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KPMG Advisory

Developing productivity elasticities for estimating WEBs in Australia – Scoping Study

Final Report

February 2015

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Dr Mark Harvey
Department of Infrastructure and Regional Development
GPO Box 594
Canberra, ACT 2601

16 February 2015

Dear Mark,

Developing productivity elasticities for estimating WEBs in Australia – Scoping Study

We have been engaged by the Department of Infrastructure and Regional Development (DIRD) to prepare a scoping study to develop productivity elasticities and parameters for estimating Wider Economic Benefits (WEBs) of transport projects in Australia. We attach our final report in connection with providing these services.

Scope of work

Our work has been performed in accordance with the Scope Section of the Contract dated 17 March, 2014; and any subsequent changes to scope as agreed with you during the course of the engagement.

Final report

As required under the scope of works, this report is in final form and has been prepared on the basis of our work commencing on 17 March 2014 and carried out up to 16 February 2015.

Procedures

Our work commenced on 17 March 2014 and was carried out up 16 February 2015. We have not undertaken to update this report for events or circumstances arising after this date (e.g. issuance of revised or new information).

Information

In undertaking our work we had access to information provided by DIRD, ABS and other public and private agencies. We have indicated in this report the sources of the information presented.

Distribution

This report has been prepared exclusively for DIRD in relation to the National Guidelines for Transport System Management Revision. This final report must not be used for any other purpose or distributed to any other person or party, except as set out in our contract, or as otherwise agreed by us in writing.

Yours sincerely

Paul Low
Partner

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Disclaimer and limitations

Advisory in nature

As a professional services firm, KPMG is required to comply with various professional standards relating to the performance of particular types of engagements where applicable. The services provided in connection with this engagement comprise an advisory engagement which is not subject to Australian Auditing Standards or Australian Standards on Review or Assurance Engagements, and consequently no opinions or conclusions intended to convey assurance will be expressed.

If we were to perform additional procedures or an audit in accordance with Australian Auditing Standards or a review in accordance with Australian Auditing Standards applicable to review engagements, other matters might come to our attention that would be reported to you. Any references to "review" throughout this report are not being used in the context of a review in accordance with assurance and other standards issued by the Australian Auditing and Assurance Standards Board.

Inherent limitations

This report has been prepared as outlined in the Scope Section of the Contract dated 17 March, 2014. The services provided in connection with this engagement comprise an advisory engagement, which is not subject to assurance or other standards issued by the Australian Auditing and Assurance Standards Board and, consequently no opinions or conclusions intended to convey assurance have been expressed.

No warranty of completeness, accuracy or reliability is given in relation to the statements and representations made by, and the information and documentation provided by, Commonwealth Government of Australia, its management and personnel, its other consultants and stakeholders, consulted as part of the process.

KPMG will indicate within its report the sources of the information provided. We have not sought to independently verify those sources unless otherwise noted within the report.

KPMG is under no obligation in any circumstance to update this report, in either oral or written form, for events occurring after the report has been issued in final form.

The findings in this report have been formed on the above basis.

Third party reliance

This report is solely for the purpose set out in the Scope Section and for Commonwealth's information, and is not to be used for any other purpose or distributed to any other party without KPMG's prior written consent.

This report has been prepared at the request of the Commonwealth Government of Australia in accordance with the agreed Scope in KPMG's proposal dated 26 February, 2014 and under terms and conditions as agreed in the contract dated 17 March, 2014. Other than our responsibility to the Commonwealth Government of Australia, neither KPMG nor any member or employee of KPMG undertakes responsibility arising in any way from reliance placed by a third party on this report. Any reliance placed is that party's sole responsibility.

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01

Introduction

Historically, most transport projects have been appraised using a conventional Cost Benefit Analysis (CBA) framework. Typically this entails the quantification of changes in generalised travel costs to existing and new users (i.e. the direct benefits of the new project due to travel time savings), as well as the likely impacts on environmental externalities and accidents etc. (these impacts may overall be positive or negative), contrasted against the cost of building the project - with all benefits and costs being discounted using an appropriate discount rate.

The CBA for transport projects has historically largely been based on the assumption of perfect competition. The presence of additional market imperfections (beyond those externalities typically identified in a standard CBA), means that the generalised cost of travel does not equate to the marginal social cost of transport supply. This divergence between price and marginal social cost gives rise to potential for additional impacts (benefits or costs) that are not captured in the conventional CBA.

These impacts, which have been typically excluded from 'conventional' CBA in the past, are now commonly referred to as 'wider economic benefits' (WEBs). Over the past few years, WEBs have entered the project evaluation framework for significant transport infrastructure projects.

The current emphasis on the productivity impacts of infrastructure has heightened the need for robust estimation of WEBs. Australian jurisdictions are currently developing the 'productivity metrics' concept, which emphasises 'productivity impacts' in infrastructure prioritisation and decision making.

The Australian jurisdictions are also in the process of revising the National Guidelines for Transport System Management (NGTSM). The revised NGTSM will provide the guidelines on the use and estimation of WEBs in Australia. The NGTSM Review Steering Committee has also been tasked to work with Transport for NSW to further develop the productivity metrics concept.

In addition to detailed guidance on the approach to estimating WEBs, rigorous estimation of WEBs also requires a robust set of locally based productivity elasticities. This is not currently available in Australia. Productivity elasticities that are currently available in Australia can be best described as approximate having been derived from highly aggregated/ synthesised data.

1.1 Project scope

On behalf of the NGTSM Revision Steering Committee, the Department of Infrastructure and Regional Development (DIRD) engaged KPMG to prepare a scoping paper for estimating Australian specific productivity elasticities. Specifically, KPMG's scope included:

- Developing a framework for deriving robust productivity elasticities and estimating WEBs in Australia
- Identifying data that can be realistically assembled from existing sources
- Developing a methodology for a recommended approach to estimating *agglomeration elasticities* including necessary regression analysis

- Providing recommendations on the 'interim' approach to assessing WEBs that can be used for practitioners for project evaluation and assessment whilst the elasticities and parameters for the recommended approach is being developed by the NGTSM revision committee
- Providing a list of issues that need to be addressed in estimating elasticities for the recommended approach
- Providing commentary on the timing of the update of elasticities for the recommended approach
- Providing commentary on a broad methodology including appropriate datasets and approach to assess WEBs associated with *labour market deepening* and *imperfect competition*
- Estimating the cost of implementing the recommended approach. This includes the cost associated with generating and obtaining relevant data and costs for a WEBs specialist/ econometrician.

1.2 Project approach

KPMG's broad approach to deliver on the above scope included:

- Background research to document the latest development on WEBs in Australia and overseas (especially UK and NZ);
- Discussions with the UK based WEBs specialists to understand latest thinking and emerging knowledge base on the approach to WEBs modelling;
- Documenting the initial findings and draft recommendations; and
- Conducting a workshop with key representatives from NGTSM Revision Committee as well as Federal, State and Territory transport stakeholders to further develop and obtain buy-in on the recommended and interim approach.

1.3 Remainder of this Paper

Following this introduction, the remainder of the paper is structured as follows:

Section 2 – Wider Economic Benefits: provides a brief overview of WEBs, the different types of benefits that are incorporated in WEBs and the relevance of these WEBs to Australia.

Section 3 – Estimating Productivity Elasticities: sets a framework to assess WEBs and details an approach to robustly quantify relevant productivity elasticities. This includes readily available data, necessary regression analysis and statistical tests as well as a list of issues that need to be addressed in estimating elasticities.

Section 4 – Recommendations: provides the recommendations for developing the elasticities and parameters for WEBs estimation in Australia.

02

Wider Economic Benefits

2.1 CBA and WEBs

As noted in the introduction, CBA for transport projects has historically largely been based on the assumption of perfect competition and no market imperfections. The presence of additional market imperfections (beyond those externalities typically identified in a standard CBA), means that the conventional CBA has the potential to either under or over-estimate the true cost/ benefits of the project being assessed. These impacts, which have been typically excluded from 'conventional' CBA in the past, are now commonly referred to as 'wider economic benefits' (WEBs). Over the past few years, WEBs have entered the project evaluation framework for significant transport infrastructure projects. The existence of WEBs for transport projects have been historically acknowledged, but they have not been typically quantified until recently.

While the theoretical foundation for WEBs is well established, the quantification of WEBs is an emerging field and the guidance material in the UK (generally deemed to be most advanced) continues to be updated regularly. A recent development has been the relabelling of 'wider economic benefits' as 'wider impacts' (WI). This is in recognition that not all transport projects generate positive impacts. Depending on the specifics of the project being evaluated, it may generate positive (benefits) or negative impacts (costs). For sake of simplicity, we continue to use the term WEBs in this paper.

2.2 Types of WEBs

There are four principal types of WEBs that are attributable to transport projects, including[1]:

- WB1 – Agglomeration economies;
- WB2 – Labour market deepening;
    - WB2a – Labour supply impacts;
    - WB2b – Move to more or less productive jobs;
- WB3 – Output change in imperfectly competitive markets; and
- WB4 – Increased competition.

Each of these benefits is briefly discussed below.

2.2.1 WB1 – Agglomeration economies

'Agglomeration economies' (WB1) refers to benefits which flow to firms and workers located in close proximity (or agglomerating). The concept of agglomeration is not new. However, agglomeration economies started receiving increased attention following the work of Paul

[1] United Kingdom, Department for Transport, 2006, Wider economic benefits and impacts on GDP

Krugman[2]. Krugman examined the centripetal and centrifugal forces that concentrate and disperse economic activity across economic space (geography). This highly influential work has generated a whole field of research known as New Economic Geography.

Agglomeration economies can be used to explain the very reason for existence of cities[3]. Consider for instance following questions:

- Why does urbanisation continue to occur despite higher land/real estate values, increased congestion, increased pollution, etc?
- Why is urbanisation occurring at a higher pace now than it did even two or three decades ago?
- Why do certain firms choose to locate in certain regions within cities?
- Why, despite higher rents, do certain types of businesses tend to locate in the central business districts more so than others?

The answer to these questions lies in the existence of agglomeration externalities/ economies. In each of these examples, the productivity benefits from agglomeration exceed the cost of agglomeration.

There are three principal sources of agglomeration economies including:

- **Input sharing** – depends on the existence of external economies. Opportunity to source intermediate inputs from a larger number of suppliers through external economies leads to lower cost (better quality inputs at the same price or same quality inputs at a lower price).

