ANZLIC - The Spatial Information Council

Economic Assessment of Spatial Data Pricing and Access

Stage 2 report: Cost Benefit Analysis of Alternative Models

November 2010

PRICEWATERHOUSECOOPERS

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Contents

1 Executive summary

Background

Fundamental spatial data constitute data about the location and attributes of features that are on, above or beneath the surface of the earth, that are captured from primary sources and, typically, cannot be derived from other data. While there are differences between jurisdictions in the delineation of what constitutes fundamental data, examples of fundamental data include topographic information, aerial photography, the cadastre and administrative boundaries.

Fundamental data have historically been produced and maintained by government agencies as part of the core activities of the agencies. Typically, one agency within each jurisdiction has assumed a role as an aggregator of fundamental data from the source agencies. The land information agency typically processes that data to a 'fit for purpose' state and acts as a 'shop front' for sale and distribution to other government and private sector users. A central element of the sale and distribution role is determining and implementing policies on the prices that the agency charges to government and private purchasers of fundamental data.

Governments in Australia and New Zealand have no common or shared view on how they should price fundamental data, or the terms under which they should make fundamental data available to users. ANZLIC – the Spatial Information Council has recognised a potential benefit in having a robust framework for managing access to, and pricing of, fundamental data to support the development and sustainability of the spatial data industry. ANZLIC accordingly commissioned this study by PwC to undertake an economic assessment of alternative models of access and pricing for fundamental data.

Objective of this study

PwC undertook this study in two stages. In Stage One, PwC developed guiding principles for access to, and pricing of fundamental data and defined four alternative pricing models. Stage Two, which is the subject of this report, comprised a comparative analysis of the economic benefits and costs of the alternative models (defined below).

Pricing and access policy has the potential to produce different economic outcomes, depending on the type of approach adopted. The analysis undertaken in this study built on previous economic studies of spatial data pricing and access in the following ways.

- The analysis explicitly addressed the dynamic effects of pricing models – addressing factors such as changes over time in funding for the producer agency and implications for data quality (accuracy, currency, and resolution). PwC used a dynamic modelling approach to evaluate the economic implications of changes in funding, changes in data quality and consequent changes in benefits to society from data use (measured as the economic concepts of consumer and producer surplus).
- An assessment was made of the capacity of alternative pricing models to address the public good characteristics of spatial data, the effect of pricing signals on consumption and production decisions (including the efficient level of investment in data quality) and the dynamics of competition and innovation.

The models

Different pricing models vary in the extent and manner in which users of fundamental data are charged prices to recover costs of production and distribution of the fundamental data.

PwC identified four models for managing the pricing of fundamental data for assessment. These lie on a spectrum of approaches that are differentiated by the extent to which costs are recovered, and by the extent to which there are differences in prices charged to commercial and non-commercial users of data.

At one end of the spectrum of models is the '**full cost recovery model**' in which data are priced to recover all of the costs (the 'full cost') of producing, maintaining and distributing fundamental data from users. The data are licensed such that each new data user is required to purchase the data product from the land information agency at a price that enables the agency to recover the full cost of the data when all data purchases are taken into account. Prices apply uniformly to commercial and non-commercial users.

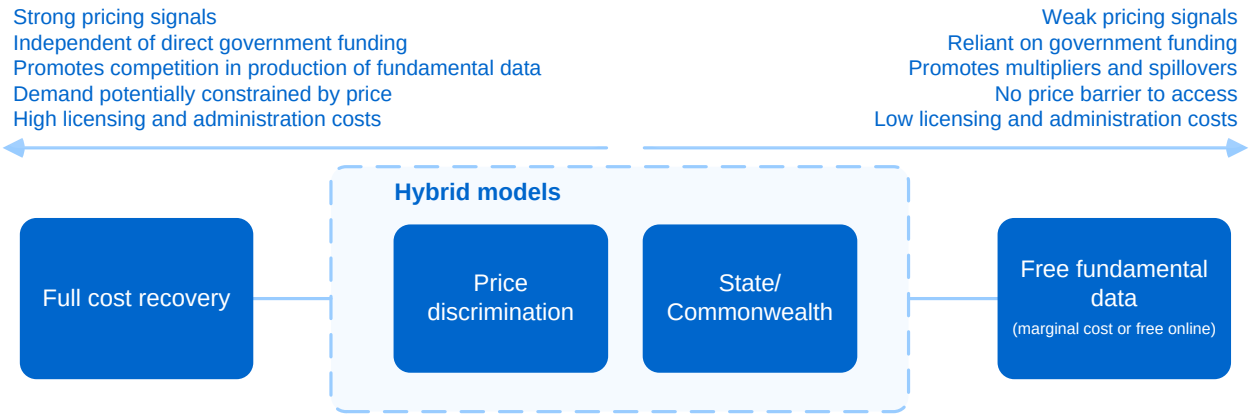
At the other end of the spectrum lies the '**free fundamental data model**' in which fundamental data are priced to recover only the marginal cost of distribution. For electronic distribution of data, such as through internet channels, the marginal cost of distribution is so low as to be effectively zero, and hence the data are made available to users for free. Under this model, governments finance all of the costs of data production, maintenance, extraction and distribution.

In between these two models is the '**price discrimination model**', which applies differential pricing according to customer type. Commercial users are supplied with data at a price based on recovery of full cost, while non-commercial users, including other government agencies, are provided with data at the marginal cost of distribution or for free. Under this model, revenues from commercial users and from government funds finance the costs of data production.

The '**Commonwealth/State model**' is a hybrid of the above models. This model involves the Commonwealth Government providing fundamental data under a free fundamental data model, and state governments providing data under the full cost recovery model.

The alternative pricing models have different consequences for the economics of data production and consumption, which are indicated in Figure 1.

Figure 1: Pricing and access models identified for analysis



Assessment methods

Economic benefits derive from the production and use of fundamental data. The four pricing models were compared on the basis of the changes in the economic benefits that would occur in changing from one pricing model to another such as, for example, changing from the free fundamental data model to the full cost recovery model, or vice versa.

We undertook the comparative analysis in four stages:

- a static welfare analysis to estimate quantitatively the benefits accruing to the producers and consumers of spatial data under each model;
- a dynamic welfare analysis to estimate quantitatively the change in benefits accruing to producers and consumers of spatial data over time due to changes in funding or quality;
- qualitative consideration of a number of other factors including competition and innovation in production of spatial data, data quality, public good values, positive spillovers from use of fundamental data, equity in data availability and pricing, complexity of pricing models, and access to raw data (fundamental data are typically processed to a 'fit for user' state before sale); and
- application of the welfare analysis to four State and Commonwealth fundamental data products.

We evaluated three of the four models quantitatively. The exception is the State/Commonwealth model, which, being a hybrid of the cost recovery and free fundamental data models, is assessed based on the findings of the other models.

Static welfare analysis

A standard modelling technique for measuring costs and benefits is used – referred to as 'welfare analysis'. This technique estimates the net benefits (or economic surplus) accruing to consumers and producers of fundamental data. This is an important measure as it represents the economic efficiency of a particular pricing approach.

We measure consumer surplus by the difference between what consumers are willing to pay and what they do pay. We estimate surpluses for two main classes of consumer – private consumers and government consumers. Producer surplus is the 'profit' earned by a producer (typically a land information agency), estimated by the difference between the revenue generated on spatial data sales and the cost of producing and distributing the data. We sum the consumer and producer surpluses to produce an estimate of the change in welfare from adopting one model over another.

We used a number of input variables in the welfare analysis, and each has a particular effect on the estimated consumer and producer surpluses (Table 1). We obtained values for the variables from both the economic literature and from data provided to PwC from several land information agencies, including Landgate (Western Australia), the Department of Sustainability and Environment (Victoria) and Geoscience Australia (Commonwealth).

Table 1: Variables used in the welfare analysis

Variable	Why important
Proportion of fixed relative to total costs	A higher proportion of fixed costs relative to total costs increases the size of the deadweight loss under the full cost recovery model
Cost of public funds	A higher cost of public funds increases the loss from government funding the fixed costs under a marginal cost pricing model
Government share of consumption	A larger government share of consumption reduces the need to raise public funds to cover the fixed costs under marginal cost pricing model. It also increases the share of benefits accrued by government from elimination of the deadweight loss.
Elasticity (change in demand in response to price)	The deadweight loss under the full cost recovery model is higher where demand is more elastic
Multiplier	A larger multiplier increases the size of the deadweight loss arising from the full cost recovery model

Dynamic analysis

The welfare analysis described above is made between the economic surpluses generated under each pricing and access model in a steady state, at one point in time. It does not take account of the costs and benefits that may accrue over time after a changeover from one model to another.

To produce an assessment that considered the costs and benefits over time, we use a dynamic modelling approach (over a period of 10 to 20 years) to evaluate the economic implications of changes in funding, changes in data quality and consequent changes in consumer and producer surplus. We undertake this analysis by making assumptions about the possible shifts in demand and supply. The interaction between the shifts in the demand curves over time will affect the total level of welfare that the model delivers.

For example, if under the free fundamental data model central government did not maintain existing levels of funding to a land information agency, this would reduce expenditure on fundamental data production. We expect the reduction in expenditure to reduce the quality of the fundamental data. In that case, the demand curve would move down, as purchasers would not be willing to pay the same price for a lower quality product. If this occurs, there is potential for welfare loss as reduced quality reduces the welfare of both marginal consumers and consumers who would purchase at a cost recovery price. This reduction in welfare is magnified if there is a multiplier effect from the use of fundamental data.

We consider the effect of the choice of quality by the agency in a similar manner.

Qualitative assessment

We assess a number of other factors qualitatively, owing to the difficulty of incorporating these factors into the quantitative welfare analysis. These include:

- Competition: Competition is a driver of the efficiency with which fundamental data are produced. Lower cost production will increase the net welfare under any of the

pricing models. A pricing and access scheme that facilitates competition in downstream markets will increase productive efficiency in those markets.

- Innovation: Competition is a driver of innovation. Competition can create incentives for innovation in the production of fundamental data products. Innovation can improve welfare through the creation of new products and new uses for the products.
- Choice of quality: how do the price signals under the pricing and access model facilitate the production of the fundamental data product to the appropriate quality?

The qualitative assessment also reviewed the models under each of the principles that PwC developed in Stage One. These include:

- Public good characteristics: does the model price appropriately for fundamental data products that have public good characteristics?
- Positive spillovers: does the model facilitate the realisation of positive spillovers?
- Equity: is the model horizontally equitable (those who benefit pay) or vertically equitable (those with the greatest capacity pay)?
- Complexity: Does the pricing and access model increase or decrease administrative complexity?
- Access to raw data: Does the model facilitate access to raw data and what are the implications of accessibility of raw data under the model?

Australian application

For each comparison between models, PwC calculated the change in welfare for consumers and producers for a sample of products from Australian land information agencies. These are aerial and topographic data from Landgate and topographic data from the Department of Sustainability and Environment (Victoria) and Geoscience Australia.

Summary of findings

The economic analysis undertaken for this study and set out in the Stage Two report demonstrates that the pricing model with greatest economic benefit varies with differences in the broader economic and policy context for production and consumption of fundamental data.

If adequate government funding can be relied upon, the free fundamental data model delivers greater economic benefits than the alternative models. The larger benefits result from increases in the use of fundamental data that would occur because of the agency providing data free or at a very low price, and flow-on effects of increases in competition and innovation in downstream markets for products and services that use fundamental data. However, the achievement of these benefits also requires that certain other conditions hold, notably that:

- the government agencies that produce the data do not rely on the purchasing decisions of data users to provide signals to guide decisions on the quality of the data; and
- the benefits of free provision of fundamental data are not negated by fewer market opportunities for competition and innovation by non-government producers of fundamental data.

Where these conditions do not hold, the benefits of the free fundamental data model may not be sustained and models that allow for cost recovery are superior in the longer term. The comparative analyses of the current study show that the full cost recovery model is superior where the free fundamental data model results in deterioration in the quality of fundamental data over time due to funding constraints or misspecification of data quality.

The comparative analyses also show that the price discrimination model achieves most of the economic benefit of the free fundamental data model, particularly where there is a significant government share of data use. The price discrimination model provides a trade off between the independent-funding benefits of the full cost recovery model and greater-use benefits of the free fundamental data model.

The price discrimination model has benefits of:

- a high level of use of fundamental data in policy and administrative processes of government agencies;
- a funding stream for fundamental data production and distribution that is at least partly independent of government funds; and
- decisions of data producing agencies on data quality being guided by market signals from purchases of commercial users of data at full cost recovery prices.

Table 2 shows that the finding that the free fundamental model is preferred in the short term is robust, but that the longer-term costs and benefits of each pricing and access model are likely to vary on an agency-by-agency (or product-by-product) basis.

Table 2: Variables and factors underpinning preferred model

Variable or factor	Requirement for free fundamental data model to produce higher welfare than full cost recovery	Is this requirement likely to be met?
Short term (static case)		
Elasticity	Where marginal cost is zero, elasticity higher than 0.5 is sufficient. For marginal cost forming 25% of total cost, elasticity greater than 0.66 is sufficient. A lower elasticity is sufficient if there is a multiplier effect.	Yes. Modern data suggests the elasticity of spatial data are above one.
Marginal cost of production	For elasticity of above 0.66, any marginal cost of less than 25% of total costs result in free fundamental data model delivering higher welfare.	Yes. Marginal cost effectively zero for electronic dissemination.
Multiplier	If the elasticity and marginal cost conditions are satisfied, no multiplier effect is required. Multipliers above one will increase the free fundamental data model benefits.	Yes
Government share of consumption	If the above conditions hold, the free fundamental data model is preferred regardless of government share. As the government share increases, the free fundamental data model benefit increases.	Yes
Public goods and positive spillovers	Where the fundamental data product is a public good (which implies a marginal cost of zero), or there are significant positive spillovers, the free fundamental data model is preferred.	Yes

Variable or factor	Requirement for free fundamental data model to produce higher welfare than full cost recovery	Is this requirement likely to be met?
Long term		
Maintenance of funding / quality	Data quality needs to be maintained at a level such that the economic benefits obtained under the free fundamental data model are not dissipated.	Will vary on an agency-by-agency basis.
Price signals	In the absence of price signals, alternative means of determining the appropriate quality of the data product are required.	Unclear. No evidence of misspecification of quality for products under free data policies examined in this report, but non-price methods have greater misspecification risk.
Competition and innovation	The benefits from competition and innovation in downstream markets need to outweigh deterioration in competition in markets for fundamental data.	Yes. However, if the natural monopoly characteristics of fundamental data production reduce, the balance may change.

