This extra step improves the reliability of the median income differential comparison presented in Table B 1. Net incomes were calculated using the 2010/11 income tax rates (ATO website accessed Dec 2012).

Table B 1 Gross Income Differentials – Degree vs. Year 12

Education Level	Median Annual Income (Base: Wollongong Statistical Region)	
	Females	Males
Degree Qualified Workers (25-64yrs – FT workers only ¹)	\$47,008	\$75,504
Year 12 Qualified Workers (18-64yrs - FT workers only ¹ , assuming 45% differential ²)	\$32,419	\$52,072
Annual Gross Income Differential	\$14,589	\$23,432

Notes:

1. Including only full time workers removes the issue of part-time, casual earnings difference between groups, and reduces the impact of government payments in the data.

2. Following Leigh (2008) and the OECD (2012), we assume gross earnings differential between degree holders and high school graduates is approximately 45%.

Source: ABS Census of Population and Housing, 2011 – unpublished median income by qualification data.

In order to estimate the gross graduate lifetime premium of UOW graduates, we assume a male working lifetime of 40 years and a female working lifetime of 38 years - slightly lower than for males to account for the higher probability that female graduates will spend an amount of time out of the workforce for family reasons. Based on these assumptions, we calculate an average gross lifetime earnings premium of \$741,409 (\$554,370 for females and \$937,291 for males).

Table B 2 shows the calculations for estimating total income foregone during degree study at UOW. Again, gross earnings derived from unpublished 2011 Census data for the Wollongong Statistical Region. Specifically, we used the median male and female incomes of 18 to 24 year olds to calculate gross annual incomes, and then apply a 20% discount factor to account for the probability of unemployment during the three year study period. This discount factor was considered important considering the high level of youth unemployment generally and the extremely high youth unemployment in the Wollongong region in particular (refer to Table 1.1 on page 34).

After subtracting taxes and assumed income (to account for the probability that the average student will do some casual or part-time work during their study or perhaps receive some government assistance, such as Austudy) the final average income forgone per student over the period of a three year degree at UOW is estimated to be \$15,280 for females and \$16,144 for males.

Average annual HECS cost assumes up-front payment of fees for three years at the mid-level student contribution band (\$6,690 in 2011), giving a total direct fee cost over three year bachelor degree of \$18,683. The direct costs of education, such as student fees (excluding tuition), text books, transport and other direct costs was assumed to be \$1,500 per annum, or \$4,500 per student over the course of a three year degree at UOW. The total annual cost to the government per UOW degree is estimated at \$30,538, which is based on dividing the total government contribution by the number of domestic degree graduates per annum.

Table B 2 Estimates of Foregone Earnings (3 year degree)

	Median Income (18-24yrs)	
	Females	Males
A. Gross annual earnings (less 20% discount for unemployment risk) ¹	\$9,693	\$10,026
B. Gross income over study period (3 x A)	\$29,078	\$30,077
<i>less - Income tax</i>	<i>\$1,662</i>	<i>\$1,812</i>
<i>less - Medicare levy</i>	<i>\$436</i>	<i>\$451</i>
C. Average net income over study period	\$26,980	\$27,814
<i>less – notional net income (casual work/Austudy)</i>	<i>\$11,700</i>	<i>\$11,700</i>
D. Average income forgone	\$15,280	\$16,114

Note: 1. Based on median income data for Wollongong residents aged 18-24yrs who completed Year 12. Discount factor accounts for the probability of a period of unemployment.

Source: ATO; ABS Census of Population and Housing, 2011 – unpublished median income by qualification data.

B2. CALCULATING THE PRIVATE AND PUBLIC RETURN ON A UOW DEGREE

In order to calculate the private and public returns to a UOW degree, methodologically we have used an Internal Rate of Return (IRR) approach. This approach has the advantage of outlining the specific costs and benefits of undertaking a Bachelor degree at UOW, and weighing up the relative returns to both individuals and society. Various applications of this broad approach have been published in the Australian literature over the past two decades (for example, see Michael, 1996; Borland et al. 2000; Larkins, 2001; Borland, 2002; and Daly et al. 2012). Taking the gross annual earnings premium calculated in section B1 above, we calculate the Net Present Value (NPV) of future earnings at a 3% discount rate. Following Larkins (2001), the NPV of an 'average' 3-year UOW Bachelor degree is defined in our study as the discounted current value of future earnings (benefits), less the average opportunity cost of obtaining a three year UOW bachelor degree (as described in section B1), which was estimated at \$30,538.