  Some economists separate labour market pooling from input sharing. However, labour is a specialist input and can be conceptualised as part of input sharing. Workers find it beneficial to reside in locations with, or in close proximity to, a larger number of firms as it offers variety of employment opportunities and lowers the risk of unemployment. Similarly, firms benefit from access to a larger pool of workers, resulting in better matching of skills.[4]

- **Knowledge/technological spillovers** – occur when firms benefit from other firms' knowledge/technology without needing to pay for it. This occurs when information is exchanged between firms without an accompanying financial transaction (in contrast to input sharing where a financial transaction is necessary). This tacit sharing of knowledge can occur through firm collaboration and joint ventures, through workers switching jobs over time (and bringing knowledge and experience from previous jobs) and organised networking and chance encounters.

  Whilst formal knowledge sharing can occur over large distances, there is significant evidence in the literature that it occurs more frequently and is of higher value when undertaken amongst economic agents that are located close together, and especially when it is undertaken face-to-face. Despite the digital revolution, most of the high-value knowledge exchange still takes place on a personal level. Some exchanges/ transactions can, and do, occur remotely, however the finalisation of most high-value exchanges still occur at the face-to-face level.

  This is especially true for knowledge-based professional services. For example, leading knowledge-based and creative employers such as Google and Facebook invest significant funds to make the workplace comfortable and easier to work. This is in recognition of the

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[2] Krugman, P, 1991, Increasing Returns and Economic Geography, Journal of Political Economy, Vol. 99(3), p 483-499.

[3] Refer to Duranton, G. and Puga, D., 2004, Micro-foundations of urban agglomeration economies, in J.V. Henderson and J.F. Thisse, eds., *Handbook of Urban and Regional Economics, Volume 4,* North Holland, New York.

[4] Note that this is related to WB2b discussed in Section 3.2 below.

productivity benefits of working face-to-face and chance encounters and impromptu meetings facilitated by the workplace[5]. Whilst these examples refer to intra-firm knowledge sharing and its impact on productivity, similar principles apply to inter-firm and inter-industry knowledge spillovers.

- **Output sharing** – economies of scale from output sharing occur when purchasers of goods can choose from a range of sellers (supplementary goods) and sellers of goods are able to capitalise on customers attracted by other sellers (complementary goods). A simple example of output sharing for both supplementary and complementary goods is shopping centres. This is the primary reason why shops in indoor shopping malls or in the centre of high street centres are typically more profitable (despite higher rents) than shops located in the outskirts of these centres.

By lowering cost of travel, efficient transport networks can have a significant impact on agglomeration/ density[6]. Lower generalised transport costs result in enhanced accessibility/ connectivity and facilitates increased formal and informal interaction. This in turn enables increased input and output sharing and, more importantly, knowledge spillovers, the principal source of agglomeration economies in the modern economy.

Over the longer term, accessibility improvements also lead to changes in land-use. Some firms (and households) move into areas that offer superior accessibility to large labour pools (or employment pools) which further enhances agglomeration and facilitates labour market pooling.

2.2.2 WB2 – Labour market deepening

Labour market deepening refers to two distinct impacts:

- WB2a – Increased labour supply; and
- WB2b – Move to more or less productive jobs.

Note that only the tax wedge component of the changes in wages arising from changes in labour supply can be added to the conventional CBA without double counting the benefits.

WB2a – Increased labour supply

In deciding whether to work, a worker weighs, amongst other factors, travel costs associated with the job against the wage received from the job. Therefore, changes in transport costs can affect the incentives of individuals to work, and may contribute to workers working longer or encouraging the under-engaged and disengaged workforce into active employment. This will result in an increase in overall labour supply in the economy.

This increased labour supply benefit (WB2a) from transport infrastructure investment can be quantified by measuring the resultant increase in wages across the economy. Where data on wages is not available, value added or gross domestic or state product (GDP/GSP) can be used as a proxy.

WB2b - Move to more or less productive jobs

'*Move to more or less productive jobs*' (M2MPJ) (WB2b) refers to how improved transport accessibility may provide employers with access to a broader range of employees (to recruit the most suitable skills), and employees with access to a wider range of jobs better suited to their skills. The benefit associated with this 'greater fit' will lead to an improvement in productivity as

[5] The Australian Financial Review, 27 February, 2013, *Yahoo's working from home ban criticised,* http://afr.com/p/technology/yahoo_working_from_home_ban_criticised_1jnDWMEqlRitfy82QNnduJ

[6] Density here does not refer to a simple measure such as the employment density per square kilometre, as it does not adequately reflect the phenomenon of agglomeration. The concept of density in this instance incorporates the generalised cost of travel and the scale of economic activity at the destination (i.e. the economic importance of travel to the destination).

employers employ workers who are better suited to their requirements, and employees move to jobs that best meet their skills and expertise. Better skills matching/ alignment, in turn, results in workers being more productive and able to produce the same or more output for a given cost. Ultimately, this will lead to an increase in GSP and GDP.

The literature on Search and Match theory[7] helps explain this phenomenon. In simple terms, increased employment opportunities within a worker's travel budget mean that a worker can search through a larger range of jobs and best match their skills to the jobs on offer, thus maximise their wage. Increased employment opportunities also mean that, over time, they are able to work in a number of different jobs/firms, which provides them with varied and valuable experiences and, in turn, makes them more productive.

There are two transmission mechanisms through which a transport project can enable better skills alignment. These include:

- **Increased employment opportunities brought within a worker's travel budget due to lower travel time*.*** The literature on the topic confirms that most workers have a pre-determined travel time budget for commuting. It is within this pre-determined travel budget that workers search for suitable employment. Consequently, a firm may not be able to match the best available skills with the job requirements. If a transport project lowers travel cost and therefore brings more jobs within the travel budget then it will facilitate better skills matching.
- **Increased employment opportunities brought within travel budget due to changes in location of firms and households in response to changes in accessibility.** For firms, moving operations to areas that offer superior accessibility reduces transaction costs in dealing with suppliers and distributors, as well as improving access to much needed workforce skills. These same dynamics apply to households. They adjust location to maximise opportunities for employment, education, recreation and other services. However, these choices are made within a more constrained environment, reflecting family ties and historic neighbourhood affiliations.

  The change in location of firms and households, in turn, changes employment opportunities available within a stated travel budget which can either enhance or worsen skills matching.

2.2.3 WB3 – Imperfectly competitive markets

Under an imperfectly competitive market, prices may exceed production costs and output is less than optimum. '*Output change in imperfectly competitive markets*' (WB3) arises from the reduction in transport costs allowing for an increase in production or output of goods or services that use transport. The existence of a price-cost mark up under imperfect competition implies that the reduction in transport cost results in higher profits.

This impact is not captured in conventional CBA as it assumes that markets are perfectly competitive.

The assessment of this benefit requires an estimate of the total user impacts to business journeys (time, money costs, reliability gains/losses etc.), which can be estimated using the outputs from the transport model and the CBA framework. The degree of imperfect competition in the marketplace that allows for realisation of these benefits is then accounted for through the application of a coefficient/ uprate factor. The selection of appropriate uprate factor is critical and is equal to the price-cost margin multiplied by the elasticity of demand.

[7] Stigler, George J. (1962), 'Information in the labor market'. Journal of Political Economy 70 (5), Part 2, pp. 94-105 and McCall, John J. (1970), 'Economics of information and job search'. Quarterly Journal of Economics 84, pp. 113-126

2.2.4 WB4 – Increased competition

Any transport project which makes an area significantly more accessible has the potential to increase market competition (WB4) in that area. Significant enhancement in accessibility and therefore reduction in transport cost allows new firms to enter the market and effectively compete with incumbent firms.

The theory behind WB4 is that reducing transport costs opens up areas to increased competition, driving production efficiencies, which in turn results in lower prices for consumers.

Despite initial support for this benefit, the UK Department for Transport has now concluded that it did not expect significant WEBs under this category in the UK. Any transport projects in developed countries, which are characterised by reasonable transport access, are unlikely to generate significant enough travel cost savings to have any material impact on competition.

Consequently, the approach to estimating benefits from increased competition is not discussed in the following section.

Case study (1): North West Rail Link NSW

The North-West Rail Line (NWRL) is a 23-kilometre rail line in Sydney. The project encompasses 15 km of railway in tunnels, 4 km of above ground railway track ("skytrain"), a further 4 km of bridges, embankments and surface track, eight new stations, approximately 4,000 commuter car spaces and a new train stabling facility. The project is expected to cost $8.3 billion.

Preliminary economic appraisal undertaken by the NSW government in its submission to Infrastructure Australia in 2011 showed an indicative BCR in the range of 0.9 to 1.15 and an NPV of $144 million. The conventional economic benefits include a reduction in travel time, road decongestion, vehicle operating cost savings, rail de-crowding and externality benefits.

The WEBs of the NWRL Project were quantified in a study undertaken, primarily via the impact of the project on employment redistribution in the Sydney Metropolitan Area. The key finding of the study was the existence of additional WEBs associated with redistribution of employment activities, as well as gains in labour productivity linked to agglomeration effects arising from these redistributions.

The WEBs add an additional BCR of 0.07 on top of the traditional economic benefits. The WEBs have been estimated at $506.7 million. **The majority of benefits were estimated to be from the agglomeration (63.4%), with some benefits from increased output from business travel time savings in imperfectly competitive markets (15.9%), and increased labour supply (20.7%)**

(Source**:** Legaspi, J., Hensher, D. & Wang, B., 2014. Estimating the Wider Economic Impacts of transport investments: investigating the case of Sydney North West Rail Link project. *Paper submitted to Transport Research A (revised)).*

03

Quantifying WEBs

3.1 WB1 – Agglomeration Economies

Conceptually, the agglomeration economies can be estimated as:

WB1 = (Elasticity of productivity with respect to effective density) x (Change in the effective density of the area due to the project) x (Gross Output or Gross Value Added in the area).

Algebraically, this takes for form of:

$WB1 = \{ \sum_j EIP_j \times (EMP_j \times \text{Gross Output or Value Added}_j) \} \times (\Delta ED / ED)$

where,

EIP_j = Elasticity of productivity with respect to effective density (ED) on industry j,

EMP_j = work-place based employment in industry j,

Gross Output or Value Added $_j$ = Gross Output or Value Added (depending on the selection of elasticity estimation approach) per worker in industry j,

ED = effective density of employment, and

ΔED = change in ED due to transport project.

3.1.1 Estimation strategies

As part of this study, select team members of this project met with a number of UK based practitioners to understand the contemporary thinking on WEBs estimation and lessons learnt from the application of the UK WEBTag recommended approach to estimating WEBs. The below discussion incorporates the latest thinking into various estimation strategies.

The estimation strategies for each variable in the above equation are discussed below.