Table 3 shows the net change in welfare for modelled scenarios for four Australia fundamental datasets. While the shift along the spectrum from cost recovery to free fundamental data is generally welfare enhancing, deterioration in data quality over time may reduce the net benefits to a level below that which would have occurred had a cost recovery model been in place. The analysis also shows that most of the benefit of a shift from the cost recovery to the free fundamental data model is captured in a shift to a price discrimination model, particularly where there is a significant government share.

Table 3: Summary of welfare effects of changes from one model to another ($m)

	DSE topographic data	Landgate topographic data	Landgate aerial photography	Geoscience Australia topographic data
Cost recovery to free fundamental data	$3.3	$1.4	$1.0	$4.7
Cost recovery to free fundamental data (after 10 years)	-$1.5	-$0.4	-$0.6	-$2.3
Cost recovery to price discrimination	$2.5	$1.3	$0.6	$3.3
Price discrimination to free fundamental data	$0.8	$0.06	$0.4	$1.3

For a change between models in the opposite direction to that indicated in the table, the welfare change is equivalent but of the opposite sign.

These welfare estimates are indicative as opposed to precise welfare effects of a change. They are heavily dependent on parameter assumptions and the form of the model used. Further, from the cost and revenue data provided by the land information agencies, there is some evidence that full cost recovery may not be possible for the data products examined due to insufficient demand. In such a case, the welfare under all of the pricing and access models would be lower than would be otherwise considered the case.

Delivery of objectives by model

Governments and land information agencies may have a range of policy objectives and priorities that will affect the optimal choice of pricing model for fundamental data. Differences in objectives may cause different pricing models to be optimal for different jurisdictions.

Table 4 indicates how different policy objectives and priorities affect the optimal choice of pricing model. The number of ticks in each cell of the table indicates how well a pricing model performs against the objective, with three ticks indicating the best performance.

Differences in government objectives may be reason for variance between jurisdictions in the optimal pricing model. Jurisdictions may adopt the Commonwealth / State model on this basis.

Table 4: Delivery of objectives by model

Objective	Full cost recovery	Price discrimination	Free fundamental data
Economic development	✓✓ Less benefit than alternative models in short term, but may be superior in long term due to access to revenues as a funding stream for data production	✓✓ Less support to economic development than the free fundamental data model but the gap is small where the share of use by non-commercial user is large	✓✓✓ Maximises the use of fundamental data and the contribution and spillover benefits of fundamental data. Benefit may decline in long term if government funding for data production is not maintained
Use of fundamental data by government agencies	✓✓ Government agencies have to pay for use of fundamental data and hence are motivated to reduce use	✓✓✓ Government agencies receive fundamental data for free or minimal price and hence are motivate to maximise use	✓✓✓ Government agencies receive fundamental data for free or minimal price and hence are motivate to maximise use
Generation of government revenue	✓✓✓ Maximises revenue generation and makes data production independent of direct appropriations of government funding	✓✓ There is some reduction in government revenue where non-commercial users use fundamental data.	No revenue generated

Objective	Full cost recovery	Price discrimination	Free fundamental data
Accountability of data producers to funders of data production	✓✓✓ The requirement of land information agencies to derive revenues from data sales makes these agencies responsive to the needs of data users	✓✓ Land information agencies may be responsive to the needs of commercial users of data, but less responsive to government and non-commercial users	✓ As land information agencies do not rely on revenues from data sales, there is no commercial motivation to be responsive to the needs of data users
Availability of data to the community to inform public participation in public policy and government decision making	✓ Public, non-commercial use of fundamental data may be restricted by limited capacity to pay prices.	✓✓ Fundamental data are freely available to non-commercial users	✓✓✓ Fundamental data freely available to all commercial and non-commercial users
Promotion of competition in production of fundamental data	✓✓✓ Competition in production of fundamental data is promoted as private firms may compete on a competitively neutral basis with government land information agencies	✓✓ Free provision of fundamental data to government agencies and non-commercial users limits the market opportunities for private data production firms	✓ Free provision of fundamental data from government land information agencies lessens commercial opportunities for private data production firms
Promotion of competition in downstream markets for services and products using fundamental data	✓ Less use of fundamental data reduces the opportunities for competition in products and services	✓ Less use of data by commercial users reduces the opportunities for competition in products and services	✓✓✓ Free provision of fundamental data promotes competition in products and services

Note: the tick scores indicated in this table indicate relative performance against policy objectives and are not intended to be interpreted as a quantitative assessment of benefits or to be additive across multiple policy objectives.

2 Introduction

Location (spatial) data are an integral component of most public sector information. Increasingly, electronic data on the physical location of objects and the metric relationships between objects is becoming an important 'enabler' of economic development and better public decision-making.

This report focuses on one class of spatial data, referred to as 'fundamental data' or the 'basic information set'. In this report, fundamental data are defined as:

> An authoritative source of spatial data that is maintained to well defined quality standards and cannot be derived from other data

Fundamental data have historically been produced and maintained by government agencies as part of the core activities of the agencies. Typically, one agency within each jurisdiction has assumed a role as an aggregator of fundamental data from the source agencies. The land information agency typically processes that data to a 'fit for purpose' state and acts as a 'shop front' for sale and distribution to other government and private sector users. A central element of the sale and distribution role is determining and implementing policies on the prices that the agency charges to government and private purchasers of fundamental data.

There is no common or shared view across governments in Australia and New Zealand on how fundamental data should be priced, or the terms under which they should be made available to users. ANZLIC – the Spatial Information Council, has recognised a potential benefit in having a consistent and robust approach across governments to manage access to, and pricing of, fundamental data. ANZLIC accordingly commissioned this study by PwC to undertake an economic assessment of alternative models of access and pricing for fundamental data.

2.1 Study objectives and terms of reference

The primary objective of this project is to develop a principles-based framework for accessing and pricing fundamental data. The full set of economic implications (costs and benefits) of alternative models for pricing/access are to be examined, with reference to the value chain for the production of and access to spatial data. Explicit account is to be taken on the dynamic nature of the costs and benefits due to technological changes, and consequent changes in supply and demand fundamentals.

It is not the intent of this study to recommend a single, preferred model for the whole of Australia and New Zealand. Instead, the role of this report is to present a comparative analysis of the various approaches and to identify how well each performs against alternative policy objectives — for example, efficiency, equity, economic development, revenue generation, innovation and data quality.

PwC has been tasked with undertaking an economic analysis that:

- identifies alternative pricing and access models for the overall spatial data management value chain, encompassing the sustainable collection, management, distribution, use, provision of access and commercialisation of 'fit for purpose', public sector spatial data

- compares the costs and benefits of a marginal cost pricing approach as compared to cost recovery models
- provides some dynamic economic analysis, taking into account longer term implications, that can:
  - elaborate on recent local and international research to appropriately provide and price access to 'fit for purpose' spatial data rather than just focussing on demonstrating the economic value of spatial data or the rationale for providing raw spatial data at marginal cost
  - incorporates all of the complex factors: different classes of users; their willingness to pay; the impact of price signals on market efficiency and the role of differential versus uniform pricing regimes
  - be used by governments to consider the key issues and provide clear access and pricing policy advice
- takes account of the practical realities of Commonwealth-State constitutional, structural and funding arrangements and the emerging needs of the spatial data industry.

2.2 Study approach

PwC has taken a two-stage approach to this study.

Stage one involved a scan of the issues, the establishment of guiding principles for pricing and access and the identification of a range of alternative model 'constructs' that could be applied to pricing fundamental data. PwC previously completed a report detailing the outcomes of stage one.

Stage Two involved an economic cost-benefit analysis of the implications of each of four pricing and access models for fundamental spatial information identified for analysis in stage one. Stage Two is the subject of this report.

This report presents PwC's findings for Stage Two of the study.

2.2.1 Stage one results

Different pricing models vary in the extent and manner in which users of fundamental data are charged prices to recover costs of production and distribution of the fundamental data.

Four models for managing the pricing of fundamental data were identified for assessment. The four models lie on a spectrum of approaches that are differentiated by the extent to which costs are recovered, and the prices charged to commercial and non-commercial users of data (Figure 2).

At one end of the spectrum of models is the '**full cost recovery model**' in which data are priced to recover all of the costs (the "full cost") of producing, maintaining and distributing fundamental data from users. The data are licensed such that each new data user is required to purchase the data product from the land information agency at a price that enables the agency to recover the full cost of the data when all data purchases are

taken into account. Prices would apply uniformly to commercial and non-commercial users.

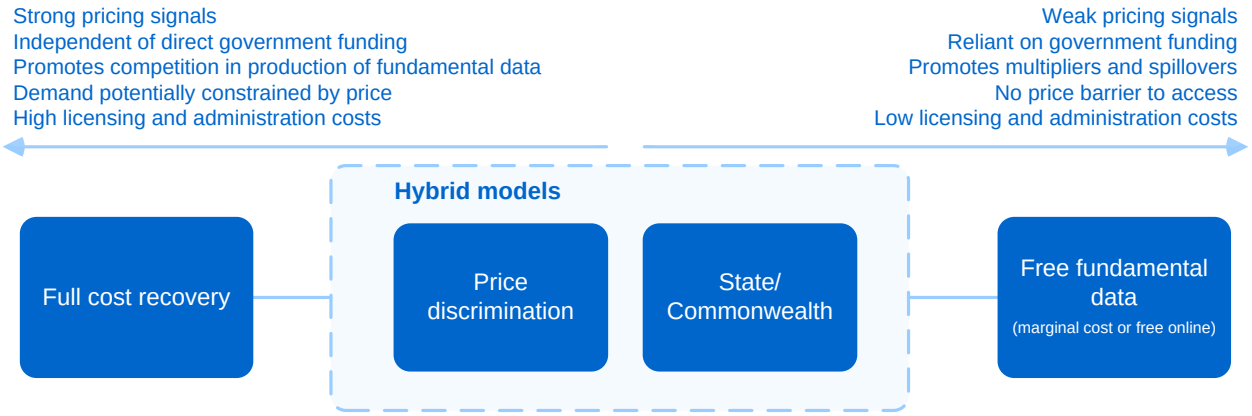
At the other end of the spectrum lies the '**free fundamental data model**' in which fundamental data are priced to recover only the marginal cost of distribution. For electronic distribution of data, such as through internet channels, the marginal cost of distribution is so low as to be effectively zero, and hence the data are made available to users for free. Under this model, all of the costs of data production are financed by governments.

In between these two models is the '**price discrimination model**', which applies differential pricing according to customer type. Commercial users are supplied with data at a price based on recovery of full cost, while non-commercial users, including other government agencies, are provided with data at the marginal cost of distribution or for free. Under this model, the costs of data production are financed by revenues from commercial users and from government funds.

The '**Commonwealth/State model**' is a hybrid of the above models. This model involves the Australian Commonwealth Government providing fundamental data under a free fundamental data model, and State Governments providing data under the full cost recovery model.

The alternative pricing models have different consequences for the economics of data production and consumption, which are also indicated in Figure 2.

Figure 2: Pricing and access models identified for analysis



2.2.2 Stage Two report

Stage Two involved an economic assessment of the benefits and costs of each of the above pricing and access models. Steps taken in Stage Two and detailed in this report included:

- a literature review of previous economic assessments of pricing and access policies for spatial data
- determination of how different cost components associated with the capture, maintenance and distribution of spatial information would be factored into the alternative pricing models

- dynamic cost-benefit analysis of the models by examining, through the use of case studies involving Australian land information agency data products, the nature and magnitude of the costs and benefits associated with one model relative to another. The costs and benefits of the following policy changes were analysed both quantitatively and qualitatively:
  - from full cost recovery to marginal cost pricing (or free online)
  - from full cost recovery to price discrimination (commercial versus non-commercial)
  - from price discrimination to marginal cost pricing (or free online)
- analysis of a Commonwealth / State model whereby cost recovery is applied at the State level and marginal cost pricing at the Commonwealth
- analysis of practical considerations related to the pricing and access models.

2.3 Organisation of this report

The report is structured as follows:

Chapter 3 sets out the methods used for the study. First, the chapter sets out the economic theory that underpins the cost-benefit analysis undertaken in this report. It includes a description of the major economic variables that underpin the analysis and the techniques by which we measure costs and benefits. Second, chapter 3 describes how we apply these techniques to the four pricing and access models selected for examination.

In Chapter 4, we review five previous examinations documented in the literature, each of which evaluate the costs and benefits of various pricing policies for public sector information. The assumptions made and methodology used in each report are summarised and critiqued.

In Chapter 5, we quantify the variables used in the cost benefit analysis. This involves an examination of previous estimates used in the literature for some of the variables and the development of new estimates based on data collected for this report.

Chapter 6 contains the cost-benefit analysis of each of the models selected for analysis. For each model, we compare the relative economic costs and benefits of one model compared to another. A number of case studies are used to illustrate the scale of the costs and benefits. Where there are considerations that cannot be included in the model in a quantitative manner, we examine qualitatively the expected direction of impacts.

Chapter 7 sets out how different policy objectives and priorities affect the optimal choice of pricing model.

3 Methods

This chapter describes the methods that PwC uses for the cost-benefit analysis.

First, we explain the theoretical background to the assessment techniques. This background provides a basis for examining previous assessments of pricing models for spatial information and some elements of the framework used in this study to analyse the four models.

Second, we provide details on how we applied the cost-benefit analysis in this study. The cost benefit analysis comprises three components:

- a quantitative economic analysis, under which the static economic gain or loss from adopting one model over another is determined
- consideration of dynamics that may affect costs and benefits over time
- a qualitative analysis of other relevant factors.