Table B 3 Net Present Value of UOW Bachelor Degree

0% Discount Rate	Females	Males	Persons
Gross Earnings Premium (annual)	\$14,589	\$23,432	\$19,010
Interval (years in work)	38	40	39
NPV (annualised)	\$14,589	\$23,432	\$19,010
NPV (Lifetime)	\$554,370	\$937,291	\$745,831
3% Discount Rate	Females	Males	Persons
Gross Earnings Premium (annual)	\$14,589	\$23,432	\$19,010
Interval (years in work)	38	40	39
NPV (annualised)	\$8,635	\$13,541	\$11,088
NPV (Lifetime)	\$328,136	\$541,632	\$434,884
NPV less costs of UOW degree	\$297,598	\$511,094	\$404,346

The NPV of income tax payable on gross earnings was calculated as the discounted NPV of lifetime earnings multiplied by the marginal tax rate of 0.35. Tax on earnings and total private costs were subtracted from gross earnings to arrive at a final NPV private earnings premium of \$174,825 for female UOW bachelor degree graduates, \$312,763 for males and an average of \$243,794 overall. Government revenue from investment in UOW was calculated as the sum of HECS payments, plus the NPV of income tax payable on lifetime earnings premiums, plus an assumed tax rate of 0.1 on the final NPV private earnings premium (Larkins, 2001).

Finally, the IRR on a 3-year degree is calculated using equation (1), assuming a 40 year working life for males and 38 year working life for females:

$$\sum_{t=1}^3 \frac{Ct}{(1+r)^t} = \sum_{t=4}^{42(f)44(m)} \frac{Rt}{(1+r)^t} \quad (1)$$

where:

Ct = opportunity costs of university degree in year t;

Rt= benefit of university degree in year t;

r = rate of return.

B3. LIMITATIONS

Estimates of earnings at the regional level are far from perfect. 2011 Census median weekly income for full-time employed males and females was the best available data at the region level. However, this data source has several limitations that need to be stated, as they may artificially inflate earnings estimates. First, Census income includes more than employment earnings - other forms of income (such as government payments, investment income etc) are also included. Whilst the inflationary effect is not great, this nonetheless means that earnings estimates will be slightly higher than were non-work income excluded. Second, although we have only included data for the proportion of the population employed full-time as at the Census date, it is likely that median annual income (which is derived by multiplying median weekly income by 52) will in all likelihood vary to some degree over a working lifetime with paid hours worked. Third, there is an implicit assumption in using current median incomes that expected future income will remain constant – in real terms – over a working lifetime. Borland et al. refer to this as a “partial equilibrium exercise”, in which variation in the supply and demand of skilled (degree qualified) labour is assumed to have no impact on the costs of a degree or future earnings outcomes (2000, p11). Finally, in the time available, the team was not able to disaggregated median incomes by age group or degree discipline. However, recent research within the Australian context (Daly et al. 2012) has shown that age and discipline of study are important factors in determining the rate of return on a Bachelor degree – factors that aggregate estimates of median annual income mask to some extent. Future updates of this report will attempt to address the above limitations where possible.

APPENDIX C: Measuring the Productivity Effects of UOW Research

A research intensive university, such as UOW, can be expected to play an important role in a regional economy through the creation and transmission of knowledge. As mentioned previously this can take place through two means – building of human capital (teaching programs) and creating and transferring knowledge through research. These, amongst other factors, contribute to regional TFP, or Total Factor Productivity, which is a variable that accounts for changes in total output (or gross regional product at the regional level) not caused by traditional measured inputs (labour and capital). Should the increase in output be more than that accounted for by inputs of labour and capital, then the residual is called TFP and can be taken as a measure of an economy's long-term technological change or technological dynamism. TFP, therefore, cannot be measured directly. Instead it is a residual, often called the Solow residual (Solow 1957), accounting for changes in total output not caused by increased inputs.

To capture the contribution of university research to regional TFP the following approach is proposed but as yet not started, providing a major extension to the results already derived from the earlier static analysis and giving a more complete picture of the economic impact of UOW. Equation 1 presents a Cobb-Douglas production function for the Illawarra economy, where total regional output (Y) depends upon regional total-factor productivity (A) (calculated as a residual), regional capital input (K) and regional labour input (L). The respective shares in production of capital and labour are given by α and β . An increase in either A, K or L will lead to an increase in output. While capital and labour input are tangible, total-factor productivity is more intangible as it will depend upon factors that are both tangible (technology) and intangible (human capital).