Effective Density (ED)

Effective density (or accessibility) is a key measure for estimating agglomeration economies as well as some of the other WEBs. There are several approaches for measuring effective density, ranging from simple metrics (the number of jobs accessible within a 45 minute journey time for example) to more complex measures reflecting connections to 'opportunities' such as other businesses, employees or customers. The selection of an appropriate measure for effective density is also dependent on the benefit being estimated. For instance, to estimate agglomeration economies, the Business to Business (B2B) accessibility is more important; whilst for WB2a – Increased Labour Supply the accessibility to labour market, i.e. effective labour market catchment, is more important (refer to section 3.2 below).

The suggested approach to derive B2B effective density (B2BEd) follows. For a workplace destination, the importance of access to other businesses in another zone is determined by:

- the generalised cost of the business trip between the origin-destination pair;
- the number of jobs in the zone; and

- a distance decay factor to incorporate the willingness to accept the generalised cost of business trips to those zones.

Needless to say, the above measure for B2BEd needs to incorporate modal split. A weighted average B2BEd can be estimated using proportion of trips undertaken by each mode between each origin-destination pair as weights.

The distance decay function represents the declining interaction between areas as the effective distance between them increases. It can be incorporated by using observed travel patterns using trip distribution matrices from the transport model. Using demand data, the share of people that are willing to accept different levels of generalised costs when making business trips is calculated. This reflects how far (in terms of generalised cost) people currently travel given prevailing conditions such as wage rates and the dispersal of businesses.

The distance decay functions can then be applied to the generalised cost data to estimate the share of people willing to make business trips between different zone pairs.

The B2BEd for a particular transport mode and zone is the sum of the B2BEd with all other zones in the model (including itself). The specific equation for estimating B2BEd is as follows:

$$B2BEd\ i,y,m\ = \sum_{i} Decay\ i,j,m\ \times Employment\ j,y$$

The overall B2BEd can then be derived by weighting the B2BEd of each mode by the proportion of trips undertaken on that mode, as follows:

$$B2BEd\ i,y,all\ modes\ = \sum_{i} Weight\ i,j,y,m\ \times B2BEd\ i,y,m$$

Where:

i= journey origin zone
j= journey destination zone
m=transport mode
y= year
$Decay_{i,j,y,m}$ = Decay curve for generalised journey costs for business travellers between zones i and j in year y by mode m.
$Weight_{i,j,y,m}$ = Proportion of trips by business travellers between zones i and j in year y by mode m.

B2BEd is an origin measure of effective density, meaning that it measures effective density of employment from a given origin.

The zonal level B2BEd derived above can then be used to estimate weighted average B2BEd for each of the SA2s[8] in Australia. The SA2 level B2BEd can be used in the regression analysis to estimate agglomeration elasticities. Although B2BEd is measured at the SA2 level, all other variables in the regression will be at the firm level. SA2 has been selected as the appropriate geographical area for productivity elasticity analysis as it is the lowest level of geography for which industry productivity data can be made available without compromising data quality (refer to section 3.1.2 for further discussion on this).

Change in Effective Density due to the project (∆ED)

[8] Australian Standard Geographical Standard developed by ABS uses the Statistical Area (SA) to collate and disseminate all statistical data. All of Australia is divided into SA level 4 (SA4) areas of which there are a total of 88. The next level down is SA level 3 (SA3) of which there are 333 regions and SA level 2 (SA2) of which there are 2,196 regions. SA2 is broadly equivalent to the Statistical Local Area previously used by ABS and familiar to most people. The next level down is the SA level 1 and mesh block.

ABS advises that the availability at SA2 level is subject to the successful proof-of-concept. Nevertheless, it expects that the data can be made available at SA2 level for larger, more populous States. It is not able to comment on the suitability of the data for less populous States at this stage.

The same approach as above needs to be applied to estimate B2BEd for each SA2 (or SA4 or 3 where data for SA2 is not available from ABS) under the Do Minimum and Project Case scenarios for each of the future modelled years and the marginal change in effective density estimated.

Elasticity of Productivity (EIP j)

Key to robust estimation of agglomeration economies includes location specific agglomeration elasticities for each industry that are:

- theoretically valid;
- derived in a statistically robust manner; and
- control for other variables that impact on industry productivity, including factors such as education, experience, occupation and that address issues of sorting and endogeneity.

It is important that Australia specific agglomeration elasticities are estimated and included in the updated NGTSM. In the absence of Australian specific elasticities, a number of studies have adapted UK/ NZ elasticities for Australian conditions. This approach is suboptimal as agglomeration economies are 'place specific' and depend on the economic structure of the area being investigated. Consequently, the UK and NZ elasticities provide a measure of a firm's impact on productivity due to changes in effective density, in the UK and NZ given their economic structure. Even within Australia, due to differences in the economic structure, different cities are expected to have different agglomeration elasticities.

Geography of analysis

The literature on agglomeration economies demonstrates that the agglomeration impacts are 'place' specific and as such different cities (more accurately economic regions) will have different agglomeration elasticities. Consequently, it is recommended that the agglomeration elasticities are estimated for each metropolitan area. In relation to regional areas in each State and Territory, it may be necessary to further dis-aggregate the region on the basis of functional economic areas. For example, under the metropolitan area versus regional area definition, Gold Coast and Sunshine Coast regions will be included in the regional area. However, Gold Coast, and to a lesser degree Sunshine Coast regions have a fairly advanced economy that are characterised by high value industries. Including Gold Coast and Sunshine Coast with other regional areas in Queensland has the potential to provide biased elasticities.

Regression specification

The specific regression equation to be estimated will depend on the statistical properties of the firm level productivity data as well as estimated B2BEd. As part of this engagement, we have investigated the possibility of obtaining firm level, longitudinal data. Assuming that this data becomes available, a pooled data regression will need to be estimated. In line with the UK and NZ studies on estimating agglomeration elasticities, we propose that a gross output production function is used instead of a value added function. This is because the value added for select firms can be negative, which in turn will mean that these firms will need to be excluded from the analysis and lead to selection bias (logs of negative numbers are undefined).

The broad equation to be estimated may take the following form[9]:

$$\ln(GrossOutput_{ind,SA2,t}) = \beta_0 + \beta_1 \ln(B2BEd_{SA2,t}) + \beta_2 \ln(labour_{ind,SA2,t}) + \beta_3 \ln(capital_{ind,SA2,t}) + \beta_4 \ln(inventories_{ind,SA2,t}) + \beta_5 \ln(inmediateinputs) + \beta_6 \ln(age_{ind,SA2,t}) + \beta_7 \ln(occ^1_{ind,SA2,t}) + \cdots + \beta_n \ln(occ^n_{ind,SA2}) + \varepsilon_t$$

Where:

β_n = coefficient

[9] Subject to data availability, the gross output in the above equation may be changed to gross value added per worker. In which case, the labour, capital and inventories can be removed from the right hand side of the equation.

B2BEd = business to business effective density

Labour = labour cost

Capital = capital cost

Inventories = cost of inventories

Intermediateinputs = cost of intermediate inputs

Age = mean age of workers in the industry, as a proxy for level of experience

Occ = occupational mix (i.e. % of jobs in occ^1 in $industry_i$ at time t for each SA2)

ε = constant term

If the firm level data is not available, then the labour and capital variables in the above equation will need to be removed; and a reduced form equation can be estimated.

The regression equation will need to be estimated for each industry. It is recommended that the equation is estimated for each of the 19 ANZSIC 1 digit industry classifications. However, it is likely that this may not be feasible for all geographic regions (potentially due to lack of SA2 level data) in which case a higher level grouping or broad super-industry groups might be necessary.

Statistical tests

In addition to the range of general statistical issues that the analysis will need to address, there are a number of issues specific to the estimation of agglomeration elasticities. These include:

- **Controlling for firm heterogeneity and sorting effects** – if firms with high productivity are disproportionately located in areas with high effective density then failing to control for this heterogeneity will lead to biased parameter estimates and will result in overstated agglomeration elasticities. There are a number of statistical approaches in which this can be controlled for and the appropriate approach will depend on the statistical properties and actual regression specification. Nevertheless, dummy variables are deemed to be better at controlling for these effects. For the NZ study, Mare and Graham (2009) included dummy variables for each local industry to control for higher productivity firms sorting themselves into areas with higher effective density.

- **Controlling for endogeneity** – endoegeneity issues arise when the error is naturally correlated with the observed x and y variables in a model. Therefore, there is an important, unobserved correlation which is endogenous to the model. Endogenous models are likely to under-estimate the impact of unobserved variables, and over-estimate the impact of observed variables. For example, a model that predicts a person's health based on physical activity but neglects to control for the impact of genetics on both health and physical activity will over-estimate the impact of physical activity on health. Endogeneity may arise when a firm decides to select an input from a particular input supplier because of the higher productivity of that provider. The choice of the selected inputs may not be observable in the data or by the econometrician. Not controlling for these issues will result in a correlation between the error terms. Endogeneity can be addressed by approaches such as inclusion of fixed effects or instrumental variables to control for these impacts.

- **Inclusion of lag and time effects** – the impact of change in effective density may impact a firm's productivity with a time lag and may be pertinent for select industries. The omission of lag effects in these instances will result in under-estimation of the impact of effective density on productivity. Similarly, the relationship between effective density and productivity is not constant; evidence suggests that the impact of effective density on productivity is increasing over time[10] and is especially true for select knowledge based industries. As part of the econometric analysis, one of the key tasks will be to identify the lag effects and lag structure, and therefore what should be included in the requirements to estimate elasticities.

[10] Department of Transport (2012), *Job density, productivity and the role of transport*, Victoria. See explanation on page 12.

Time lag effects will be tested explicitly in the regression and if assessed to be statistically significant, incorporated into the analysis.

- **Diagnostic tests** – a range of diagnostic statistics will need to be undertaken to assess the robustness of the estimated model. The exact tests to be undertaken will depend on the exact equation as well as the type of regression analysis undertaken. Nevertheless, the basic tests that should be undertaken and reported on include tests on statistical significance, correlation coefficient, multi-collinearity and heteroskedasticity.

Sectoral workplace based employment (EMPj) and Sectoral Value Added/ Gross Output per employment (GDPj)

Sectoral employment data are required as part of the transport modelling. To ensure consistency, the sectoral employment used for agglomeration economies should be the same as those used for transport modelling. Sectoral gross output or value can be estimated using firm level data held within ABS.

3.1.2 Data for estimating agglomeration elasticities

The estimation of agglomeration elasticities requires three principal datasets. These include:

- Travel time and trip matrices – available from strategic transport models held by jurisdictions;
- Land use inputs (i.e. employment by industry, population and households) underpinning transport modelling – available from transport models; and
- Small area, detailed productivity data.