Welfare analysis is a primary tool utilised for quantitative cost-benefit analysis. Economic welfare is defined as the net benefit generated to society from the production and consumption of a good or service. In the context of spatial data, it is a measure of benefits accruing along the value chain, net of costs. However, welfare analysis as described below does not allow full consideration of the public good characteristics of the spatial data and has limited capacity to deal with changes in quality, the effect of pricing signals or the dynamics of competition and innovation. To capture these other impacts, PwC conducts supplementary analysis of the dynamics and qualitative analysis of other factors in this report.

We have applied cost-benefit analysis such that an assessment is made of each pricing model against the pricing and access principles identified in stage one. Those principles were:

- there should be no hard constraints to access (i.e. non-price barriers)
- pricing should promote efficiency
- pricing should be adjusted for public goods and positive spillovers
- pricing should facilitate equity
- pricing should be consistent with competition principles
- pricing and access should be determined on a product-by-product basis.

The cost-benefit analysis performed in this study was designed to each of the stage one principles (Table 5):

Table 5: Summary of methods to assess model performance under pricing principles

Principle	Method	Explanation
Efficiency	Welfare analysis	Welfare analysis provides a static measure of efficiency
	Dynamic considerations	Deterioration in quality over time due to funding or signalling issues can reduce efficiency
	Qualitative analysis	Obstacles to competition and innovation can reduce efficiency Complexity can reduce efficiency and increase administrative costs
Public good characteristics	Welfare analysis Qualitative analysis	Public good characteristics can be examined in the context of a welfare analysis where the decision is a binary decision of whether to supply data or not Otherwise, public good characteristics are analysed qualitatively
Positive spillovers	Welfare analysis Qualitative analysis	Some positive spillovers can be captured through use of an economic multiplier. However, issues such as facilitating non-commercial use require broader qualitative analysis
Equity	Welfare analysis Qualitative analysis	A welfare analysis estimates changes in net benefits across private and government customers and the land information agency Qualitative analysis is used to consider other parties such as taxpayers
Competition principles	Qualitative analysis	Competition may affect efficiency and total welfare over time
Hard constraints to access	Qualitative analysis	Accessibility (or not) of raw data may have competition effects and affect the price signals received by the agency
Product-by-product basis	No explicit analysis	This element is not examined in detail, but it is noted that any pricing and access policy should be implemented on this basis as the balance between the costs and benefits vary between data products

After examining the models quantitatively, dynamically and qualitatively, we apply the analysis to two types of fundamental data products produced by Australian government agencies. These are:

- fundamental topographic data produced by Landgate, Victoria's Department of Sustainability and Environment (DSE) and Geoscience Australia
- aerial photography produced by Landgate.

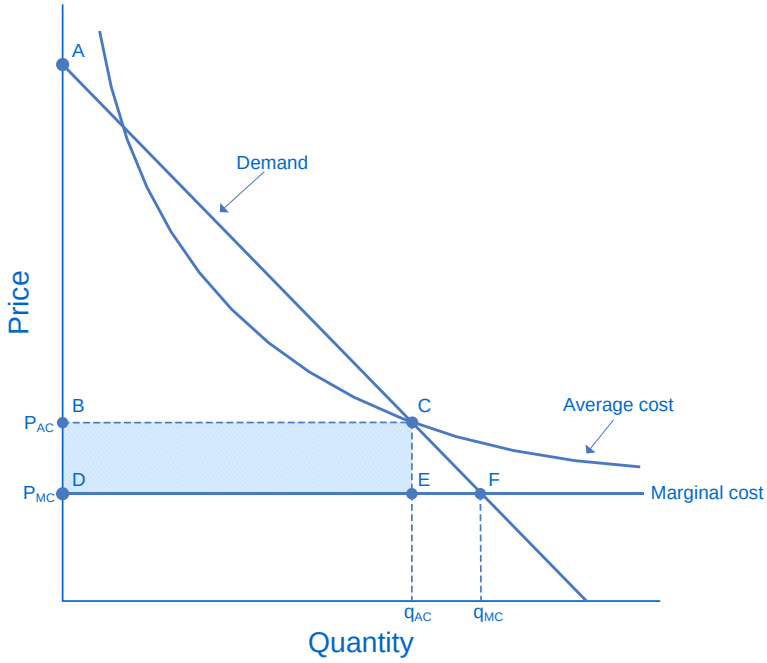
For each dataset, we estimate the costs and benefits of adopting one model relative to another (using a series of pair wise comparisons) and the dynamic implications, and discuss other relevant qualitative issues.

3.1 Quantitative analysis

3.1.1 Welfare analysis

The starting point for welfare analysis is an examination of the demand and supply for fundamental data. We can use a supply-demand relationship to assess welfare changes associated with changes in spatial data pricing policy. This includes situations where the spatial data product is a public good for which there is only a supply, not a quality, decision (quality attributes of spatial data include the current of the data, resolution and coverage). A theoretical representation of the demand and supply relationship for a single spatial information product of fixed quality is shown in Figure 3.

Figure 3: Supply-demand relationship



On the vertical axis is the price of the product and on the horizontal axis is the number of units of the spatial data product that the agency sells (customers purchase).

The demand curve is a downward sloping line, with demand for the spatial data product declining as the price increases. In Figure 3, the demand curve is a straight line, implying a constant absolute change in the quantity demanded for each unit change in price.

The supply curve is the cost curve of the land information agency. Two potential supply curves are shown in Figure 3, each representing different pricing decisions of the supplier. The first is the average cost curve. A supplier would price at the average cost of production if they intended to recover all of their costs (fixed costs plus those that vary with additional units of production). In Figure 3, the average cost declines as the quantity produced increases. The marginal cost curve is the supply curve if the supplier prices at marginal cost (that is, an amount that would just cover the cost of producing an

additional unit of the spatial data product but not fixed costs). Marginal cost should be distinguished from avoidable costs, which are the costs incurred if maintenance, extraction and distribution of a particular spatial data product was ceased.

In Figure 3, the horizontal marginal cost line represents a constant marginal cost regardless of the quantity produced. PwC assumes this to simplify the analysis, although it is also a reasonable assumption for the production and distribution of an information product.

The declining average cost curve and constant marginal cost is representative of production of a good with a specific initial fixed cost, with each additional unit of the good produced for the same cost after that initial outlay. This could represent a fixed cost involving collection and processing of data, with the cost of distribution of each unit of output constant. In this diagram, the fixed cost is equal to shaded area of the rectangle BCDE, which is the difference in the level of cost recovery between pricing at average or marginal cost. Marginal cost pricing does not recover the fixed costs.

Equilibrium between supply and demand occurs where the supply and demand curves intersect. In Different pricing models vary in the extent and manner in which users of fundamental data are charged prices to recover costs of production and distribution of the fundamental data.

Four models for managing the pricing of fundamental data were identified for assessment. The four models lie on a spectrum of approaches that are differentiated by the extent to which costs are recovered, and the prices charged to commercial and non-commercial users of data (Figure 2).

At one end of the spectrum of models is the '**full cost recovery model**' in which data are priced to recover all of the costs (the "full cost") of producing, maintaining and distributing fundamental data from users. The data are licensed such that each new data user is required to purchase the data product from the land information agency at a price that enables the agency to recover the full cost of the data when all data purchases are taken into account. Prices would apply uniformly to commercial and non-commercial users.

At the other end of the spectrum lies the '**free fundamental data model**' in which fundamental data are priced to recover only the marginal cost of distribution. For electronic distribution of data, such as through internet channels, the marginal cost of distribution is so low as to be effectively zero, and hence the data are made available to users for free. Under this model, all of the costs of data production are financed by governments.

In between these two models is the '**price discrimination model**', which applies differential pricing according to customer type. Commercial users are supplied with data at a price based on recovery of full cost, while non-commercial users, including other government agencies, are provided with data at the marginal cost of distribution or for free. Under this model, the costs of data production are financed by revenues from commercial users and from government funds.

The '**Commonwealth/State model**' is a hybrid of the above models. This model involves the Australian Commonwealth Government providing fundamental data under a free fundamental data model, and State Governments providing data under the full cost recovery model.

The alternative pricing models have different consequences for the economics of data production and consumption, which are also indicated in Figure 2.

Figure 2, a land information agency that chose to recover all costs would price where the average cost line intersects with the demand curve (at point C), resulting in a price of p_{AC} and the sale of quantity q_{AC}. Alternatively, pricing at marginal cost would result in the sale of quantity q_{MC}.

Calculating elasticity

Price elasticity of demand is a ratio of the increase (decrease) in demand for a product where there is a decrease (increase) in the price of that product. It is the percentage change in quantity demanded resulting from a one percent change in price. The price elasticity is an important parameter as it effectively determines the shared benefits to consumers and producers from changes in price.

Elasticity is typically determined at a point and represents changes in response to infinitesimally small changes in price. However, the data available concerning changes in the price of spatial (or other public sector) information is typically over large ranges, such as reductions in price from full cost recovery to zero.

In such a case, an average elasticity can be calculated over that range, but the value calculated varies depending upon the method of calculation (Pollock et al, 2008). Use of the high price, low quantity data point as the base of the change will result in the calculation of a higher elasticity (more price responsive) than use of the low price, high quantity data point. In this report, both pairs will be used to calculate lower and upper bound elasticities, utilising the following equations:

Equation 1: Price elasticity of demand using old price-quantity pair

$$\varepsilon_0 = -\frac{\%\,change\,in\,quantity}{\%\,change\,in\;price}$$

$$= -\frac{(q_1 - q_0)/\,q_0}{(p_1 - p_0)/\,p_0}$$

Equation 2: Price elasticity of demand using new price-quantity pair

$$\varepsilon_1 = -\frac{(q_1 - q_0)/\,q_1}{(p_1 - p_0)/\,p_1}$$

We define elasticity in these equations to be positive.

Where price is reduced to zero, we cannot calculate the lower bound elasticity. In that case, Equation 2 would be undefined.

Calculating consumer and producer surplus

Figure 3 allows the welfare of the land information agency (the producer) and consumers to be analysed. The welfare benefit obtained by the consumer and producer is termed the consumer and producer surplus respectively.

Consumer surplus represents the gap between what the consumer is willing to pay and what they do pay. The customer accrues any difference as a benefit. The area above the price line and below the demand curve represents consumer surplus. In the case of price equalling average cost, the area ABC in Figure 3 is the consumer surplus. Where price equals the marginal cost, the consumer surplus is equal to the larger area ADF.

Producer surplus is the 'profit' earned by the producer. In the case of a cost recovery policy where the price equals the average cost, the producer surplus equals zero. Where price equals marginal cost, the producer surplus is negative, and in Figure 3 is equal to the area BCDE. Area BCDE represents the fixed costs that the producer is unable to recover.

Total social welfare (subject to some considerations noted below) is the sum the consumer and producer surplus. Welfare is maximised where the sum of producer and consumer surplus is maximised.

Deadweight loss

Where a pricing regime results in social welfare being less than the maximum possible, the loss of welfare is called the deadweight loss. In Figure 3, the deadweight loss of a full cost recovery pricing policy is area CEF. **The sum of producer and consumer surplus is maximised when the price is set at marginal cost**.

The intuition of why there is a deadweight loss associated with average cost pricing can be understood as follows. Suppose that price is set at average cost. This means that a group of consumers is willing to pay more than the marginal cost (represented by the demand between points E and F of Figure 3). A sale to these consumers at a price between their willingness to pay and the marginal cost, with the other consumers continuing to pay the average cost price, would leave both the producer and the new consumers better off, and no party worse off. The additional sale has unequivocally improved welfare.

The size of the deadweight loss is larger where there is a high elasticity of demand. If there is high elasticity, consumers are very responsive to changes in price. A shift from average cost pricing to marginal cost pricing with high elasticity of demand will result in a large increase in consumption of the spatial data product. The benefit obtained by these additional consumers represents the deadweight loss that would otherwise be incurred under the average cost pricing policy.

The size of the deadweight loss is also larger, relative to the fixed costs associated with production of the spatial data product, where there are low variable costs (or low marginal cost). Put alternatively, **the larger the share of fixed costs as a proportion of total costs, the larger the size of the deadweight loss relative to the fixed costs**. This is because the difference between the variable costs and total costs is proportional to the difference between the marginal cost and average cost price. A larger relative difference in price increases the size of the deadweight loss.

Equations for the derivation of the deadweight loss are derived in Appendix B.1.

Multiplier

In some circumstances, it may be appropriate to adjust the deadweight loss by a multiplier (λ).

The primary reason for this is that the supply-demand analysis described above is only for direct producers and consumers. It does not incorporate others further down the value chain. If some users of the information are firms which in turn have consumers with their own consumer surplus, the demand curve used in the welfare analysis will underestimate both the initial welfare and the welfare benefits of lower prices.

A second reason is the presence of dynamics and innovation. The demand curve in the welfare analysis is static and does not provide any information on how current prices will affect future demand. Pollock et al (2008) argued that lower prices today might stimulate the rate of innovation of complementary goods or stimulate the development of new goods and services.

A further consideration towards application of a multiplier would be the presence of positive externalities or public good characteristics. If the benefits of consuming spatial data extend beyond the purchaser, the purchaser's willingness to pay will underestimate the social benefit that results from their purchase of the information. A multiplier is one way to try to account for these spillover benefits.

Inefficiencies of raising revenue through tax

The provision of government resources through taxation is inherently inefficient. Costs incurred include collection costs, compliance costs and deadweight loss due to changes in incentives. This inefficiency is termed the marginal cost of public funds. If the marginal cost of public funds were, say, $1.25 for each dollar of taxation revenue raised; this would imply a welfare loss of $0.25 for each dollar of taxation revenue.

In conducting a welfare analysis, the marginal cost of public funds is applied to the level of government funding. For a marginal cost pricing regime with constant marginal cost, the government contribution would be equal to the fixed costs.

As government expenditure on spatial information is small relative to total government revenue, we can take the marginal cost of public funds to be the average cost of public funds for the purposes of the analysis. Therefore, letting 1+β be the marginal cost of public funds and F the fixed costs of production, we can express the deadweight loss resulting from government funding the fixed costs as in Equation 3.