$$Y = A \times K^{\alpha} \times L^{\beta} \quad (1)$$

Once TFP (A) has been calculated it is then important to identify key explanatory variables explaining changes in it. Using the approach of Khan and Luintel (2006)) we can postulate the following functional form for Illawarra regional TFP (A) as given by equation 2:

$$A = f(S^b, S^p, S^f, S^{uni}, H, Z, F^1, F^0, X^h, M^h, U) \quad (2)$$

Where:

S^b – business knowledge stock

S^p – public sector knowledge stock (excluding university)

S^f – foreign firm knowledge stock

S^{uni} – university knowledge stock

H – human capital stock

Z – public infrastructure related knowledge stock

F^1 – stock of inward FDI/regional gross fixed capital formation

F^0 – stock of outward FDI/regional gross fixed capital formation

X^h – high tech manufactured exports/total regional exports

M^h – high tech manufactured imports/total regional imports

U – regional business cycle

A fixed effect dynamic (autoregressive) equation for TFP (A) will then be estimated. This approach has a number of advantages. It will be based upon regional data; it will facilitate identification of the absolute and relative contribution of the university to regional TFP and facilitate an evaluation of the relative importance of individual contributions that make up the university knowledge stock to TFP. This framework will facilitate identification of components of the university knowledge stock that are under-performing and those which are over-performing, and thereby enable identification of policy priorities. A major disadvantage of this approach is that it is data intensive. Data series for a number of the above variables will need to be generated on an annual or quarterly basis over a number of years. Data for many of these variables is simply not published. As a consequence a number of measurable proxies may need to be used instead, with the aim of generating robust and reliable econometric results. If successful, it should also be possible to quantify the contribution of UOW research to gross regional product.

APPENDIX D: Research Team

Centre for Small Business & Regional Research

The Centre for Small Business & Regional Research (CSBRR), located at the University of Wollongong, specialises in research and analysis of regional economic development issues. It also provides wide-ranging expertise in issues of concern to policy makers and small and medium-sized enterprises. The Centre brings together commercially experienced researchers from across the University of Wollongong into a cross-disciplinary team that provides access to leading expertise in applied econometric research and consultancy for regional businesses and governments. CSBRR also works with researchers from other institutions and bodies both in Australia and internationally.

Guy West

Dr. West is one of the foremost input-output modelers in Australia. He has over 30 years of experience in regional economics, much of it spent at the University of Queensland, and specialises in applied quantitative economics. Over his career, Dr. West has been published in the top journals in econometrics (e.g. *Econometrica*) and regional science (e.g. *Regional Studies*), and has been involved in over 200 collaborative government and industry research projects, both in Australia and internationally, in the area of economic impact analysis, planning, development and economic policy for federal, state and local government and the private sector. Current research interests include the theory and application of inter-industry models particularly in an integrated spatial econometric framework, the nature of economic structure at the regional and national levels, and regional economic projection, planning and growth. This revolves primarily around the study and identification of economic structure, involving concepts such as fundamental economic structure, structural change and evolution. Accomplished computer programmer and has developed a number of specialised economic models for analysing structural change, as well as more generalised software for interindustry analysis. Author of input-output modeling software which is now regarded as the Australian standard for regional input-output impact analyses, and is used extensively by universities in Australia, US, UK and Europe. Customised versions of this software have been developed for various organisations, including the Queensland Tourist and Travel Corporation and the Queensland Events Corporation. Author of input-output multiplier definitions and conventions which are now used throughout Australia, including the Australian Bureau of Statistics.

Charles Harvie

Charles is the Director of the Centre for Small Business and Regional Research, and Associate Professor in the UOW School of Economics. Dr. Harvie is internationally respected for his expertise on policy impacts on small and medium enterprises, and has presented a number of invited keynote addresses on SMEs at international conferences throughout Asia, including that in China, Japan, Malaysia, Vietnam, Indonesia and Australia. He is currently employed as a consultant by the ASEAN research unit to conduct a study into enhancing the role of regional SMEs in Asian production networks.

Brad Braithwaite

As a research fellow at CSBRR, Brad undertakes research for a range of UOW stakeholders on economic modelling and applied market research issues. He has nearly a decade and a half of experience consulting to all levels of government and industry in applied economics, statistics, and market research. Brad has delivered major studies across the government, banking and finance, media, health, tourism and community sectors. His corporate experience includes senior management roles in the research consulting, insurance, tourism and retirement living sectors.

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— STRATEGIC PLAN, 2013-2018 —

VERIFICATION NOTICE:

The methodology, analysis and findings of this study have been independently verified by:

Deloitte Access Economics

Deloitte.

and

The Regional Research Institute



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