It is expected that data from the transport models would be available from:

- relevant jurisdictions' strategic transport models for metropolitan areas; and
- where available using the relevant jurisdictions' strategic transport models' outputs, or alternatively travel time matrices using Google Earth or GIS layers on road networks (with link descriptors) from jurisdictions and estimation of travel time matrices;[11]

Current approach and limitations

Typically, the approach used for assessing agglomeration economies in Australia has included:

- Using agglomeration elasticities from UK/ NZ/ international benchmark;
- Regression analysis based on *synthesised* small area (typically SA2/ SLA) specific productivity estimate regressed against effective density. Synthesised data uses employment by industry and wage (and other variables) to estimate 'value added' (or Gross regional Product) and labour productivity for SA2/ SLA; and
- Estimated coefficients applied to future marginal change in effective density to estimate agglomeration benefit

Regression analyses are often undertaken on one independent variable, being effective density, and a constant and an error term. Such an approach does not control for other factors that impact on labour productivity such as education, experience and occupation to name a few. This in turn leads to biased elasticities. Regression analyses that simply identifies correlation between productivity and effective density is not sufficient. Causality tests on the regression are

[11] It is noted that the datasets proposed for travel time and trips matrices in regional areas may only be feasible for 2011, and therefore the regression analysis will be using 2011 data only (cross-section data only as per Graham's work).

not necessarily undertaken and reported. The regression analyses also do not control for endogeneity, sorting/ displacement effects[12] and reverse causality.

Diagnostic statistics are also not typically reported, making it difficult to assess the robustness of the coefficients and thereby providing confidence on the analysis. Agglomeration economies under the ‘with project’ scenario are estimated using the future marginal change in effective density and seldom incorporates a distance decay factor, thereby overestimating the agglomeration benefits arising from small improvements in effective density.

Lastly, the lack of readily available, fine-grain, firm level longitudinal data on business performance and other characteristics limits the accuracy of WEBs analyses in Australia.

Detailed sectoral, geospatial productivity and employment data is necessary to estimate the relationship between changes in effective density and agglomeration economies. As part of this study a number of data sources were investigated. The most appropriate and fit for purpose datasets include:

- readily available, but aggregated data from ABS Census and National Accounts;
- customised dataset from ABS; and
- Linked Employer-Employee Database.

Customised dataset from ABS – recommended approach

The key dataset required to rigorously estimate productivity elasticities would include a longitudinal dataset for firms by industry categories and location of operation. Specific data items include:

- Turnover by source of revenue (specifically separating revenue from productive activity to other activities such as asset sales);[13]
- Capital inputs measured as cost of capital services which includes depreciation, capital rental and leasing costs and the user cost of capital;[14]
- Cost of labour and intermediate inputs;[15]
- Debts and liabilities;
- Other costs by type including interest, insurance and taxes,
- Value of inventory held;[16]
- Net revenue;
- Employment by occupation by type of labour and hours worked
- Wages bill; and
- Other overhead costs on labour.

Along with the relative data-points, ABS will also need to report an estimate of the Relative Standard Error and any relevant information on missing or under-reported data points.

Ideally the data should be as fine-grained as possible. However, the balance between detailed data and confidentiality restrictions need to be considered to ensure the extracted data is not as fine-grained to restrict any meaningful interpretation after randomisation.

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[12] Sorting/ displacement effects refers to range of market and non-market forces leading to higher productivity firms being concentrated in key locations (with higher effective density for instance) while the lower productivity firms are pushed to the periphery. Not controlling for such sorting effects can lead to over-estimation of agglomeration economies.

[13] Subject to data availability, the gross output in the above equation may be changed to gross value added per worker. In which case, the labour, capital and inventories can be removed from the right hand side of the equation.

[14] See footnote 11

[15] See footnote 11

[16] See footnote 11

Alternatively, the econometric analysis could be undertaken by ABS internally. ABS however will need support from a WEBs specialist to direct the work and ensure consistency with the theoretical base as well ensuring that the lessons learnt from previous such exercises (globally and from within Australia) are incorporated.

Time-series data (5 years from 2006 to 2011, being the relevant Census years and for which most transport models in Australia are calibrated to) is recommended. For the purpose of estimating elasticities, only the 2006 and 2011 data can be used. Nevertheless, the time series to cover the intervening years between 2006 and 2011 (if feasible) may be extracted to facilitate statistical tests necessary to understand the statistical properties of the dataset such that any issues are appropriately controlled for in the regression analysis.

Transport for NSW (TfNSW) had previously engaged with the ABS to ascertain if firm level, longitudinal, geo-coded data could be made available. As part of this study, KPMG followed up on TfNSW's previous engagements with ABS.

The ABS has advised that it will investigate a number of data sources, such as the Australian Industry Survey, ATO's Business Income Tax and Business Activity Statement, Counts of Business including Entries and Exists and Geography and Transport catchment area boundaries.

ABS envisages that data can be provided at SA2 level for larger, more populous States. At this stage, ABS is not able to advise if the data can be produced at SA2 level regional areas or at a level lower than SA4 for less populous States and Territories until a full quality assessment on the data output is undertaken.

ABS will then apply an acceptable approach to control for businesses with multiple operating locations, a key concern with businesses that are head quartered at a geographic location and have multiple operating locations across Australia.

It is recommended that a close working relationship between the WEBs specialist and ABS project manager is established to ensure the extracted data is fit for purpose and sufficiently detailed to enable robust estimation of elasticities.

Benefits

The ABS sourced dataset is expected to provide a fine-grained longitudinal, geo-coded, firm level data to enable robust and defensible estimation of agglomeration elasticities.

The dataset (along with other information readily available in Australia) will also enable estimation of other elasticities and parameters necessary for assessing WB2 and WB3.

Limitations

Limitations include:

- Relatively high cost when compared to using aggregated ABS data;
- A small risk that the feasibility study (i.e. proof of concept) to be developed by ABS identifies issues which may mean that the ABS is not able to undertake the econometric analysis; and
- A small risk that the proof of concept identifies issues which mean that the data cannot be released by ABS at SA2 level even for more populous regions

Updates to productivity elasticities

Due to the rapid changes in the economic structure and geography, we recommend that estimated elasticities are updated regularly. We recommend updating the productivity elasticities at the time of the release of new census data, i.e. every 5 years. The selection of 5 years for updates ensures that sufficient time has elapsed for structural changes in the economy to have fully transpired. It is also not too long a time period such that estimated elasticities become completely obsolete. The choice of Census years ensures that relevant transport modelling and land use data necessary to estimate elasticities and parameters are available.

It is worth noting that the cost associated with updating the elasticities using this approach will be substantially lower. This is because ABS will not need to prove the concept, will have the framework in place and therefore will only need to run the queries and extract the data.

Similarly, the WEBs specialist will need to simply check the analysis using updated data, check for consistency and undertake other relatively simple statistical tests.

Wage Function Framework – Interim approach

It is worth noting that the elasticities and parameters using the recommended approach will not be available for at least 12 months. An alternative to using the customised dataset from ABS is to use the ABS Census data on Employment by Industry by Wage and Employment by Occupation from Working Population Profile (i.e. based on place of work not place of usual residence). This approach will use the Wage Function Framework which uses the economic theory that labour is compensated commensurate to its productive capacity.

This is a relatively cost efficient approach to assessing agglomeration benefits and can be used by the transport practitioners for the purpose of project evaluation and assessment whilst the elasticities and parameters for the recommended approach is developed by NGTSM revision committee.

Benefits

The ABS Census, Place of Work profile is readily available and have been utilised in various forms for estimating agglomeration elasticities by others within Australia. These include KPMG, David Hensher, and Roman Trubka to name a few. The WEBs estimates using elasticities based on the Wage Function Framework reduces the risk of over-stating the benefits.

Limitations

Besides the limitation of using aggregated data, the exclusion of returns to capital can provide a conservative estimate of agglomeration economies. This is because the Wage Function Framework does allow for the returns to owners of capital from productivity improvement.

Costs

This is a low cost option as data acquisition costs are not necessary.

Linked Employer-Employee Database - longer term solution

ABS is currently developing a plan to produce a “Linked Employer-Employee Dataset” (LEED). This will include combining the Australian Tax Office (ATO) data with Australian Business Register (ABR) data. LEED will provide the most robust dataset for estimating productivity elasticities. However, this is a long term endeavour being undertaken by ABS that is expected to take around 2 years to develop the proof of concept and another year or so to have the data ready for release. ABS is currently developing a business case to obtain funding for developing LEED.

3.2 WB2 – Labour Market Deepening

This category of wider economic benefits has two elements:

- The impacts generated from more people choosing to work due to changes in effective wage rates, i.e. after commuting cost wage (WB2a). This includes existing employees working longer and under-engaged and dis-engaged workers choosing to actively participate in the labour market due to higher effective wage rates; and
- The impacts generated from working in more productive jobs (WB2b).

WB2 captures the tax wedge associated with the impacts generated from WB2a and WB2b. Past studies have assessed the relevant tax wedge as being equivalent to 21% for WB2a (the applicable average tax rate for average annual income) and 32.5% for WB2b (the marginal tax rate applicable for increase in marginal income). Overall, average tax wedge for Australia has been estimated at 28%[17].

3.2.1 WB2a – Increased labour supply

There are two transmission mechanisms for increased labour supply due to reduction in generalised cost of travel:

- Existing employees choosing to work longer hours; and
- Under-engaged and disengaged workers choosing to actively participate in the labour market.

There is significant evidence to suggest that workers typically do not increase the hours worked in response to small changes in commuting time[18]. The increase in effective wage rate (i.e. after transport cost wage rate) is more likely to encourage the under-engaged and dis-engaged into active employment.

Notwithstanding the above, the ABS sourced dataset (for WB1), specifically data on hours worked, will allow the ABS and WEBs specialist to validate this hypothesis.

Estimation of the welfare impact from increases in labour supply can be conceptualised as follows:

$$WB2a = (dGC_{commuting}) \times ELS_{ind,\,SA2} \times WAP_{SA2} \times AW_{ind,\,SA2} \times tax\ wedge$$

where,

dGC = the change in average generalised cost of commuting

ELS = labour supply elasticity

WAP = working age population

AW_i = Average wage[19] per worker in industry i

The variables required for WB2a will be readily available if the data for the recommended approach for WB1 is obtained from ABS.

Key to estimating this benefit is assessing the labour supply elasticity (ELS). The estimation of labour supply elasticity will require an assessment of the changes in effective density. The estimated effective density will be different to that estimated for WB1 as the connectivity measure needs to assess the connectivity of labour force to employers. For a particular

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[17] http://comparativetaxation.treasury.gov.au/content/report/html/06_Chapter_4-07.asp

[18] Department for Transport (2005), *Transport, Wider Economic Benefits, and Impacts on GDP*, UK Government. See notes 245 to 247.