Equation 3: Loss from use of public funds (CPF=cost of public funds)

$$CPF = \beta F$$

We need to adjust this calculation where government is a purchaser of the fundamental data. To the extent that government is a purchaser, a change in pricing regime for government purchasers only transfers funds within government. There is no need to raise additional tax revenue. Letting *g* be the proportion of purchases made by government, we can restate the loss from the use of public funds as in Equation 4.

Equation 4: Loss from use of public funds with government purchasers

$$CPF = (1 - g)\beta F$$

Welfare assessment

Where there is a change in pricing policy, we can use the above elements to construct the change in welfare of the government producers and consumers (ΔGS) and of private

consumers (ΔCS). Summing the change in government consumer and producer surplus and private consumer surplus gives the total change in welfare. The components of welfare for each of these parties can be summarised as follows:

- government land information agencies either recover the fixed costs of production through cost recovery, or pay the fixed costs themselves (using Treasury appropriations)
- government consumers may gain some of the deadweight loss that occurs under a cost recovery pricing regime where pricing moves to marginal cost pricing, plus the portion of the fixed costs they previously paid for when cost recovery was in place
- private consumers can gain the share of fixed costs that they previously paid for plus a share of the deadweight loss if pricing moves from cost recovery to marginal cost.

From the discussion above and as is well established in the literature, we can summarise the effect of a number of the variables on the welfare consequences for each party. These include:

- **high elasticity of demand results in a larger distortion (deadweight loss) for full cost recovery pricing**
- **a high proportion of fixed costs relative to marginal cost increases the distortion from full cost recovery pricing**
- **a large multiplier increases the deadweight loss from full cost recovery pricing**
- **a high cost of government funds increases the cost of marginal cost pricing (the free fundamental data model)**
- **a high government share of consumption mitigates the cost to government from marginal cost pricing and allows government to share in some of the benefits.**

The welfare analysis conducted in chapter 6 examines how these trade-offs play out for each pricing model across a range of parameters and case studies.

3.1.2 Limitations of welfare analysis

Welfare analysis aims to estimate benefits and costs through examination of the supply and demand curves of consumers and producers and using this information to determine changes in consumer and producer welfare. However, it is a simplification of reality and other considerations may add to or detract from consumer or producer surplus. A welfare analysis of the form presented above is subject to a number of limitations.

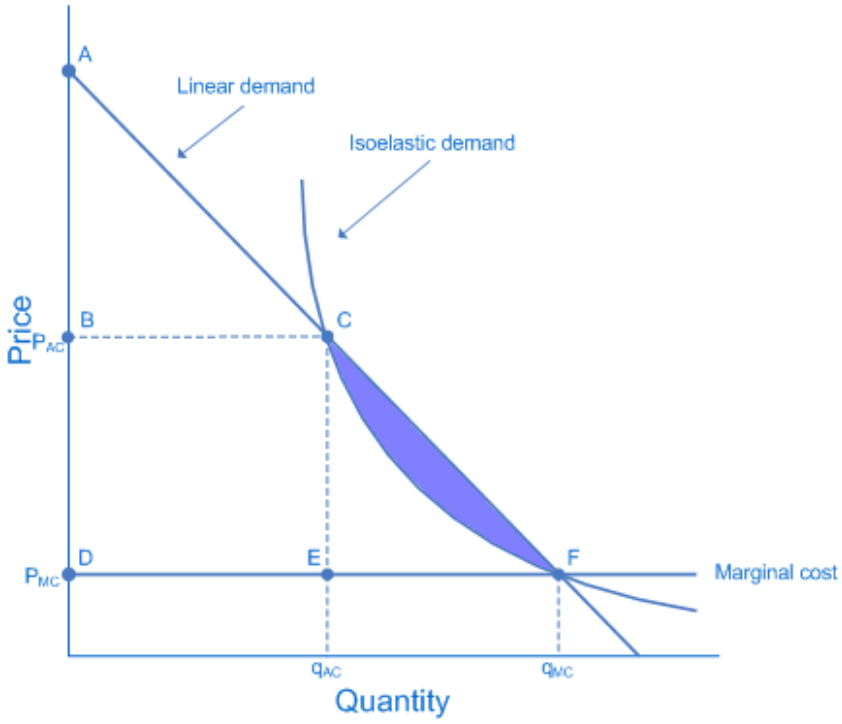
First, it is best suited to evaluating a single product and does not directly deal with changes in quality of that product. We would need to conduct an analysis of each individual spatial data product to determine the welfare effects of adopting alternative pricing policies. For changes in quality, demand curves for each level of quality would be required to allow a comparison of welfare.

The form of the demand curve is critical in determining the outcome of a welfare analysis. The empirical estimates of elasticity and demand curves in this report are generally based on two price/quantity observations, with little evidence on the shape of the demand curve between the observations or as price or quantity approach zero.

A simplification adopted in Figure 3 is a linear demand curve. This leads to constant absolute changes in quantity with each unit change in price. The choice of a linear demand curve implies that the price elasticity of the product, the percentage increase (decrease) in demand for a product for a given percentage decrease (increase) in the price of that product, decreases as price decreases. This is because as price nears zero, a unit change in the price is a larger proportionate change in price but results in the same absolute change in demand.

An alternative assumption of elasticity is constant elasticity. An example of a constant elasticity (isoelastic) demand curve is shown in Figure 4. Compared to the linear demand curve, the constant elasticity demand curve produces larger absolute changes in quantity as price approaches zero. This has implications for the size of the deadweight loss.

Figure 4: Supply-demand relationship with constant elasticity



We have based the two demand curves in Figure 4 on the same two data points (points C and F). The deadweight loss is lower for the constant elasticity demand curve than for the linear demand curve by an amount equal to the shaded area. As is discussed in more detail in section 5.1.1, there are grounds to suggest that an assumption of a linear demand curve has weak support.

A further limitation is that the welfare analysis does not incorporate some other factors that may affect the consumer surplus and deadweight loss, particularly over time. These include changes in quality, the public good characteristics of the product or dynamic factors such as competition and innovation.

Given these limitations, the results of welfare analysis should not be viewed as conclusive. Rather, the welfare analysis serves as an indication of the implications of different pricing and access models, with this being one of a range of relevant factors for an agency to consider.

3.1.3 Application of static welfare analysis

The quantitative assessment will involve a welfare analysis as described above. For each model, the deadweight loss will be calculated and from this, the component government and consumer surpluses that are generated by each model (relative to another base model). We will use these surpluses to determine a total change in welfare. This section describes the variables used in the static welfare analysis and how they enter our calculations.

Variables

The theoretical background above and the reports reviewed in chapter 4 highlight a range of variables that affect the welfare of a cost recovery or marginal cost pricing model. These are summarised in Table 6.

Table 6: Parameters that affect the size of the consumer and producer surplus

Variable	Why important
Proportion of fixed (FC) relative to total costs (TC)	A higher proportion of fixed costs relative to total costs increases the size of the deadweight loss under full cost recovery
Administrative costs	Higher administrative costs will reduce welfare Each pricing model requires decisions around issues such as price, set of data products produced etc., which carries associated costs
Cost of public funds (β)	A higher cost of public funds increases the loss from government funding the fixed costs under a marginal cost pricing model
Government share of consumption (g)	A larger government share of consumption reduces the need to raise public funds to cover the fixed costs under marginal cost pricing model. It also increases the share of benefits accrued by government from elimination of the deadweight loss.
Elasticity (ε)	The deadweight loss under full cost recovery is higher where demand is more elastic
Multiplier (λ)	A larger multiplier increases the size of the deadweight loss arising from full cost recovery
Proportion of purchases by firms	If firms pay tax, a larger proportion of purchases by firms decreases the need to raise additional public funds to fund a marginal cost pricing model
Delay in benefits	If the benefits from changing to a marginal cost pricing model are delayed, a larger delay will reduce the net present value of the benefits of that change

3.2 Dynamic analysis

Changes in welfare between pricing models will also be analysed dynamically (over time) to illustrate the potential effects of a number of considerations that may affect welfare in the longer term. These include:

- **Funding implications: what are the funding implications of the model and what effect does this have on quality and other spatial information characteristics?**

- **Choice of quality: how does the pricing and access model facilitate the choice of the appropriate level of quality?**

- **Competition and innovation: does the pricing and access model facilitate competition and innovation in the production of spatial data products and their use.**

Previous analyses in the literature of the costs and benefits of public sector information pricing policies have typically not been incorporated the first two of these considerations.

3.2.1 Funding implications

We can examine funding implications and changes in quality through shifts in the supply and demand curve. For example, if central government reduced the level of funding provided to a land information agency for the production of spatial data, this would reduce the level of expenditure on spatial data production and result in a downward shift of the average cost curve. We would also expect the reduction in cost to reduce the quality of the spatial data. In that case, the demand curve would also move down, as purchasers would not be willing to pay the same price for a lower quality product.

If quality reduces and the demand curve shifts, the potential for welfare loss is increased, as it is not only the welfare of the marginal consumer that is affected. Reduced quality also reduces the welfare of purchasers who would purchase at a cost recovery price. This reduction in welfare is magnified further if there is a multiplier effect from the use of spatial data.

The interaction between the shifts in the demand curves over time will affect the total level of welfare that the model delivers. In this report, we examine some illustrative examples of this interaction and apply them to the Australian land information agency case studies.

3.2.2 Competition and innovation

Competition is a driver of productive efficiency. While a welfare analysis provides an indication of net benefits based on production and supply of a spatial data product for a certain cost, it is quiet on whether that cost of production is efficient. Lower cost production will increase the net welfare under any of the pricing models. If there is only a single producer of a product, or they are providing the product at a price against which no one else can compete, this will prevent competition from being a driver of productive efficiency.

Competition is also relevant in downstream markets. A pricing and access scheme that facilitates competition in downstream markets will increase productive efficiency in those markets. Broad availability of inputs might facilitate competition in this manner.

Competition is also a driver of innovation. On the one hand, competition might drive productive efficiency by creating incentives for innovation in the production of spatial data products. Further, facilitation of innovation itself can improve welfare through the creation of new products and new uses for the products. The creation of new products

and uses increases welfare by providing goods that provide higher welfare to consumers.

As it is not easy to incorporate competition and innovation into a welfare analysis, we will discuss competition and innovation qualitatively in relation to each of the changes between models.

The availability of raw data products will also have competition and innovation implications. These are discussed separately in section 3.3.6.

3.3 Qualitative analysis

A number of theoretical considerations underpin the qualitative analysis undertaken in this report. This section seeks to explain the basis for these considerations and how we apply them to the models assessed. We then describe how the elements that will be qualitatively analysed in this report.

We noted a number of these qualitative features of the pricing and access models in the Stage One report.

3.3.1 Choice of quality

For many fundamental datasets, land information agencies face a choice as to what quality they should develop the fundamental data. Dimensions of quality requiring consideration include features such as accuracy, currency and resolution.

The choice of cost recovery regime may influence this choice and the ability of the agency to determine the appropriate level of quality.

Suppose that an agency can choose to produce fundamental data at two different levels of quality. Production to a higher quality incurs extra cost. In what circumstances should the agency produce the higher quality data product? If the agency was only interested it its own welfare, it would increase quality until the increase in revenue (the marginal revenue) is equal to the increase in costs. However, this effective exercise of monopoly power is not welfare enhancing for society as a whole.

If the agency was interested in total welfare and currently priced using a cost recovery pricing model, the agency should produce the product to the higher quality if the total consumer surplus increases with the increase in quality and price. However, as is discussed below, this benchmark may result in underproduction where the spatial information has public good characteristics.

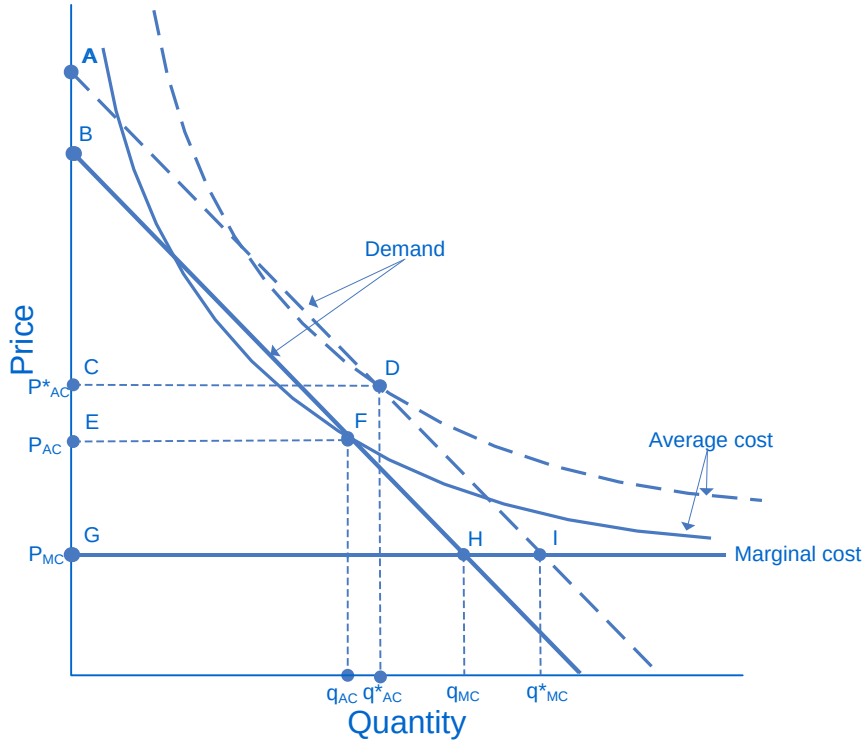
Figure 5 is one diagrammatic representation of the possible implications of a change in quality. In this figure, an increase in quality results in higher fixed costs of production, leading to a higher average cost (the dashed average cost line) but also higher demand for the data product (the dashed demand line).