[19] Where average wage data is not available, average gross output can be used as a proxy.

workplace destination, the number of potential employees within the catchment of a workplace is determined by the:

- generalised cost of the commuting journey from the origin zone to the workplace;
- number of potential employees in the origin zone; and
- willingness of potential employees to accept the generalised cost of commuting.

Similar to the B2BEd, a distance decay factor needs to be incorporated into the effective density measure using trip distribution matrices from the transport model. Using demand data, the share of people that are willing to accept different levels of generalised costs when making commuting trips can be calculated. This reflects how far (in terms of generalised cost) people are willing to travel for work given prevailing conditions such as wage rates and the dispersal of businesses.

The distance decay functions can then be applied to the generalised cost data to estimate the share of people willing to make commuting trips between different zone pairs.

The overall labour force to business effective density (L2BEd) for a particular zone is the sum of the L2BEd with all other zones in the model (including itself). The specific equation for estimating L2BEd is as follows:

$$L2BEd\ j,y,m\ = \sum_{i} Decay\ i,j,m\ \times Working\ age\ population\ i,y$$

Where:

i= journey origin zone
j= journey destination zone
m=transport mode
y= year
$Decay_{i,j,y,m}$ = Decay curve for generalised journey costs for commuting between zones i and j in year y by mode m.

L2BEd is a destination measure of effective density, meaning that it measures effective density of the labour force from a given destination.

Similar to the SA2 level B2BEd, the zonal level L2BEd derived above can be used to estimate weighted average L2BEd for each of the SA2s (or SA4 or 3 where data for SA2 is not available from ABS). The SA2 (or SA4 or 3) level L2BEd can be used in the regression analysis to estimate labour supply elasticity.

Current approach and limitations

WB2 has not been routinely quantified in Australia. Where quantified, the approach typically has entailed:

- Estimating increased ***labour supply*** as a result of a decline in generalised cost of travel (and therefore effective take home pay being after tax wage less transport cost) by applying an assumed labour supply elasticity of between 5 and 10 per cent. This, together with an average tax rate on personal income is used to estimate the welfare benefits from increased labour supply. This aims to capture impacts generated from more people choosing to work due to changes in effective wage rates, i.e. after commuting cost wage (WB2a). This includes existing employees working longer and under-engaged and dis-engaged workers choosing to actively participate in the labour market due to higher effective wage rates

A key limitation of the current approach is the use of assumed elasticities with respect to labour supply. These limitations should be addressed to provide more confidence in the acceptability and use of labour market deepening benefits in project appraisals. Selected approaches to addressing these limitations include:

- Estimating location specific labour supply elasticity using labour mobility data and ABS labour force data on hours worked to estimate labour supply impacts.

- Investigating availability of customised dataset from ABS and/ or ATO on firm level labour input to estimate labour supply impacts of transport accessibility improvements.
- Alternatively, using a Computable General Equilibrium (CGE) model to understand the dynamic interaction between leisure demand and labour supply. The CGE model incorporates labour supply, leisure and consumers' welfare (utility) function. The CGE model can be augmented to specifically account for changes in transport cost and resultant effective take home pay in the labour and leisure functions. A change in transport cost enabled by a transport project can then be incorporated into the CGE model and simulations undertaken to understand the impact on labour supply.

Customised dataset from ABS – recommended approach

The regression analysis will use the data from the ABS sourced for WB1 along with the estimated L2BEd and relevant census data to estimate the labour supply elasticity. No additional dataset is necessary to undertake the analysis. Specific data that will be used from the ABS includes:

- Employment by occupation by type of labour and hours worked[20]
- Wages bill; and
- Other overhead costs on labour.

Interim approach

The following alternative approaches can be used in the interim by transport practitioners whilst the recommended approach is developed by NGTSM revision committee:

- Option 1 – Approach adopted by Transport for NSW (TfNSW): Estimate increased labour supply as a result of a decline in generalised cost of travel (and therefore effective take home pay being after tax wage less transport cost) by applying labour supply parameter of between 5 and 10 per cent.
- Option 2 – CGE modelling: Utilise CGE modelling to estimate labour market impacts due to changes in effective take home pay.

3.2.2 WB2b – Move to More or Less Productive Jobs

The broad framework for estimating WB2b includes:

$$WB2b = ELS_{ind} \times dW_{ind} \times EMP_{ind,\,SA2} \times AW_{ind,\,SA2} \times \text{marginal tax wedge}$$

where,

ELS_{ind} = percent change in employment in an area divided by the percent change in commuting costs. Commuting costs are calculated using a weighted average for all OD pairs, weighted by the proportion of trips from each origin.

dW_{ind} = percent change in wage due to move to more/ less productive jobs

AW_i = Average wage[21] per worker in industry i.

The estimation of ELS_{ind} will require an estimate of the effective density similar to L2BEd. However, unlike L2BEd, the workers to business effective density (W2BEd) will be based on employed workers and not working age population.

Current approach and limitations

As noted above, WB2 has not been routinely quantified in Australia. Where quantified, the approach typically has entailed:

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[20] The objective of this measure is to understand how existing (employed) workers change their hours worked in response to changes in commuting cost.

[21] Where average wage data is not available, average gross output can be used as a proxy.

- Estimating benefits based on assumed percent of employees who switch jobs due to transport accessibility improvements to those who are estimated to switch jobs in a year, and assumed percentage increase in wage. This together with marginal tax rate is used to estimate the welfare benefits from move to more productive jobs.

A key limitation of the current approach is the use of assumed elasticities with respect to labour supply and move to more productive jobs. These limitations should be addressed to provide more confidence in the acceptability and use of labour market deepening benefits in project appraisals. Selected approaches to addressing these limitations include:

- Move to more productive jobs should be ideally estimated using a Land Use and Transport Interaction (LUTI) model. Since such a model is not readily available for Australian cities, an alternative is to adopt a traditional urban planning based approach to understand likely impact on land use (and the implications for changes at zonal level for workforce and employment) as a result of accessibility changes where relevant. This information can then be used to understand the combined impact of land use changes and travel time changes on the 'job budget' (i.e. change in number and types of jobs available within a travel time budget) and the estimated elasticity of number of workers that will move to more productive jobs.

Customised dataset from ABS – recommended approach

The W2BEd along with data on employment by occupation and wage bill from the ABS (sourced for WB1) can be used to estimate ELS_{ind}. No additional dataset is necessary to undertake the analysis. The objective of the regression analysis will be to isolate the propensity of existing workers to move to higher/ lower wage jobs in response to changes in W2BEd.

Interim approach

The following alternative approaches can be used in the interim by transport practitioners whilst the recommended approach using detailed firm level data is developed by NGTSM revision committee:

- Option 1 – TfNSW approach: Estimate based on TfNSW assumptions of percent of employees who switch jobs due to transport accessibility improvements to those who are estimated to switch jobs in a year, and assumed percentage increase in wage. TfNSW research shows that 11.7% of workers switch jobs in any one year. Of those employees changing jobs, 1% would be due to improved transport accessibility, with an average productivity increase of 10%.

- Option 2 – CGE modelling: Utilise CGE modelling along with the estimated land use impacts of transport project to estimate M2MPJ impacts.

3.3 WB3 – Imperfectly Competitive Markets

According to Venables et al (1999)[22], WB3 can be estimated as:

$$WB3 = V \times (BTS + RG)$$

where,

V = ELD*(P-MC)/P = an uprate factor which is the product of the price cost margin ((P-MC)/P) and the elasticity of demand (ELD),

BTS= Business time savings

RG=Reliability gains to business.

An estimate of BTS will be provided from the transport models, and this will be an element of the conventional CBA. RG as well will be an element of conventional CBA where quantified. This implies that the uprate factor of V is the key for the estimation of WB3.

The price-cost margin necessary for estimating V can be estimated by dividing gross output by labour and capital costs as well as cost of intermediate inputs for the relevant sectors. As these variables will be compiled for the calculation of WB1 using the ABS sourced dataset, there will be no additional data requirements. Each sectoral price-cost margin can then be weighted to calculate a region-wide price-cost mark up.

A demand function for the each of the industry and region can be specified to estimate or calibrate the elasticity of demand for the products of transport using industries using ABS publications (including Modellers database[23] and price indices) and demand side information from a CGE model database (such as the KPMG CGE model). KPMG CGE models contain estimates of demand elasticities at a very detailed level of products and can be used to calibrate elasticities for various geographical regions.

Current approach and limitations

Typically, the approach used for assessing output change in imperfectly competitive markets in Australia has included the application of an assumed elasticity with respect to output change due to a change in generalised cost for business travel. Based on UK and other international evidence, the elasticity have been assumed to be around 10 percent.

A better approach would entail obtaining customised datasets from ABS and/ or ATO on firm level data on changes in output (business production related turnover) and regressing these against historical changes in generalised cost (whilst controlling for other variables) to obtain industry and location specific elasticities.

CGE database – recommended approach

A CGE model can be used to simulate the impact of changes in total production cost (i.e. including transport cost) on industry level economic output for each geographical area.

Interim approach

It is suggested that the following alternative approaches be used in the interim:

- Option 1 – TfNSW approach: Estimate based on TfNSW approach which recommended using 10% as the appropriate uprate factor (V)

[22] Venables, A.m M. Gasiorek, D. Newbery, P. McGregor, R. Harris and S. Davies (1999), The Welfare Implications of Transport Improvements in the Presence of Market Failure – the Incidence of Imperfect Competition in UK sectors and regions, DETR.

[23] The Modeller's database is an ABS database (Cat. No. 1364.0.15.003) for economic modellers.

- Option 2 – CGE modelling: Utilise CGE model to simulate the impact of changes in total production cost (i.e. including transport cost) on industry level economic output.

Case study (2): Crossrail UK

Crossrail is a 118-kilometre railway line under construction in England. In common with other major planned transport investments, a formal business case was prepared for Crossrail, quantifying where possible – and comparing – the benefits and costs of building the railway.

The WEBs of Crossrail was also estimated, with analysis demonstrating that the impact of Crossrail on the wider economy would be substantial. The increase in UK GDP derived from the implementation of Crossrail is focused on enabling the growth of Central London employment.

In total, Crossrail's wider impacts were estimated to be between £6bn and £18bn in welfare terms (at 2002 prices), including increased tax receipts, exceeding the initial public sector funding required to build Crossrail. Including the WEBs in the appraisal increased the BCR from 1.87 to between 2.73 and 3.05 (using UK wide values of time as applied by the Department for Transport) and from 2.55 to between 3.47 and 4.91 (using London values as applied by Transport for London).