If price was initially set at average cost (P_{AC}), the increase in quality increases the price paid by consumers (to P^*_{AC}) and the quantity demanded at that price (q^*_{AC}). Although quantity increases in this diagram, whether the quantity consumed at the higher price is greater than that initially would depend on the specific case. The change in welfare also

depends on the specific case and is an empirical question that depends upon the size of the consumer surplus before (area BEF) and after (area ACD) the change in quality.

In this diagram, we assume that marginal cost is constant, reflecting a constant cost of extraction and distribution regardless of quality. If price were set at marginal cost, increased quality leads to increased consumption of the product (to q^*_{MC}). The change in welfare resulting from an increase in quality with marginal cost pricing would depend on the trade-off between the increase in consumer surplus (which is unequivocally positive – from Area BGH to Area AGI) and the cost of public funds associated with increased expenditure by government.

Figure 5: Supply demand relationship with change in quality



We should note that we could draw this diagram in a number of other ways. If the shift in the demand curve was smaller than the shift in the average cost curve, there may no longer be an equilibrium price where cost recovery is possible. Alternatively, if only a small proportion of purchasers desired the data at higher quality, the demand curve may shift in a way that increases its slope or sees the upper portion of the curve shift outwards by a greater amount. In each of these cases, the question of whether production of higher quality data is welfare enhancing would be an empirical question.

Finally, the way in which we drew this diagram implicitly assumes that the original lower quality data are no longer available. If both the low and high quality data were available, the demand curves for each are likely to be more complex, with some customers likely to be satisfied with the lower quality data despite the availability of the higher quality data set. If the lower quality data are not available, this raises competition questions of the type addressed later in this report.

A further problem is that empirically determining shifts in the demand curve in response to data quality changes is difficult, particularly where an agency supplies data at a price equal to marginal cost. In that case, the agency could estimate the demand curve from

requests from customers to produce the data to a higher quality, but this may not be a reliable signal that the agency should increase quality as the requesting party faces a price less than the cost of production. The agency needs other tools to determine if the extra cost would create additional value of a level commensurate with that cost.

3.3.2 Public good characteristics

A good is a public good when its provision to one consumer does not affect its availability and cost to others (non-rival), and after provision to the initial customer, it is then available to all others (non-excludable). Public goods are non-rivalrous, meaning that use of data by one customer does not reduce the amount available to others, and non-excludable, meaning that once the data are available to some, they cannot preclude others from using or re-using it. The Productivity Commission (2001) also suggested that from a public policy perspective, the non-excludability of a good should be assessed from the *desirability* of excluding use.

As a public good is non-excludable, it needs to be provided only once. If the good is purchased or provided, all consumers benefit. The welfare gain from the purchase of a public good by an individual is not just the gain by the purchaser but also includes the amount that the other users gain (i.e. how much each of those individuals would have been willing to pay for the good themselves). This total welfare gain of all consumers is the relevant benchmark for whether government should provide a public good. Further, if a good is non-excludable, there may not be any willing buyers as each seeks to free ride on the purchase of others.

Accordingly, where there is a simple yes or no decision as to whether a public good should be provided, it should be provided where the sum of the willingness to pay of the consumers (the consumer surplus at zero marginal cost) exceeds the cost of provision (adjusted by the cost of government funds). This is equivalent to the welfare analysis, presented in section 3.1.1, where there is zero marginal cost.

There are also cases where the decision to supply a public good is not a binary decision but incorporates various levels of provision of the public good, such as variations in quality. As for the binary case, an agency should base the decision of whether to provide the public good on the benefit accruing to all consumers. To examine how an agency might make the decision, consider provision of the good at its lowest quality. If expenditure of one dollar to increase quality (adjusted for the cost of government funds) resulted in a greater than one dollar increase in welfare across all consumers, quality should be increased until the point that a further increase in expenditure does not result in an equivalent increase in total consumer welfare.

As for quality generally (see section 3.3.1), **we cannot conduct an analysis of the optimal quality of public goods through a simple welfare analysis without confronting significant issues concerning the estimation of demand curves.** As a result, analysis in this report restricted to qualitative discussion.

3.3.3 Positive spillovers

Fundamental data may produce positive spillover effects. Spillover effects (or externalities) are indirect welfare effects on firms or individuals other than producers or consumers of the good. They can be positive or negative.

The use of a multiplier in the welfare analysis may account for some positive spillovers. However, the use of a multiplier is unlikely to capture non-commercial benefits such as

public benefit from better decision-making or improved accountability. Accordingly, we discuss positive spillovers qualitatively.

3.3.4 Equity

The welfare analysis can assist analysis of the equity of a pricing and access model through its identification of the welfare change for the major parties associated with the production and use of spatial data products. This provides a basis for the assessment of some facets of horizontal equity – whether those who benefit pay. However, the analysis is quiet in relation to some parties, such as taxpayers, and it provides a limited perspective on vertical equity – whether those who have the greatest capacity to pay are those who are paying.

3.3.5 Complexity

Complexity can cause a loss in welfare due the resources that must be dedicated to operating in a complex environment. Complex licensing arrangements, for example, can increase administrative costs and transaction costs (for both producers and customers), and create non-price barriers to access.

Data relating to complexity, such as administrative costs, is obtained from a number of case studies of shifts between pricing and access models. We use the observations from these case studies to inform the qualitative discussion of the complexity of each of the pricing and access models.

3.3.6 Hard constraints to access

We conduct the welfare analysis in this report for a particular data product and under the assumption that the product is freely available at the price determined by the pricing model. Where an agency does not allow access to that product at any price, the welfare under any of the pricing models is lost.

From the perspective of the four pricing and access models examined in this report, there are no direct hard constraints to access. However, under various permutations of each model, there is a question as to whether the agency should make ‘raw data’ available. Raw data are defined as the unprocessed data underpinning fundamental data. In some circumstances, land information agencies maintain a monopoly on production of most fundamental data because they do not sell or release the raw data precursors.

This question cannot be examined by simply analysing the welfare of raw data sales and assuming that welfare is lost if it is not available. This is because the sale of the raw data is likely to affect the sale of processed data products and the welfare associated with those sales. Data on the relationship between raw and processed product sales were not available for this report.

Accordingly, for each pricing model, we will qualitatively discuss the implications of allowing access to raw data under each of the four pricing models.

3.3.7 Product-by-product basis

The Stage One report contained a principle that pricing for data products should be set on a product-by-product basis. Different fundamental data products will have differing level of public good characteristics and positive externalities, differing degrees to which different parties capture the benefits and varying levels in which it might contribute to public policy decision making or government accountability. With this variation in attributes between fundamental data products, it is unlikely that a uniform agency level pricing and access policy will be appropriate.

Only one of the models established for assessment in this report was set up to price products on this basis – the free fundamental data model. On that basis, we will not qualitatively discuss the implications of each model under this principle.

4 Previous cost-benefit studies

This chapter reviews five previous reports that have analysed the costs and benefits of different pricing regimes for public sector information. A number of common threads can be drawn from these reports:

- **Marginal cost pricing is preferred where there is high price elasticity of demand (i.e. demand is sensitive to price) and low marginal cost (relative to fixed costs), as in these circumstances average cost pricing (full cost recovery) results in a larger distortion (or deadweight loss).**
- **For tractability of analysis, the demand curve is assumed to be linear.**
- **The assumptions of elasticity and marginal cost vary from one report to the next.**
- **Some assumptions used to underpin the earlier reports may no longer hold.**
- **They generally do not incorporate analysis of quality or dynamics.**

The assumptions underpinning the analysis in each report are highly dependent upon the date of the report and vary depending upon the evidence examined and the method of calculation used. The two studies published prior to the spread of access to fast broadband assume inelastic demand and high marginal cost of dissemination. The methods of calculation of elasticity also vary, with the choice of base for the price change in the earlier reports resulting in lower estimates than could be obtained through using the new price and quantity data point as the base (see section 3.1.1).

4.1 HM Treasury: *The Economics of Government Information*

As part of the 2000 spending review, the United Kingdom's HM Treasury (2000) considered the economics of government information (not specifically spatial data) and the implications of deviating from a price equal to the long run marginal cost. Marginal cost may be higher over the long run as expenditure that is fixed on a day-to-day basis may be varied over a longer period.

The report compared the costs from the distortion (namely, loss in consumer and producer surplus) associated with average cost pricing (full cost recovery) to the distortion arising from government funding under marginal cost pricing, with the marginal social cost of raising public funds was assumed to be around 20-30 per cent of the extra tax receipts. The report's authors theorised that government should provide the subsidy to allow pricing at marginal cost if the distortion associated with full cost recovery is greater than that for providing government funding.

Whether this occurs depended upon the elasticity of demand and the size of the government subsidy relative to total costs. In the case of constant marginal cost, the level of government funding is equal to the fixed costs. A higher elasticity of demand or a higher proportion of government funding (i.e. high fixed costs relative to variable costs) implies that there will be a larger distortion associated with full cost recovery pricing, make marginal cost pricing more attractive. While a higher proportion of fixed costs increase the level of government funding required under marginal cost pricing, high fixed

costs result in a higher average cost relative to the marginal cost, resulting in a larger distortion.

HM Treasury assumed that both elasticity of demand and the size of the fixed costs relative to total costs were low. They considered that the magnitude of scale economies would be less than short run increasing returns, putting long run fixed costs between 10 and 30 per cent of total costs. HM Treasury assumed elasticity of demand was inelastic, as information is an input into production and should be a small proportion of input costs. This was effectively as assumption that the customers were firms. They gave an example where if the price elasticity of a product was two and the information costs 10 per cent of total costs, the derived elasticity of demand for the information products would be 0.2.

Under these assumptions, HM Treasury considered that, in general, the distortions from taxation exceed the distortions associated from pricing at a full cost recovery price, so an agency should seek full cost recovery. HM Treasury noted, however, that in the case of some agencies that raise little revenue from sales, and as a result are already paying the fixed costs, marginal cost pricing will result in little excess tax burden, with little additional burden incurred through additional sales to the public.

Our critique of the findings

The HM Treasury analysis assumes lower elasticity for government information than is assumed in more recent examinations of elasticity, such as Pollock et al (2008) and the results of those made in this report. The low elasticity assumption could be due to the internet being in its infancy. However, HM Treasury does note that if demand were to become much more elastic at low prices, the distortion would only be greater at the bottom of the price range.

The HM Treasury paper also assumes that fixed costs form a smaller proportion of total costs than might be considered the case for most spatial data. The shift to electronic distribution has significantly reduced the marginal costs of production. The estimate that fixed costs are around 10 to 30 per cent of total costs would be well below modern estimates. In the calculations presented in the HM Treasury paper, proportions of 70 per cent to 90 per cent, which might be more accurate today with electronic distribution, result in marginal cost pricing having a lower distortion than full cost recovery for all elasticities above one.

Ultimately, the low estimates of elasticity and fixed costs as a proportion of total costs drive the conclusion that full cost recovery would be welfare enhancing for trading funds.

The analysis also considers only private sector purchases. If a large portion of purchases is by the government sector, as is the case for many spatial information products, a shift to a marginal cost pricing regime has no taxation inefficiency associated with the funding of the government purchases. This is because it has no net budget impact at a whole of government level. This weights the analysis toward cost recovery.

Although public good characteristics are noted, the HM Treasury analysis does not contain any adjustments for public good characteristics or positive spillovers by a multiplier. This naturally has the effect of assuming a multiplier of one.

4.2 Berenschot: *The Wealth Effects of Different Methods of Financing Electronic Databanks*

The Dutch Ministry of the Interior and Kingdom Relations commissioned Berenschot and NEI (2001) to study the effect on wealth of various forms of funding access to electronic databanks. Three of the four databanks examined were engaged in the distribution of spatial information. These were:

- the Large-scale base map of Rotterdam of the Municipality of Rotterdam
- the Current Elevation Model of the Netherlands of the Survey Department of the Directorate General for Public Works and Water Management
- the Top-10 Vector Databank of the Netherlands Topographical Agency.

For these databanks, the wealth effects of changing from the current pricing regime to full cost, marginal cost and zero cost pricing policies were examined, with the wealth effects broken down into the following categories:

- microeconomic effects: changes in consumer surplus, changes in producer surplus and changes in the use of alternatives (substitutes)
- mesoeconomic effects: changes in demand for alternative products, derivative products, competition, quality changes and transparency
- macroeconomic effects: the public sector budget, employment, the democratic process and foreign trade.

In each case, Berenschot found the microeconomic wealth effects of marginal cost pricing to be positive when compared to alternative pricing policies. The effects were generally low, however, as it was determined from survey data that demand among current customers was inelastic. Berenschot also assumed the potential for new customers was low due to the complexity of the data and the technical skills to utilise them.

Berenschot qualitatively assessed the meso and macroeconomic impacts. The potential impact on quality through lower income was noted, as was the potential for increased transparency and democratic participation

Our critique of the findings

The Berenschot study considers many factors that the other cost-benefit analyses of pricing spatial information reviewed in this report did not incorporate. This includes affects on transparency, the quality of the spatial information and facilitation of participation in democracy. However, the difficulty in incorporating these factors into a cost benefits analysis limits analysis to these factors to qualitative review.

The microeconomic wealth effect varies from other reports in this area by not incorporating the efficiency cost of raising government funds. Inclusion of this cost may have changed the balance of the microeconomic wealth effect impacts.

Berenschot based the low elasticity used in the analysis on a survey of existing customers. They assumed there was little potential for new customers. Additionally, and as for the HM Treasury report, the outcomes of this report reflect the time of its release

and pre-date the full spread of high-speed broadband access and the increased accessibility and use of digital products.

The consideration of competition and the ability of the private sector to produce some spatial information products reflected the age of the report. For example, Berenschot considered that were was small likelihood of any competition in production of the elevation model of the Netherlands as private individuals not capable of developing a database of this kind. The entry into the market of firms such as Intermap with this capability has resulted in a more competitive environment than was considered possible at the time.

4.3 Pollock et al: *Models of Public Sector Information Provision via Trading Funds*

The Department for Business, Enterprise and Regulatory Reform and HM Treasury commissioned a report on the pricing of public sector information held by trading funds as part of the Government's response to a report of the Office of Fair Trading into the Commercial Use of Public Information (BERR, 2008). The report by Pollock et al (2008) set out estimates of the costs and benefits of marginal cost pricing.