Expressed in terms of impacts on GDP, the wider impacts are worth up to £42bn in 2002 prices or £50bn in 2010 prices.

(Source: Department for Transport, 2010. *Crossrail business case: Summary report,* London: DfT.)

3.4 Costs and timing

ABS has advised that it will require $52,500 to undertake the scoping study for the development of customised datasets and WEBs elasticities and parameters for WB1, WB2 and WB3.

ABS has further estimated that it will cost around $140,000 to undertake a feasibility analysis (Stage 1), including variable construction, preliminary modelling and analysis and preliminary assessment of the quality, confidentiality and risks (refer to Appendix A for the ABS' paper on estimating WEBs elasticities and parameters and Appendix B for further detail on the cost estimate provided by the ABS).

ABS estimates that a budget of $160,000 should be set aside for undertaking econometric modelling to estimate the agglomeration (WB1) and WB2 elasticities and associated reporting.

Moreover, an indicative budget of around $150,000 should be set aside for ABS to develop gross output estimates for small areas (SA2).

In total, it is expected that ABS may require around $500,000 (excluding GST) to undertake the work associated with compiling the necessary data and undertaking econometric analysis (under guidance of an experienced WEBs specialist, see below) to assess the elasticities and parameters for assessing WB1 and WB2.

Additionally, a WEBs specialist should be budgeted to work with the ABS and NGTSM Revision Steering Committee to develop a methodology paper, define the statistical tests and regression analysis to be undertaken, testing diagnostics of regression and to appropriately document the results in an overarching WEBs report. The WEBs specialist is also expected to develop the elasticities and parameters for estimating WB3 (see Appendix C for further information on the indicative scope and fee estimate for WEBs specialist).

Table below summarises the estimated costs for different components as well as anticipated time to undertake the work.

Summary of resource requirements

Scope item	Cost ('000)	Time (months)
ABS scoping study: WB1, WB2 and WB3	$52.5	0.5
ABS Stage 1: Feasibility analysis	$138.5	6
ABS Stage 2a: Econometric work for elasticities (WB1 and WB2)	$157.8	6
ABS Stage 2b: Small area gross output estimates	$150.0	3 (concurrently with Stage 2a)
Total, ABS	$498.8	Approx. 12 months
WEBs specialist/ consultant (Methodology paper and strategic advice on WB1 and WB2, estimation of WB3 parameters and development of overarching WEBs report)	$186.0	12 months (concurrently with ABS engagement)
Grand total	**$684.8**	**Approximately 12-14 months**

This suggests that around 12 -14 months will be required to implement the recommended approach and submit relevant materials to NGTSM revision committee for consideration and inclusion in the updated guidelines.

04

Recommendations

The key recommendations and conclusions arising from the scoping study are summarised below.

Recommendation 1: Recommended approach

It is recommended that the customised, firm level dataset be developed by the ABS and used for estimation of WEBs related productivity elasticities and parameters in Australia. Our recommendation is based on the fact that:

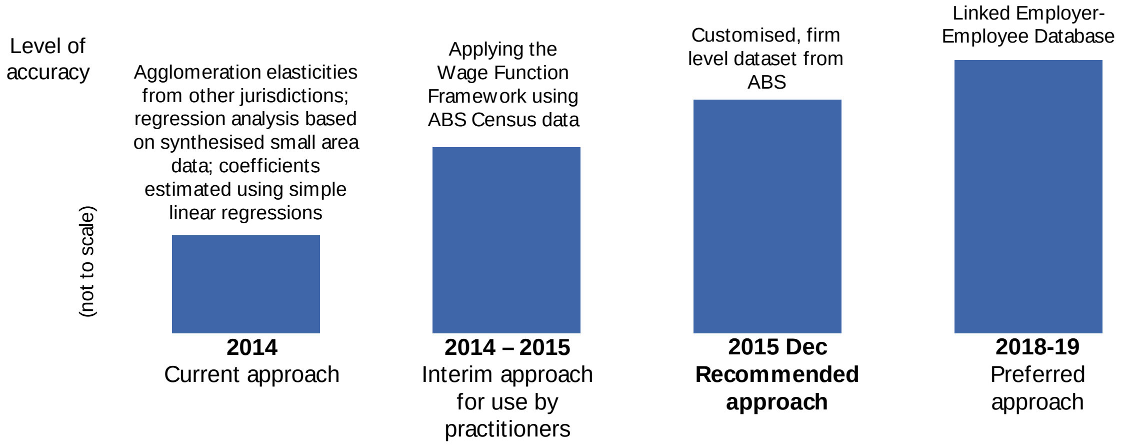
- Use of firm level data is considered the best practice approach to estimating elasticities and parameters necessary for estimating WEBs;
- ABS has indicated that it can undertake a proof of concept to develop the dataset and undertake econometric analysis[24]. It expects to develop the firm level data within 6 months and econometric analysis will take a further 6 months;
- The dataset will also enable estimation of relevant elasticities for assessing WB2 – Labour Market Deepening; and
- CGE modelling can be readily applied to develop the elasticities for estimating WB3 – Imperfect Competition for each region across Australia.

Whilst the NGTSM revision committee is developing the above recommended approach, it is recommended that the transport practitioners use the Wage Function Framework to estimate elasticities and parameters and adopt these to assess agglomeration economies.

This interim approach using the Wage Function Framework is based on the economic theory that labour is compensated commensurate to its productive capacity. Majority of the data required to estimate WEBs using Wage Function Framework is readily available from the ABS Census. This data can be utilised to estimate agglomeration elasticities by practitioners within Australia. This also presents a low cost option that can be adopted by practitioners in the interim and will ensure that all projects are assessed and prioritised using a consistent approach.

Longer term and subject to LEED data from ABS becoming available in the next few years, we recommend that the productivity elasticities using LEED be estimated at an appropriate time.

[24] Please note that the ABS may encounter difficulties in developing the custom dataset. This may impact on both the duration and cost of the project. In addition, the ABS has the option of terminating the project at any time if intractable difficulties are encountered.



Recommendation 2: Interim approach

As the recommended approach will take at least 12 months for implementation, it is recommended that in the interim, a Wage Function Framework which uses the economic theory that labour is compensated commensurate to its productive capacity be used for estimating agglomeration elasticities.

For WB2a and b and WB2, the following of the two approaches can be applied in the interim.

WB2a – Labour Supply

- Option 1 – Approach adopted by Transport for NSW (TfNSW): Estimate increased labour supply as a result of decline in generalised cost of travel (and therefore effective take home pay being after tax wage less transport cost) by applying labour supply elasticity of between 5 and 10 per cent.
- Option 2 – CGE modelling: Utilise CGE modelling to estimate labour market impacts due to changes in effective take home pay

WB2b – Move to More Productive Jobs

- Option 1 – TfNSW approach: Estimate based on TfNSW assumptions of percent of employees who switch jobs due to transport accessibility improvements to those who are estimated to switch jobs in a year, and assumed percentage increase in wage. TfNSW research shows that 11.7% of workers switch jobs in any one year. Of those employees changing jobs, 1% would be due to improved transport accessibility, with an average productivity increase of 10%.
- Option 2 – CGE modelling: Utilise CGE modelling along with the estimated land use impacts of transport project to estimate M2MPJ impacts.

WB3: Imperfectly competitive markets

- Option 1 – TfNSW approach: Estimate based on TfNSW approach which recommended using 10% as the appropriate uprate factor (V)
- Option 2 – CGE modelling: Utilise CGE model to simulate the impact of changes in total production cost (i.e. including transport cost) on industry level economic output

Recommendation 3: Update timings

It is recommended that the productivity elasticities and parameters are updated every five years and upon the release of census data. The selection of 5 years for updates ensures that sufficient time has elapsed for structural changes in the economy to fully transpire. It is also not too long a time period such that estimated elasticities become completely obsolete.

It is worth noting that the cost associated with updating the elasticities using the ABS sourced dataset under the recommended approach will be substantially lower. This is because the ABS will not need to prove the concept, will have the framework in place and thereby will only need to run the queries and extract the data.

Similarly, the WEBs specialist will need to simply check for consistency and undertake other relatively simple statistical tests.

Recommendation 4: Long term, preferred approach

Subject to LEED data from ABS becoming available in the next few years, we recommend that the productivity elasticities using LEED be estimated at an appropriate time.

Recommendation 5: WEBs Specialists

An experienced WEBs specialist, with extensive experience in undertaking spatial econometric analysis, particularly in relation to transport and land use intensification projects be engaged to undertaken the econometric analysis. As required by the project brief we have identified the following firms in Australia with this expertise. These include:

- KPMG
- PwC
- Ernst & Young
- SGS Economics and Planning

In addition to the professional services providers, there are a select group of academics who have undertaken research on WEBs in Australia. These include David Hensher and Roman Trubka.

There are also a number of professional service providers and academics in UK with relevant experience in estimating productivity elasticities for transport projects. These include:

- Volterra Partners
- Steer Davies Gleave
- Spatial Economics Research Centre
- Dan Graham

Recommendation 6: Working arrangements between ABS and WEBs Specialist

It is recommended that a close working relationship between the WEBs specialist who is selected to advise on the WEBs elasticities and parameter estimation and ABS project manager responsible to manage the data collection and econometric analysis for WEBs is established. This will ensure that the extracted data is fit for purpose and sufficiently detailed to enable robust estimation of elasticities. It will also ensure that the lessons learnt from elasticity estimation in Australia as well as UK and NZ are incorporated within the estimation technique that will be applied by ABS.

A.

Appendix A

ABS scoping paper

Scoping Paper for a Possible Consultancy on the Wider Economic Benefits Analysis of Transport Projects

Prepared by the Analytical Services Unit, Analytical Services Branch, ABS

August 2014

1. Introduction

The Department of Infrastructure and Regional Development (DIRD) has asked the Australian Bureau of Statistics for assistance in (1) constructing a firm-level dataset and running a firm-level regression and (2) constructing small area estimates of output, which will allow for the estimation of the Wider Economic Benefits (WEBs) of transport projects.

This document provides a brief description of the ABS understanding of the department's requirements, key issues to be addressed, some preliminary assessment of the nature and scope of the work, and the suggested way forward.

2. Background

The DIRD is interested in the WEBs of transport projects to better understand and assess the links between transport investments and economic benefits that are not captured by traditional cost-benefit analysis. Among these benefits is what is known as agglomeration economies. These are positive externalities derived from the spatial concentration of economic activity. The externalities arise from increased opportunities for input sharing, including that of labour, technological spillovers and output sharing.

The DIRD also indicated interest in the research direction for measuring the welfare effects of transport investments that arise from labour market deepening and increased output in imperfectly-competitive markets.