The approach by Pollock et al was similar to that of the HM Treasury report, although they considered a number of other significant factors. These included:

- consideration of firms as users of spatial information, with these firms returning taxation income to government
- discounting for differences in time between realisation of costs and benefits
- consideration of government as a purchaser of spatial information
- a multiplier effect.

Pollock et al also used a number of recent estimates of the elasticity of demand for information products based on experiences of information agencies moving to zero cost pricing models for online information.

As for HM Treasury, the cost of moving from a full cost recovery to marginal cost model (the payment of fixed costs by government) was compared to the benefits obtained (the transfer of the value of the fixed costs plus elimination of the deadweight loss). To obtain a meaningful comparison, Pollock et al made adjustments for the marginal cost of government funds, the proportion of revenue from government sources, the proportion of producer surplus down the value chain returned to government as tax and the delay in obtaining the benefits.

From this model, the preferred charging regime for different parameter ranges for elasticity (ε) and the multiplier effect (λ) was determined. As is shown in Table 7, for all elasticities above 0.5 (ranging from inelastic to elastic), it was found that marginal cost (MC) pricing is preferred. For elasticities below 0.5 (considered inelastic), the results are mixed. Where we list both, each regime is preferable at different parts of the range, with the pricing method in brackets preferred at the mid-point of the range.

Table 7: Preferred charging regime for different parameter ranges (Pollock et al, 2008)

		λ (multiplier)			
		1	1-2	2-4	4-10
ε (elasticity)	0.0-0.5	AC	AC/MC (AC)	AC/MC (MC)	AC/MC (MC)
	0.5-1.5	MC	MC	MC	MC
	1.5-2.5	MC	MC	MC	MC

While included in the analysis, the tax flow to the government and the time difference between the impact of the benefits and costs had minimal impact on the result.

Pollock et al then applied the model across six United Kingdom trading funds, including Ordnance Survey and HM Land Registry. They also considered a range of products within each trading fund, with the elasticity of demand, multiplier effect and proportion of product supplied to government estimated for each individual product.

With the exception of products from the UK Hydrographic Office, Pollock et al concluded that marginal cost pricing resulted in higher welfare than full cost recovery pricing for all products. This result was robust to reductions of the multiplier to one and the proportion of surplus going to producers to zero. In the case of Ordnance Survey, they estimated that the net benefit to society from a change to marginal pricing was £156 million.

Our critique of the findings

As can be seen in Table 7, the results of Pollock et al's analysis are entirely dependent on the elasticity of demand. If elasticity is lower than 0.5, average cost pricing may be preferred. Otherwise, marginal cost pricing is preferred. This implies that we will have to examine this parameter is some detail in this report.

While the authors have a large number of examples of high price elasticity, the examples relied on as a basis for assuming a high elasticity incorporate a price reduction to zero. As is shown in section 5.1.4 of this report, there is considerable evidence that the elasticity of demand is high where there is a shift to a zero price. This may be due to mental transaction costs, which is the effort involved in deciding whether to purchase or due to the inconvenience associated with payment. Both of these costs will be present even with a very low cost.

This raises two points. First, if elasticity is increasing as price drops and reaches a peak near a price of zero, the use of a linear demand line based on two data points, while resulting in a tractable solution, may result in over or underestimation of the deadweight loss. Second, a demand curve cannot be used to estimate the potentially significant value of uses that would only occur at a price of zero as a welfare analysis assumes that

if someone only purchases at zero price, there is no consumer surplus (or benefit to the consumer) from that purchase.

Pollock et al also assume that the surplus gain from a change to marginal cost pricing accrues solely to private consumers, rather than to government users. This assumption shifts the balance toward cost recovery pricing as government only incurs the cost of public funds where a source of funding external to government is lost.

4.4 Pollock, *The Economics of Public Sector Information*

Pollock (2009) simplified the model presented in Pollock et al (2008) by removing from the analysis tax flow to the government and the time difference between the impact of the benefits and costs. Pollock considered that these factors would likely have a small impact.

Pollock determined the preferred charging regime for different parameter ranges for elasticity (ε) and the multiplier effect (λ). As is shown in Table 8, the results are consistent with those in Pollock et al (2008) despite the omission of variables relating to taxation of firms and delays in benefits.

Table 8: Preferred charging regime for different parameter ranges (Pollock, 2009)

		λ (multiplier)		
		1	1-3	3-9
ε (elasticity)	0.0-0.5	AC	AC/MC (AC)	AC/MC (MC)
	0.5-1.5	MC	MC	MC
	1.5-2.5	MC	MC	MC

Unlike Pollock et al (2008), this report did not seek to examine specific trading funds or products.

Our critique of the findings

The assumptions and implications of this report are similar to those made in Pollock et al (2008). While it may be too simplistic to assume that all consumers have the same price elasticity of demand or that price elasticity does not vary across products, the results from Pollock (2009) and Pollock et al suggest that elasticity tends to be high enough to justify marginal cost pricing across all products. We will examine this assumption in this report as it may provide scope for a price discriminating model.

4.5 ACIL Tasman, *The Value of Spatial Information*

ACIL Tasman's (2009) analysis of the economic impact of spatial information on the Australian economy included consideration of the cost of inefficient access to data and the identification of the factors creating those inefficiencies.

ACIL Tasman noted a number of access issues with current arrangements. These included the lack of simple and effective access, poor quality metadata (information in the data that describes the data) and the lack of a consistent access framework. Costs of these problems included:

- slower development of applications
- less than optimal levels of application and innovation
- less penetration of spatial information into new areas.

For pricing, ACIL Tasman noted that fundamental data are a public good and that charging for cost recovery is inefficient, leading to sub-optimal economic outcomes. They cited the Productivity Commission (2001) report on cost recovery in support of this observation. ACIL Tasman noted that state governments in Australia have not implemented the Productivity Commission recommendations and that they were charging prices higher than marginal cost for fundamental data.

ACIL Tasman did not seek to quantify the economic loss due to the existing pricing policies. However, the authors noted that a more optimal use of fundamental data would have occurred under efficient pricing policies (i.e. policies implemented as per the Productivity Commission recommendations) and that this would have increased productivity and national welfare.

ACIL Tasman sought to make an approximate estimate of the impact of all of the impacts of inefficient access to data including lack of availability, lack of adequacy of spatial data infrastructure and the pricing and access issues noted above. While noting that they could not estimate the constraints on innovation with certainty, ACIL Tasman estimated that the economic impact of the spatial industry in Australia would have been around 7 per cent higher in 2006-07 in the absence of these constraints. ACIL Tasman estimated this by putting the predicted impact on productivity (by sector) through a general equilibrium model.

Our critique of the findings

While the quantitative estimate of the loss from inefficient access to spatial data should be viewed with caution (as ACIL Tasman itself notes), the qualitative observations concerning the impact of the loss is in accordance with the views of stakeholders expressed during consultations for this report.

One element worth highlighting is the observation that public goods should be provided at marginal cost, as was also recommended in the Productivity Commission's report. While not explicitly defining what they consider fundamental data, ACIL Tasman considers that all fundamental data are a public good (non-rivalrous, not desirable to make excludable) and equates to the 'basic information set' identified in the Productivity Commission report. Whether this proposition holds would depend upon a dataset by dataset assessment of the public good characteristics.

5 Data sources

In this chapter, we assign values (or ranges of values) to variables for the quantitative analysis of the different pricing and access models. For some factors that are examined qualitatively, this chapter also examines evidence of the direction and magnitude of their effects.

Sources of data in this chapter include:

- provision by land information agencies and other government agencies that distribute public information
- previous estimates in the literature
- agency annual reports.

5.1 Data for quantitative analysis

5.1.1 Costs

In this section, we use costs for the production, extraction and distribution of data by Landgate (Western Australia), Victoria's Department of Sustainability and Environment (DSE) and Geoscience Australia to obtain parameters for the modelling analysis undertaken in chapter 6. We use a sample of fundamental data products, and in particular, aerial imagery and topographic information products, to derive these parameters.

Western Australia topographic data

The Land Information Authority Regulations 2007 categorises 'land information that consists exclusively of basic topographic information' to be fundamental data. The regulations in turn define basic topographic information as 'land information representing the topography of the surface of the land (including the surface of the natural and the built features of the land)'.

For the production of fundamental topographic data by Landgate, the cost associated with production and maintenance (as opposed to extraction and distribution) incorporates more than 90 per cent of the total costs of providing topographic data products to customers. The production and maintenance costs include a share of agency overheads. The costs incurred for fundamental topographic data in the 2008-09 are shown in Table 9.

Table 9: Western Australia fundamental topographic data production and distribution costs 2008 ($000)

Item	Cost ($000)
Operating costs	929
Capital cost	276
Cost of production and maintenance	1,329
Policy development	70
Production and maintenance subtotal	**2,604**
Topographic extraction database	30
Delivery channel infrastructure costs	239
Extraction and distribution subtotal	**269**
Total	**2,873**

Western Australia aerial photography

The Land Information Authority Regulations states that land information that consists exclusively of aerial photographic images that, among other things, are:

- of the surface of the earth
- have been collected using funding allocated under the State Land Information Capture Program
- are presented in digital form
- have been modified to remove distortions caused by the camera lens, the curvature of the earth and the motion of the aircraft
- have not been modified in any other way.

As for topographic data, the costs associated with this fundamental aerial imagery are predominantly associated with production and maintenance, with this comprising over 90 per cent of the costs (Table 10).

Table 10: Western Australia aerial photography production and distribution costs 2008 ($000)

Item	Cost ($000)
Processing / maintenance	1,194
Database / Application infrastructure	343
Contracts	1,330
Policy development	70
Production and maintenance subtotal	**2,937**
Delivery (labour and shopfront)	190
Extraction and distribution subtotal	**190**
Total	**3,127**

Victorian topographic data

The topographic data products distributed by the Victorian DSE cannot be easily categorised into the fundamental data category used by Landgate, with the DSE distributing topographic data through its range of "Vicmap" products. A large number of Vicmap products including topographic data, including:

- Vicmap 1:50,000 and 1:25,000 scale published maps.
- Vicmap Topographic 1:30,000 Maps Online
- Vicmap Elevation - 1-5 Contours and 10-20 Contours
- Vicmap Hydrography
- Vicmap Vegetation
- Vicmap Features of Interest
- Vicmap Administrative Boundaries (Local Government Areas)
- Vicmap Transport
- Vicmap Property (parcel approved layer).

For the purposes of this costing exercise, we have grouped these products together as *topographic data products*, with Table 11 detailing the costs of production, maintenance, extraction and distribution.

Table 11: Victoria topographic data production and distribution costs 2009-10 ($000)

Item	Cost ($000)
Employees	$670
Spatial information policy setting	$692
Business operations	$1,089
Notification & editing service	$268
Custodial support functions	$637
Application support	$501
Professional services	$276
IT infrastructure & hardware	$866
IT software maintenance/support	$271
Maintenance IT equipment	$9
Map printing	$50
Vicmap product maintenance contracts	$2,615
Production and maintenance subtotal	**$7,945**
Telecommunications network / data infrastructure	$105
Customer engagement	$909
Advertising and publicity	$14
Sponsorships	$6
Extraction and distribution subtotal	**$1,035**
Total	**$8,980**

The DSE was not able to provide a precise split of expenditure between production and maintenance and extraction and distribution. Items such as IT infrastructure are aggregated across both functions. Accordingly, the above split is indicative only.

As is the case in Western Australia, the fixed costs of production and maintenance are the major part of total costs, with extraction and distribution costs representing only 12 per cent of the total.

The overheads costs associated with production of these products are large, particularly in relation to the level of revenue from these products. This is due to the way in which overheads are allocated between Victoria's fundamental data products. The DSE allocated eight percent of overheads to each product, with eight products considered part of the topographic product suite. Accordingly, the DSE allocates 64 per cent of overheads to the products examined in this part. The overheads are shown in Table 12.

Table 12: Victorian overheads in the production of fundamental data 2009-10 ($000)

Item	Cost ($000)
Spatial information management policy setting	$1,039
Departmental expenses	$1,634
Customer Engagement	$1,394
Application support	$752
IT infrastructure	$1,876
Total	**$6,695**

Of these overheads, $4,285,000 is allocated to topographic data products.

Geoscience Australia topographic data

Geoscience Australia produces a range of topographic data and maps. These cover all of Australia and are generally at the 1:250,000 scale, although they also provide some larger scale data on the Australian Capital Territory and smaller scale data products. They also use these data in the production of some hard copy mapping products.

The costs of production, maintenance, extraction and distribution are shown in Table 11.

Table 13: Geoscience Australia topographic data production and distribution costs 2009-10 ($000)

Item	Cost ($000)
Collection, processing and maintenance	$6,279
In-kind contribution (funds)	$659
In kind contribution (imagery)	$2,045
Product creation and support	$1,157
Overheads	$3,572
Production and maintenance subtotal	**$13,290**
Web download cost[1]	$2
Extraction and distribution subtotal	**$2**
Total cost	**$13,292**

[1] Based on 2008-09 web download cost. 2009-10 data not available.

As for the other agencies examined above, the split between production and maintenance and extraction and distribution is approximate. It is not possible to split the share of overheads between extraction and distribution and the production of the data, with items such as ICT service costs likely to be shared across both categories. Overheads comprise staff training and development, human resources support costs, workers compensation, organisational services costs, ICT services costs and property operating expenses.

Geoscience Australia also sells a number of DVD units of maps and data. Geoscience Australia had sales of $74,628 in 2008-09. The above figures also do not include hard copy map sales.

Another important point is that Geoscience Australia, as for other agencies, does not develop data in a vacuum. On the one hand, this is reflected in the in-kind contribution of funds and imagery by other jurisdictions and agencies towards the production of Geoscience Australia's products. Operating in the other direction, the costs incurred by Geoscience Australia in producing topographic data are higher than they would incur if they produced only the data required for their products. Geoscience Australia often collects data at higher resolutions than it requires based on jurisdictional requirements (under the National Topographic Information Coordination Initiative). This has the effect of both increasing Geoscience Australia's costs and reducing those of the agencies that benefit from the initiative.

Proportion of total costs from fixed costs

As was noted in HM Treasury (2001) report, the relative proportion of fixed to total costs is a significant factor in whether an average cost or marginal cost pricing regime preferred.

Where marginal cost is zero, fixed costs equal total costs. This was the basic assumption in Pollock et al (2008) for dissemination of information electronically.

From the Western Australian and Victorian cost data, there is no evidence to move from the assumption of zero marginal cost for online distribution. Geoscience Australia provides a more direct estimate of marginal cost, with the estimate that the cost of web downloads in 2008-09 were $1,842, a cost of $0.01 per MB. This is effectively zero in relation to the $13.3 million in total costs.

To draw out concerns of the land information agencies in relation to the costs associated with extraction and distribution, we will examine marginal costs of between 0 and 25 per cent of the total cost for the general welfare analysis. For specific data product case studies, we will use a marginal cost of zero. If we alternatively assumed that all costs of extraction and distribution are avoidable, we could have a marginal cost of up to 15 per cent of the price. However, this makes would have only minor effects on the quantum of the welfare change is the case studies and would not change the direction of the welfare effect.

Administrative costs

Each of the pricing and access models under consideration carry related administration costs. In the case of a cost recovery pricing regime, there are costs associated with pricing, licensing and customer service. A free online access model avoids some of these costs but may result in other costs such as an increased level of customer contact and the need to use of demand measurement mechanisms as a substitute for pricing.

This section examines some evidence of the scale of these administration costs.

Cost of administering pricing and access regime

Landgate estimated that it engages 1.1 full time equivalent employees in the pricing and 2.1 full time equivalent employees in the licensing of fundamental data products. This staff time costs approximately $250,000. As noted above, the Victorian Department of Sustainability and Environment spends $909,000 on customer engagement under its current pricing model.

Evidence from the scale of administrative savings from agencies that have moved to a free online pricing model indicates that they may be significant relative to the scale of the revenue lost through the change in pricing model.

During consultations, the Australian Bureau of Statistics estimates that it gained efficiencies of approximately $400,000 through the decision to release all online products for no charge. This is over 10 per cent of the lost revenue of $3 million.

The New Zealand National Institute of Water and Atmospheric Research (NIWA) estimated the reduction in administration costs more than covered $NZ120,000 in revenue lost through removing access charges for the National Climate Database.

Statistics New Zealand also identified a number of efficiencies resulting from the decision in 2007 to remove charges for the Streetlink and Digital Boundaries products. These included:

- no need for billing, payment collection or receipting
- ne need for price determination
- no need to deal with resellers
- no need for licensing, such as signing licence documents.

This in turn allowed Statistics New Zealand to reallocate staff within other functional areas. Quantification of these efficiencies was not available, although they were not of a scale to cover fully the lost revenue, with direct government funding making up most of the gap.

These figures are likely to under represent the full scale of administrative costs as they do not capture the administrative costs incurred by the private sector in their dealings with pricing and licensing issues.

Cost of administering free online pricing and access policy

The administrative costs associated with the shift to a free online distribution model might arise through the increased number of customers and the need to identify alternative means to determine levels of demand for information products.

After the Australian Bureau of Statistics removed charges for online products, the total level of contact remained roughly flat, despite the increase in the number of downloads and page views. There has been, however, a shift towards using email as a method of customer contact during the last five years. These trends are shown in Table 14.

Table 14: Number of customer emails and calls completed by the Australian Bureau of Statistics (ABS, 2009)

Year	Emails	Calls	Total
2004-05	12,862	60,820	73,682
2005-06	12,588	56,257	68,845
2006-07	14,278	58,040	72,318
2007-08	15,772	56,739	72,511
2008-09	16,293	50,716	67,009

One method of assessing demand utilised by the ABS are user groups through which the ABS consults with stakeholders concerning its work program. These groups discuss data collection requirements such as question format and data collection techniques. However, these user groups were in place before the change in pricing policy and the ABS does not consider that the number of user groups has changed significantly as a result.

The removal of charges for NIWA's National Climate Database resulted in an increase in inquiries from users. These inquiries included lost passwords (registration is required to access the database), data inquiries and users pointing out errors. However, NIWA considered that the efficiency gains from moving away from charging still outweighed the lost revenue.

Administration cost assumption

Administrative costs were not typically included in previous assessments of land information pricing models. In cases where the report authors explicitly noted them, they generally set them to zero. As the authors considered that administrative costs were higher under the cost recovery model, they saw this as a conservative assumption that weighted the analysis towards cost recovery pricing. It was on this basis that Pollock et al (2008) assumed that the administration costs associated with a pricing and access regime were zero.

This appears to be a sound assumption, with the administrative costs associated with cost recovery appearing to be an order of magnitude larger than those caused by an increased user base. However, in the case of the ABS and NIWA noted above, they removed all charges from the online product as opposed to the release of only selected products, enabling them to avoid fully certain administrative functions.

Accordingly, while we should note administrative cost implications, we will not incorporate them into the quantitative cost benefit analysis.

5.1.2 Revenue and government share of consumption

For fundamental land information in Western Australia, government is the dominant consumer. Between 1 July 2009 and 14 May 2010, Landgate obtained revenue of $1.15 million through the sale of fundamental data. Of this, $1,000,000 was from commercial sources, $3,500 from government and $150,000 for non-government, non-commercial users. However, Landgate provided discounts of $7.95 million for fundamental data products to government users of the information. By value, government is responsible for over 85 per cent of fundamental data consumption. By number of items, the government share is even higher, with Landgate providing 98 per cent to government (115 million of 117 million).

This pattern of use is similar for individual Landgate datasets. The smallest share of government consumption is for aerial photography where commercial consumers purchase $575,000 worth of aerial imagery, non-government non-commercial users consume $45,000 worth and government users consume $1.15 million worth. This puts the government share at around 65 per cent. On a quantity basis, government users consume over 99 per cent (106 million of 107 million). For topographic data, commercial users purchase $158,000 of data, non-government, non-commercial users purchased $27,000 (for $20,000) and government users consumed $2.93 million worth, putting the government share at close to 95 per cent. The government share was similar by number of units supplied.

The above figures exclude royalty payments, such as those that come from provision of data to the PSMA. In the case of royalty payments from the private sector, exclusion of these is appropriate or royalty revenue would artificially inflate the private share of consumption. Royalties from the PSMA, which totalled just over $200,000 in 2008-09, are excluded for a similar reason.

These figures also exclude the proportion of fundamental data production costs covered through the sale of value added products. This is unlikely to distort significantly the result as the fundamental data proportion of the value added revenue is small.

This government share for these datasets must be viewed with caution as government and commercial consumers face different prices and the government share may be significantly smaller if government users also paid a cost recovery based price. However, to approach a level of use equal to that of commercial users (i.e. a government share of 50 per cent) would require government to have a high price elasticity of demand. For example, if government consumption was to halve due to the introduction of cost recovery pricing for their purchases (giving an upper bound elasticity of two), the government share would still be 40 per cent for aerial photography and 90 per cent for topographic data.

For fundamental land information products supplied by Victoria's DSE in 2008-09, DSE received $3.41 million in revenue, with $1.88 million of that revenue from government. In addition to the over 580 digital products sold in 2008-09, over 200 were provided at no charge within government. In addition, the DSE also provides 78 Victorian local councils, catchment management authorities and educational institutions with access to a range of Vicmap products at no charge.

From the revenue figures alone, the government share for the DSE's fundamental data products is approximately 55 per cent. Given the additional products distributed free of charge, the actual government share is likely to be higher. However, we will use the 55 per cent figure for the subsequent analysis, weighting the analysis slightly towards cost recovery pricing.

There is no breakdown between government and private users available for the topographic data or other fundamental data products produced by Geoscience Australia.

These figures are also typical of other jurisdictions. Tasmania's Department of Primary Industries, Parks, Water and Environment receives $18,000 per annum from the sale of spatial information. However, under data sharing agreements with local and state government and the private sector, data to the commercial value of $17.8 million in transferred, of which $5.8 million is to customers external to the department (Table 15).

Table 15: Value of spatial data sharing by Department of Primary Industries, Parks, Water & Environment ($000)

User	Value
Local government and water utilities	$300
State government	$5,300
Intra-departmental	$12,000
Private sector	$200
Total	**$17,800**

No division of revenue between fundamental and non-fundamental data is available for Tasmania.

Queensland's Department of Environment and Resource Management receives around $2 million per annum from the sale of spatial information. Of this, around $280,000 relates to products that would be classified as fundamental under the classification used by Landgate in Western Australia.

Government share of consumption assumption

From the above evidence, PwC will make an assumption of a substantial government share in the analysis in this report. For general analysis, we use a government share of 0.5, which is towards the lower bound of the level of government use. The use of a share near the lower bound will slightly favour cost recovery pricing.

For the welfare analysis of specific data products from Victoria and Western Australia, we should estimate the government share based on both government and private users facing the same price. If government faces no price and private users a cost recovery price, the government share will be inflated. For the cost-benefit analysis, we will assume that government consumption will halve with the introduction of a price. The shares derived by this method are shown in Table 16.

Table 16: Government share of consumption for welfare analysis

Product	Government share
General	0.5
Landgate topographic	0.9
Landgate aerial	0.4
Victoria topographic	0.55
Geoscience Australia	0.5

We will also assume that government is one of beneficiaries of the elimination of the deadweight loss. We have done this to capture improved decision-making and service delivery and cost efficiencies that arise from the improved access to information.

5.1.3 Marginal cost of public funds

One estimate for Australia is that for $1 of tax revenue, the marginal cost is $1.24, meaning that government funding should only be procured where benefits outweigh costs by a factor of 1.24 (Campbell, 1997). HM Treasury (2000) put the marginal cost of public funds in the United Kingdom at around 20 to 30 per cent of the funds raised.

For the welfare analysis in chapter 6 a marginal cost of public funds of 1.25 is used, conservatively weighting the analysis towards a cost recovery model.

5.1.4 Elasticity

Price elasticity of demand is a ratio of the increase (decrease) in demand for a product where there is a decrease (increase) in the price of that product.

Elasticity can be determined though examination of changes in demand in response to price changes. However, as elasticity is typically measured at a point and the available data usually relates to large price changes, there are measurement issues. A range of elasticities can be determined from a single change in price and demand, dependent on the choice of the original or new price and quantity data point as the point from which the elasticity is measured. The use of a single change in price and quantity also provides no evidence as to how elasticity varies along the full length of the demand curve.

Estimates of elasticity in the literature

While HM Treasury (2000) examined a range of possible elasticities in its cost-benefit analysis, it considered that the elasticity was around 0.2 for public sector information.

HM Treasury based this on the assumption that information is an input into production and a small proportion of input costs.

The Office of Fair Trading report on *The Commercial Use of Public Information* (2006) derived a number of estimates of elasticity for public sector information. They used sales and revenue changes that resulted from the introduction of cost recovery for mapping data in New Zealand[2] to derive an elasticity of 0.3. However, Pollock et al (2008) pointed out that 0.3 was a lower bound and that they could derive an upper bound of 2.2.

Similarly, the Office of Fair Trading derived an elasticity of 1.7 from a study in the Netherlands that predicted a 60 per cent price drop for public sector geographic data would lead to 40 per cent annual turnover growth (Bedrijvenplatform, 2000). Pollock et al calculated a lower and upper bound elasticity of 0.48 and 4.17 using those figures.

From the above, the Office of Fair Trading concluded that the elasticity of demand for public sector information is relatively low, with the low, medium and high elasticities for their analysis being set at 0.3, 0.8 and 1.5 respectively.

In addition to the calculations noted above, Pollock et al (2008) examined a number of elasticity estimates from other literature and data from previous pricing changes.

One example examined was the release of material on the ABS website free. Before the June and December 2005 announcements releasing publications and data for no charge on the ABS website, the ABS charged a flag fall for data, with the total cost dependent on the number of cells. The period following the change in policy saw a rapid increase in downloads from the website, as is shown in Table 17 (the drop in 2008-09 reflects the timing of Census releases).

Table 17: Australian Bureau of Statistics – downloads from website

Year	Downloads
2003-04	948,956
2004-05	962,872
2005-06	1,868,280
2006-07	4,501,530
2007-08	7,029,854
2008-09	3,150,630

Using the average dissemination in 2003 to 2005 and 2005 to 2007 as the old and new quantities, Pollock et al estimated an elasticity of 2.33. The quantity of downloads continued to increase after 2006-07, although increased internet usage may have plated some role.

[2] As described in Longhorn and Blakemore (2004)

Pollock at al also determined an elasticity from data obtained under the *Commonwealth Policy on Pricing of Fundamental Spatial Data*. Since the policy's introduction, there has been a rapid increase in the number of datasets obtained, as shown in Table 18. Pollock et al determined an upper bound elasticity of 10.45. As this large increase may be in part attributable to increased availability and use of information technology, Pollock et al also calculated the elasticity by de-trending the data by the level of increase in ABS downloads over that same period (which is before the change in ABS policy) and obtained a revised elasticity of 1.65.

Table 18: Datasets obtained under *Commonwealth Policy on Pricing of Fundamental Spatial Data* (OSDM, 2003 to 2007)

Year	Datasets
2001-02	75,310
2002-03	83,049
2003-04	52,565
2004-05	219,821
2005-06	862,530

Pollock et al also derived elasticity estimated for spatial data products released by Statistics New Zealand for no charge: Streetlink and Digital Editions. However, since Pollock et al made these estimates, further data has become available and we have made new estimates below.

Updated elasticity data

Statistics New Zealand

Before 7 July 2007, Statistics New Zealand charged the prices shown in Table 19 for its Streetlink and Digital Boundaries products.