3. Description of the DIRD requirements

The DIRD requires assistance in estimating the parameters that are needed in measuring agglomeration economies (WB1).

WB1 is calculated as:

WB1 = (elasticity of productivity wrt effective (employment) density) x (change in the effective density of the area due to the infrastructure project) x (gross output in the area) (Equation 1)

where effective density refers to a measure of the concentration of employment in an area adjusted for the size of the area and the distances or cost of travel between areas.

In order to obtain the elasticity of productivity with respect to effective (employment) density, the DIRD is proposing to adopt an approach where effective density is added into a production function, together with labour, capital and intermediate inputs (Graham 2005; Mare & Graham 2010).

The production function will be estimated via a regression approach, where the resulting coefficient for effective density is the elasticity measure that is needed for the calculation of WB1.

$$\ln(GrossOutput_i) = \beta_0 + \beta_1 \ln(B2BEd_{ind,area}) + \beta_2 \ln(labour_i) + \beta_3 \ln(capital_i)$$
$$+ \beta_4 \ln(Intermediateinputs_i) + \beta_5 \ln(age_i) + \beta_6 \ln(occ_i^1) + ... + \beta_{n+5} \ln(occ_i^n) + \varepsilon_i$$

(Equation 2)

where

i denotes firm; *ind* and *area* signify industry and area of interest.

To be able to estimate the above production function (Equation 2), DIRD requires a dataset that contains the appropriate firm-level data for the following indicators:

Table 1. List of variables

1. An output measure, e.g. turnover
2. value of inventory held
3. net revenue
4. capital inputs

5. cost of labour and other labour overheads
6. cost of intermediate inputs
7. debts and liabilities
8. other costs by type
9. employment by occupation by hours worked
10. age
11. occupation type

The firm-level regression will be run in such a way it produces the required elasticity estimates (of effective density) by industry or broad industry category for the eight capital cities, and probably a broader level of geography for rural areas, depending upon the sample size, quality and confidentiality restrictions of the data.

In order for the DIRD to calculate the WB1 (Equation 1), a measure of gross output at a small area level is needed. DIRD is therefore asking the ABS to also produce SA2 level estimates of gross output.

Thus this possible consultancy will look at producing two outputs for DIRD:

1. Constructing a firm level dataset and estimating Equation 1. Because of restrictions to firm-level data access, the estimation will be run inside ABS. Only the modelling results can be provided to DIRD; and

2. Constructing SA2 level data of gross output.

The ABS will define each of the data items in Table 1 in accordance with the System of National Accounts concepts and standards. Note that the DIRD will calculate the effective (employment) density variable themselves using their transportation model, and will provide this to the ABS in order to estimate Equation 1 in-house.

The initial discussions between DIRD and ABS also discounted the provision of time series or longitudinal data, as these are not available. ABS will look into which cross-sectional data will be most appropriate or feasible for estimating Equation 1.

The DIRD is also asking ABS to look into the other measures of wider economic benefits, specifically those coming from labour market deepening (WB2) and imperfect competition (WB3). The impact of transport investments via WB2 channel is perceived to be a result of increased in labour supply due to improved take-home pay of workers or improved accessibility to a larger labour market that necessitates better skills matching. WB3 captures the additional benefits resulting from a wedge between value placed on additional production (price) and production cost due to imperfect competition. The DIRD is interested in ABS examining the concepts and framework of WB2 and WB3 and identifying the potential data requirements needed for the analysis (i.e. for estimating the required elasticities and parameters – see KPMG (2014, p.20)).

The present scoping paper only addresses the requirement for WB1, as per the instruction from DIRD. The ABS could provide another scoping paper in relation to WB2 and WB3 requirements, and the associated cost.

4. Proposed Feasibility Study

Current ABS data sources are inadequate to readily produce all the firm-level variables for Equation 1. The ABS will need to first undertake a feasibility study (Stage 1) to determine if there are available data sources to support the data construction at firm-level and understand the data quality associated with this work. It will also need to look at the confidentiality issues associated with producing the SA2 level data for gross output.

The feasibility results would indicate whether the ABS could provide the DIRD with the desired area and industry level estimates of the agglomeration elasticities and gross output data required for the calculation of WB1. All the preliminary estimation results will be subject to quality, confidentiality and risk assessments.

If found feasible, the feasibility study will specify the next detailed tasks to be undertaken (i.e. in-house modelling using firm level data – Stage 2), the expected output, and will give informed estimates of the timing and resources, including the revised costs required for that next stage.

5. Aspects to be examined by the feasibility study

Data compilation

The data sources that will be investigated include (but not restricted to) the Australian Industry Survey (AIS), ATO's Business Income Tax (BIT) and BAS (Business Activity Statement), Counts of Business, including Entries and Exits (CABEE), Geography and Transport catchment area boundaries, and Census data.

The Linked Employer-Employee Data (LEED), which is currently being constructed by ABS, will also be examined to see its usefulness to this work in the future (e.g. in allocating businesses to areas).

If the BIT/BAS and the AIS data are going to be used, the feasibility study will also need to examine if there are definitional differences between the datasets that could affect the quality of the area/industry estimates and/or regression modelling. This will require conceptual mapping of the BIT/BAS with the System of National Accounts framework, including that of the industry classification. Plotting the data and adjusting for differences accordingly will need to be done as part of any data preparation. Additional data cleaning/editing may also be required. As the study will require linking of administrative and survey datasets, an approval will also be sought from the ABS Data Integration Steering Committee.

The use of BIT/BAS data will mean that the regression estimation can only be undertaken inside ABS as there are restrictions to its use outside ABS.

Treatment of Multi-location firms

One of the challenges in uncovering the effect of location on productivity will be the identification of the locations of multi-location businesses, usually those belonging to the top 200 businesses. This is necessary to break up the data for these firms to their various geographic locations. In the feasibility study, the ABS will need to explore different options for addressing this complexity and recommend the best option.

Variable construction

Variables required for the estimation of Equation 2 will be constructed. It will follow from the data items mentioned in Table 1. As mentioned earlier, the ABS is in the good position to construct the required variables following their knowledge of SNA concepts and methods. The construction of the variables might also require some modelling procedure. Note that the DIRD will supply the effective density variable during the conduct of the feasibility study. The ABS will check and assess the quality of the compiled variables.

Small area estimation of gross output (SA2 level)

To provide DIRD with the estimate of gross output for SA2s needed in equation 1, the feasibility study will investigate and recommend options to compile this area/industry specific estimate. The additivity issues associated with estimates for areas will need to be examined. As the ABS also published state level estimates, the consistency of the area estimates with that of the published figures will be examined. The preliminary estimation results will still be subject to quality, confidentiality and risk assessments. ABS reserves the right to decide whether the small area estimates will be fit for purpose or suitable for release outside of ABS.

Econometric modelling

The feasibility study will recommend the most appropriate econometric modelling procedure to run Equation 2. The feasibility study will assess whether the said equation can be further modified/improved based on the availability of the ABS data. This econometric modelling will be very preliminary and will only test if elasticities of productivity can be estimated using the KPMG recommendation.

Minimum Quality Standards

The feasibility study will specify the minimum quality standards required for regression modelling outputs. The ABS reserves the right to have the final say on whether the quality of the outputs meets the minimum standards required by the ABS.

The feasibility study will also look into the provision of quantifiable measures of the statistical accuracy associated with the small area estimates of gross output and advice on their suitability for the stated purposes.

If this work proceeds beyond the feasibility study, the consultancy will be conducted using a stage-gate process. At each stage, the statistical quality of outputs will be assessed and a decision will be made, in consultation with the client, on whether to proceed to the next stage. Where feasible, ameliorative steps may be taken to reach minimum quality standards in order to progress to the next stage.

Confidentiality

Estimates of the gross output at the small area (SA2) level and by industry or rural/urban area may pose some confidentiality issues that need to be recognised and addressed. Disclosure risks may be substantial and if cannot be resolved, may restrict the release of the fine level data outside of the ABS. The feasibility study will look into these risks and identify possible options to mitigate them.

Risks to ABS

The feasibility study will identify and examine the risks for ABS if the gross output small area (SA2) estimates are used inappropriately. One of the concerns is that the estimates for areas may be used to derive sub-state national accounts estimates. Even with all the necessary caveats, the estimates might be used for purposes beyond what they were originally intended for. The feasibility study will weigh all the risks and determine if releasing such a data will be beneficial to all parties. If released, the stringent conditions for its use will be specified clearly and strongly.

6. Key stakeholders and dependencies

The Department of Infrastructure and Rural Development (DIRD) is the key stakeholder for this consultancy. DIRD will be contracting services to advise on and undertake the econometric analysis to produce the measures of wider economic benefit related to various types of transport infrastructure. For the feasibility study, the DIRD will be the key client. The DIRD may contract the services of another party to deal with the ABS on the requirements and conduct of the feasibility study. The

DIRD will formally advise the ABS of this arrangement. The ABS will examine if it is permitted to undertake the work under such an arrangement.

7. Recommendations

It is proposed that a feasibility study be first conducted to determine data availability, quality, feasibility of in-house modelling of the firm-level data required, and to address more fully the various issues identified above. The feasibility study will determine whether the actual consultancy work for DIRD proceeds or not. If it does, the consultancy will be conducted using a stage-gate process, where at each stage the statistical quality of outputs will be assessed and a decision will be made, in consultation with the client, on whether to proceed to the next stage.

The feasibility study will specify the next required tasks involved and the revised costing of in-house econometric modelling as well as the estimation of gross output for areas.

The identified steps including the corresponding costing (without GST) for the feasibility work are presented below. As the resource requirements for the next stage (Stage 2) will be determined by the findings of the feasibility investigation, the steps and tasks including the associated costs in the table for this stage are only indicative. Costs for the stage 2 are subject to changes, following the completion of stage 1. As mentioned earlier, the client will be consulted on whether to proceed to Stage 2.

Table 1. Indicative stages/phases and preliminary cost estimates (without GST)

Stages/Phases	Indicative cost ($)	Expected time duration
Scoping paper (inclusive of meetings and communications, project management) 1. For WB1 2. For WB2 and WB3 **Expected Output:** Scoping paper with indicative costing for the activities	 22,500 30,000	 2 weeks 2-3 weeks
Stage 1: Feasibility Analysis	**138,498**	6 months
1. Data assessment/linking/compilation 2. Treatment of multi-location firm 3. Variable construction 4. Preliminary modelling and analysis 5. Preliminary assessment of quality, confidentiality and risks 6. Writing of the feasibility report 7. Meetings and communications Note: Costs associated to project management, exploration of related studies, travel, SAS/Stata coding, technical requirement required from other ABS areas, other incidental are covered in the indicative costs. **Expected Output:** Feasibility report containing the ABS recommendations. It will include the preliminary results and the preliminary assessment of the quality, confidentiality and risks.	54,882 13,743 9,543 29,496 14,976 9,862 5,996	
Stage 2a - Econometric Modelling to produce the agglomeration elasticities	**157,800**	6 months
1. Data compilation for modelling requirements (additional tasks based on the stage 1 results) 2. Modelling and analysis (by area and industry level) 3. Diagnostics and quality assessment of the modelled results	17, 498 83,245 9,225	

4. Confidentiality risk assessment 5. Report writing 6. Discussion/presentation on the application of the estimates to clients 7. Meetings and communications	10,092 23,821 8,143 5,776	
Stage 2b - Production of small area estimates of gross output	TBA (dependent on the outcome of the possible separate project called “Regional Turnover Project “ to be undertaken by another ABS area.	
Expected Output: Final Report containing the estimated agglomeration elasticities and gross output data by area		

B.

Appendix B

Scope of work for ABS

REQUEST FOR QUOTE

Developing firm level data and estimating the elasticities and parameters necessary for estimating WEBs in Australia

1. Purpose

The Department of Infrastructure and Regional Development (DIRD) is seeking assistance in (1) constructing a firm-level dataset; (2) constructing small area estimates of gross output and (3) running a firm-level regression to derive elasticities which will allow for the estimation of the Wider Economic Benefits (WEBs) of transport projects.

2. Background

Conventional CBA has the potential to either under or over-estimate the true cost/ benefits of the project being assessed. These impacts, which have been typically excluded from 'conventional' CBA in the past, are now commonly referred to as 'wider economic benefits' (WEBs). Over the past few years, WEBs have entered the project evaluation framework for significant transport infrastructure projects. The existence of WEBs for transport projects have been historically acknowledged, but have not been typically quantified until recently.

DIRD is interested in the WEBs of transport projects to better understand and assess the links between transport investments and economic benefits that are not captured by traditional cost-benefit analysis. Among these benefits is what is known as agglomeration economies (WB1). These are positive externalities derived from the spatial concentration of economic activity. The externalities arise from increased opportunities for input sharing, including that of labour, technological spillovers and output sharing.

WB1 is calculated as:

WB1 = (elasticity of productivity wrt effective (employment) density) x (change in the effective density of the area due to the infrastructure project) x (gross output in the area) (Equation 1)

Where, effective density refers to a measure of the concentration of employment in an area adjusted for the size of the area and the distances or cost of travel between areas.

In order to obtain the elasticity of productivity with respect to effective (employment) density, the DIRD is proposing to adopt an approach where effective density is added into a production function, together with labour, capital and intermediate inputs (Graham 2005; Mare & Graham 2010).

The production function will be estimated via a regression approach, where the resulting coefficient for effective density is the elasticity measure that is needed for the calculation of

WB1.

$$\ln(GrossOutput_i) = \beta_0 + \beta_1 \ln(B2BEd_{ind,area}) + \beta_2 \ln(labour_i) + \beta_3 \ln(capital_i)$$
$$+\beta_4 \ln(Intermediateinputs_i) + \beta_5 \ln(age_i) + \beta_6 \ln(occ_i^1) + ... + \beta_{n+5} \ln(occ_i^n) + \varepsilon_i$$

(Equation 2)

where

i denotes firm; *ind* and *area* signify industry and area of interest.

DIRD is also seeking assistance in determining the parameters to measure other types of WEBs, labour market deepening (WB2) and output change in imperfectly competitive markets (WB3).

3. Project scope

DIRD requires assistance in estimating the parameters that are needed in measuring agglomeration economies (WB1), as well as for labour market deepening (WB2) and output change in imperfectly competitive markets (WB3).

It is expected that the ABS will work in close cooperation with the WEBs Specialist, to be commissioned separately by DIRD.

The WEBs Specialist will work closely with ABS to develop a detailed methodology paper. ABS' role will be to work with the WEBs Specialist to develop the required datasets and undertake econometric analyses.

To be able to estimate the productivity elasticities and parameters, DIRD requires a dataset that contains appropriate firm-level data at SA4 level for the following indicators:

Table 1. List of variables

- An output measure, e.g. turnover
- value of inventory held
- net revenue
- capital inputs
- cost of labour and other labour overheads
- cost of intermediate inputs
- debts and liabilities
- other costs by type
- employment by occupation by hours worked
- age
- occupation type

The firm-level regression will be run in such a way that it produces the required elasticity estimates (of effective density) by industry or broad industry category for the eight capital cities, and probably a broader level of geography for regional areas, depending upon the sample size, quality and confidentiality restrictions of the data.

In order to calculate the WB1 (Equation 1), a measure of gross output at a small area level is also needed. DIRD is therefore asking the ABS to also produce SA2 level estimates of gross output.

The ABS will produce two outputs for DIRD:

1. Constructing a firm level dataset and estimating Equation 1. Because of restrictions to firm-level data access, the estimation will be run inside ABS. Only the modelling results and associated diagnostic statistics need to be provided to DIRD; and
2. Constructing SA2 level data of gross output.

The ABS will define each of the data items in Table 1 in accordance with the System of National Accounts concepts and standards. Note that the DIRD will calculate the effective (employment) density variable themselves using their transportation model, and will provide this to the ABS in order to estimate Equation 1 in-house.

The DIRD is also seeking other measures of wider economic benefits, specifically those coming from labour market deepening (WB2) and imperfect competition (WB3). The impact of transport investments via WB2 channel is perceived to be a result of increased in labour supply due to improved take-home pay of workers or improved accessibility to a larger labour market that necessitates better skills matching. WB3 captures the additional benefits resulting from a wedge between value placed on additional production (price) and production cost due to imperfect competition.

It is expected that the ABS will also examine the concepts and framework of WB2 and WB3 and estimate the required elasticities and parameters – see KPMG (2014, p.20)).

4. Project timing

It is anticipated that the project will be completed by December 2015.

Deliverable	Timing
Project inception meeting	Within 1 week of project commencement
Agreement on methodology and delivery schedule	1 week from project inception
Development of detailed methodology paper in associating with WEBs Specialist	1 month from agreement on methodology and delivery schedule
Scoping paper with detailed costings	2 weeks from finalisation of detailed methodology paper.
Feasibility report containing recommendations, preliminary results and preliminary assessment of the quality, confidentiality and risks	6 months from agreement on methodology and delivery schedule
Final report containing the estimated elasticities and gross output data by area (subject to the outcomes of the feasibility report)	12 months from agreement on methodology and delivery schedule (December 2015)

5. Pricing

Quotes exclusive of GST are sought on a fixed price basis. The fee estimate should include the fee breakdown for undertaking feasibility report and for the final report.

6. Reporting arrangements

The ABS is expected to work with the WEBs Specialist throughout the project on the requirements and conduct of the study.

It is expected that the ABS will provide fortnightly reports to DIRD and will regularly communicate with the WEBs Specialist. Progress meetings will be scheduled monthly between the ABS, the WEBs Specialist and DIRD.

C.
Appendix C

Scope of work for WEBs Specialist

REQUEST FOR QUOTE

Assistance from WEBs Specialist to support the development of parameters to measure agglomeration economies

1 Purpose

The Department of Infrastructure and Regional Development (DIRD) is seeking assistance from a Wider Economic Benefits (WEBs) Specialist to support the development of elasticity parameters to measure WEBs in Australia.

As part of a separate request for quote, DIRD is also seeking assistance from ABS for (1) constructing a firm-level dataset and running a firm-level regression and (2) constructing small area estimates of output, which will allow for the estimation of the Wider Economic Benefits of transport projects.

It is expected that both consultancies will be engaged concurrently and will work together to ensure elasticities developed are fit-for-purpose according to the WEBs methodology paper.

2 Background

Conventional CBA has the potential to either under or over-estimate the true cost/ benefits of the project being assessed. These impacts, which have been typically excluded from 'conventional' CBA in the past, are now commonly referred to as 'wider economic benefits' (WEBs). Over the past few years, WEBs have entered the project evaluation framework for significant transport infrastructure projects. The existence of WEBs for transport projects have been historically acknowledged, but have not been typically quantified until recently.

DIRD is interested in the WEBs of transport projects to better understand and assess the links between transport investments and economic benefits that are not captured by traditional cost-benefit analysis. Among these benefits is what is known as agglomeration economies (WB1). These are positive externalities derived from the spatial concentration of economic activity. The externalities arise from increased opportunities for input sharing, including that of labour, technological spillovers and output sharing.

3 Project scope

As part of the engagement, the WEBs specialist will be expected to:

- Prepare a detailed methodology paper for WB1 and WB2 for implementation by ABS
- Provide strategic advice and guidance to ABS as required
- Work in close collaboration with ABS to ensure the extracted data is fit for purpose and the estimated regression analyses are in line with international best practice
- Provide advice on econometric analyses (to be undertaken by ABS) to estimate elasticities and parameters for each of the agreed economic regions in Australia. The exact definition of the economic regions across Australia will be decided by the project team (DIRD, ABS and WEBs Specialist) during the course of the project.
- Review the work undertaken by ABS to ensure it addresses DIRD and NGTSM Revision Committee's objectives and is able to withstand independent scrutiny

- Undertake CGE modelling to estimate elasticities and parameters for estimating WB3 for each of the Capital cities and other regional economic regions.
- Prepare an overarching WEBs report that documents the approach and findings of the analysis. This includes detailed statistical analysis and tests as well as discusses the implications of the findings. The report will also provide detailed equations for estimating WB1, WB2 and WB3 in each of the economic regions in Australia.

Project timing

It is anticipated that the project will be completed by December 2015.

This allows for the report to be finalised once ABS' work is completed in November 2015.

Pricing

Quotes exclusive of GST are sought on a fixed price basis. DIRD's expectations of the likely time commitment for each task are provided below. DIRD expects that the overall budget for the WEBs Specialist will not exceed more than $186,000 excluding GST.

Task	Time Allocation (Days)
Detailed Methodology paper for WB1 and WB2	8
Strategic advice on WEBs to ABS	15
Advice on econometric analysis	10
Review of work undertaken by ABS for estimating parameters for WB1 and WB2 and data for estimation of WB3 as well as Small area gross output estimates	12
CGE modelling to derive elasticities and Parameters for WB3	50
Preparing an overarching WEBs report	10
Project management and reporting	5
Grand Total, Days	**110**
Grand Total, Fees (exc. GST)	**$185,625**

Reporting arrangements

The selected WEBs Specialist will work as part of an integrated team with ABS and DIRD throughout the course of this project.

Contacts in relation to this report include:

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