Table 19: Prices for Statistics New Zealand Streetlink and Digital Boundaries data products

Product	Price
Streetlink	$NZ6,000 plus GST for first supply $NZ2,000 plus GST for annual updates
Digital Boundaries Level One	$NZ25,120 plus GST
Digital Boundaries Level Two	$NZ3,300 plus GST

On 7 July 2007, Statistics New Zealand removed the charges from these products. As is shown in Table 20, this caused a large increase in downloads.

Table 20: Purchases and downloads of Streetlink from Statistics New Zealand (Cosgrove, 2007b, communication with Statistics New Zealand)

Date	Streetlink	Digital Editions
Jul 2006 to Jun 2007	8	47
Jul 2007	75	250
Aug 2007	20	35
Sep 2007	29	16
Oct 2007	25	31
Nov 2007	20	26
Dec 2007	17	220
Jan 2008	26	321
Feb 2008	24	203
Mar 2008	23	236
Apr 2008	28	214
May 2008	28	175
Jun 2008	24	196
Jul 2008	25	158
Aug 2008	23	176
Sep 2008	25	150
Oct 2008	20	131
Nov 2008	26	141
Dec 2008	24	122
Jan 2009	24	199
Feb 2009	21	150
Mar 2009	31	200

Seventy-five downloads of Streetlink occurred in July 2007 compared to 8 downloads in the previous year. A similarly large increase occurred for the Digital Editions products.

Pollock et al (2008) calculated an upper bound elasticity of 34 from the initial increase in Streetlink distribution. As only the July 2007 data was available and it likely represented

a short term upsurge of latent demand (as subsequent data showed was the case), Pollock et al calculated the elasticity on the basis that 75 downloads were made over the *year* following the pricing change. Using a similar approach for Digital Editions, Pollock et al calculated an upper bound elasticity of around six.

With the data through to March 2009 available for this report, we can make an alternative calculation. From August 2007 to July 2008 (omitting the July 2007 outlier), 289 downloads of Streetlink were made. This gives an upper bound elasticity of 35. For the Digital Editions products, allowing a period for demand to settle, 2012 datasets were downloaded between April 2008 and March 2009. This number gives an upper bound elasticity of 42.

Government and private sector elasticity

One element of elasticity for which there is little evidence is whether government and the private sector have different elasticities of demand for different products. To obtain this data would require evidence arising from changes to price discrimination policies and from price discrimination to a marginal cost model.

Variation in elasticity

With a linear demand curve, a certain absolute price changes results in a constant absolute change in quantity, resulting in the elasticity of demand decreasing towards zero as the price nears zero. The above evidence does not provide strong support for a linear demand curve assumption. The elasticity estimates are highest when an agency reduces the price to zero, suggesting absolute changes in quantity increase as price approaches zero. Given this, a demand curve that is flatter at lower prices, such as a constant elasticity curve, may be a better approximation.

As is noted above, the choice of demand curve may have implications for the calculation of deadweight loss. The evidence addressed above suggests a case for considering alternative demand curve shapes as part of the analysis.

A theoretical consideration

If demand for a good is elastic (i.e. elasticity greater than one), the seller of the good can increase their revenue by decreasing the price. This is because for any decrease in price, quantity will increase by a greater proportion.

Accordingly, if the elasticity estimates above are accurate and there is elastic demand for spatial (or other government) data, the agency could reduce price and increase revenue. This raises the question of why government has not taken this action, or alternatively, why the government is pricing at a level above that required to recover costs.

Possible resolutions to this question include lack of responsiveness by government (as it is a natural monopoly), large changes in demand around a zero price inflating the elasticity estimates or a non-zero marginal cost of production. In the first case, a reduction in price with the maintenance of a cost recovery policy would enhance welfare, while in the second, we need to again consider the consequences of variation in the shape of the demand curve. Finally, if the additional revenue is not sufficient to cover the marginal cost of each additional unit, it would not be optimal to increase price. However,

this final explanation is not reflective of the near zero marginal cost of electronic distribution.

Elasticity values for analysis

Due to the broad range of elasticity estimates and the potential for variation in elasticity as price approaches zero, the cost benefit analysis in this report will test across a range of elasticities. The tested elasticities are 0.3, 0.5, 0.75, 1 and 2. The lowest elasticity of 0.3 matches the lowest of any observed elasticity (although this is above the HM Treasury estimation of 0.2). As was shown in previous cost-benefit analyses, elasticities above two strongly favour marginal cost pricing across all feasible ranges of the other parameters.

We also test these elasticities for linear and constant elasticity demand curves. In the case of the constant elasticity demand curve, only elasticities less than one are considered. For the zero marginal cost case, an elasticity above one results in an infinite deadweight loss for any non-zero price.[3]

Finally, for the case studies relating to specific data products, we will use an elasticity of one. While above the lowest estimates in the literature, an elasticity of one is below modern estimates involving products distributed online. We do not have adequate data to differentiate the elasticities between different data products.

Table 21: Elasticities of demand for welfare analysis

Product	Elasticity
General	0.3, 0.5, 0.75, 1, 2
Landgate topographic	1
Landgate aerial	1
Victoria topographic	1
Geoscience Australia	1

5.1.5 Multiplier

There is little empirical evidence of the size of the multiplier effect that results from the production and distribution of fundamental data. To determine the size of consumer surplus down the value chain would require detailed demand data at each value chain step. The multiplier impacts of innovation and dynamics would require detailed time series data at an industry level. Data of this nature is not available.

Pollock et al (2008) reviewed some examples that indicated the multiplier might be significant. This included the dynamism of the United States weather data sector

[3] This occurs as any price reduction results in a proportionally larger increase in quantity, which in turn increases revenue. This could be repeated continuously, generating unbounded revenue gains.

compared to Europe, the economic impact of the release of Ordnance Survey data and evidence of the benefits of information in other sectors. However, given the varied and anecdotal nature of the evidence, Pollock et al examined a range of multipliers from one to 10.

We consider multiplier values of 1, 1.5, 2 and 3 in this report. For multipliers above three, the multiplier drives the result (in a similar manner to high elasticities) and marginal cost pricing is always favoured.

We have undertaken the analysis of specific datasets from Australian land information agencies with the assumption of a multiplier of one, which favours a cost recovery model.

5.1.6 Purchases by firms

Pollock et al (2008) included in their analysis the impact of tax paid by firms that are consumers of spatial data (see section 4.3). The analysis in this report does not incorporate this element, as we do not have relevant data of use further down the value chain. This will favour cost recovery in the welfare analysis as increased consumption by private sector firms under a marginal cost model as inclusion of this element would result in a flow of tax to the government, partially offsetting the government funding of the fixed costs of spatial data production. However, as was established in Pollock (2009), it is a relatively minor impact that will not significantly change the results (see section 4.4).

5.1.7 Delay in benefits

Pollock et al (2008) incorporated a delay between achieving the benefits changing pricing regime and obtaining the benefits from elimination of the deadweight loss. They adopted a delay of a year and a half based on delays in the increase in usage after changes in pricing regime (see section 4.3).

Given the short timeframe involved, the discount due to the delay has a small effect on the preferred pricing model and accordingly, Pollock (2009) excluded the delay in benefits from the analysis. We take the same approach in this report, slightly weighting the result towards marginal cost pricing.

5.2 Data for qualitative analysis

5.2.1 Quality

An agency can produce spatial data at varying levels of quality. Examples of variations in quality might be the frequency with which they update the data, the resolution of the data or the area of coverage. An agency could take aerial photography at varying levels of detail while topographic data can be at differing scales. Variations in quality have cost implications and are likely to result in shifts in both the supply and demand of spatial data.

Quality may vary due to decisions by the agency (based on signals from customers) or through limitations on the funding available for the production of spatial data. In this section, PwC examines evidence for changes in quality under different pricing and

access regimes to provide a basis for examination of change in quality for the cost-benefit analysis.

There are a number of possible proxies for the quality of spatial data. These proxies include the product range, data accuracy and timeliness. In addition, the level of funding provided for development and maintenance of data may provide an indication.

These proxies as to quality may arise either due to explicit choices made by the agency or due to funding implications that arise through the pricing and access model under which the agency makes the data available.

Australian Bureau of Statistics

While a quantity measure, the number of products released free online is effectively a quality measure due to the increased information coverage provided by the ABS. There has been a large increase in the number of spreadsheets released each year by the ABS since the shift to a policy of releasing all online products for no cost. There was increase from 705 spreadsheets in 2004-05 to 10,000 in 2008-09. There has also been a small increase in the number of publications over this period, as seen in Table 22.

Table 22: Datacubes, time series spreadsheets and publications released by year (ABS, 2009)

Year	Datacubes & spreadsheets	Publications
2004-05	705	733
2005-06	5,373	781
2006-07	7,546	711
2007-08	8,773	818
2008-09	10,000	805

As indicator of accuracy, the ABS reports the rate of revision for the quarterly gross domestic product and current account transactions estimates between the initial release and one year later. There has been no significant change in the level of revision for these products, as shown in Table 23.

Table 23: Revisions to quarterly gross domestic product and current account transactions – difference between first estimate and one year later (ABS, 2009)

Year	Quarterly gross domestic product (% points)	Quarterly current account transactions (%)
1999-00	0.1	2.3
2000-01	0.2	3.4
2001-02	0.2	2.7
2002-03	0.1	1.8
2003-04	0.2	1.2
2004-05	0.1	1.7
2005-06	0.1	1.1
2006-07	0.2	1.6
2007-08	0.2	2.6

Commonwealth fundamental data provision

Since the implementation of the *Commonwealth Policy on Pricing of Fundamental Spatial Data*, expenditure on fundamental data by the Commonwealth was steady between 2002-03 and 2005-06 (Table 24). There was a large decline in expenditure after the first year of operation of the policy is a result of a large expenditure for the National Land and Resources Audit and unusually high expenditure by the Australian Hydrographic Survey on 2001-02. Geoscience Australia, the major Commonwealth provider of fundamental data, slightly increased expenditure between 2001-02 and 2005-06.

Table 24: Annual expenditure on fundamental data ($000) (OSDM, 2007)

Year	Geoscience Australia	Total
2001-02	59,116	102,327
2002-03	60,600	78,297
2003-04	63,556	88,232
2004-05	62,148	86,100
2005-06	67,565	85,741

The Office of Spatial Data Management has not collected any agency expenditure data since the 2005-06 financial year.

Statistics New Zealand

Since the removal of charges for access to the Streetlink and Digital Boundaries products, there has been no change in the frequency of updates to these products or the level of coverage.

New Zealand National Institute of Water and Atmospheric Research

While there are no substantive measures of quality for the National Climate Database, the increased level of contact from customers under the no charging policy has included the identification of errors in the data. This has some potential to drive an improvement in quality.

6 Model Analysis

In this chapter, we compare the full cost recovery, free fundamental data and price discrimination models through a quantitative welfare analysis and a qualitative analysis of factors that an agency should consider in a pricing and access decision. We also perform a qualitative analysis of the Commonwealth / State model in the light of the analysis of the other three models.

Section 6.1 summarises the costs and benefits of shifts between the various pricing models.

Section 6.2 analyses the costs and benefits of a shift from a cost recovery to free fundamental data model. We undertake a quantitative analysis of the change in welfare for each party involved in the transaction, with consideration of dynamics, and a qualitative assessment of factors not incorporated into the quantitative welfare analysis. The section closes with an analysis of welfare changes utilising for a sample of products from Australian land information agencies. While the pricing policies currently applied to the Australian land information agency products vary, as does the level of costs recovered, each is analysed from the perspective of this policy change to enable comparability of results.

Sections 6.3 and 6.4 contain a similar assessment for a shift from the cost recovery to the price discrimination model and a shift from the price discrimination to the free fundamental data model.

Section 6.5 contains a qualitative analysis of the Commonwealth / State model. As this model involves a combination of the models discussed in the previous sections, the focus of the analysis of the Commonwealth / State model is on features of the Commonwealth and States that may shift the weighting of costs and benefits in different directions for each.

6.1 Summary of results

6.1.1 Quantitative analysis

A static welfare analysis of the pricing and access models shows, as was demonstrated in previous reports, that changes in welfare are largely a function of the cost of public funds incurred through funding the production of fundamental data and the deadweight loss that is incurred through a cost recovery pricing model.

Free fundamental data relative to full cost recovery

Except in cases of low elasticity of demand (which is atypical), the free fundamental data model generally delivers the greatest social welfare at a point in time. This is the case even where the lowest possible multiplier of one is applied.

In a dynamic context, the welfare obtained under the free fundamental data model may be eroded if funding is not maintained from central government for production of fundamental data or if there is misspecification of quality. It is possible to develop scenarios where the benefits of the free fundamental data model are dissipated over a

relatively short period, with subsequent years resulting in a reduction in welfare relative to cost recovery.

Price discrimination relative to full cost recovery

A shift from the cost recovery to price discrimination model is always welfare enhancing, although it does involve redistribution of benefits between the land information agency and the rest of government. The redistribution involves the land information agency being required to fund the fixed costs of production itself (from Treasury appropriations). Where there is a large government share of consumption, most of the welfare benefits from the free fundamental data model are captured under the price discrimination model.

If the funding to the land information agency from Treasury appropriations is not maintained, the benefits of the price discrimination model could be dissipated over time.

Free fundamental data relative to price discrimination

The shift from the cost recovery to free fundamental data model is more likely to generate a positive change in welfare than the shift from price discrimination to free fundamental data as the former has government as a beneficiary, which does not have an associated cost of public funds. For the shift from the price discrimination model to free fundamental data, all of the lost revenue carries with it an associated cost of public funds.

We have presented mathematical representations of the changes in welfare in Appendix C.

Application to Australian products

Application of Australian cost and elasticity data finds the net benefit across all producers and consumers of a free fundamental data model compared to full cost recovery for Landgate's topographic and aerial data, Victorian topographic data and Geoscience Australia's topographic data estimated to be approximately $1.4 million, $1.0 million, $3.3 million and $4.7 million respectively. For a shift from a price discrimination model to the free fundamental data model, the benefits are $0.8 million, $0.06 million, $0.4 million and $1.3 million. The benefits are much smaller for the shift from price discrimination to free fundamental data as most of the benefit is obtained in the shift from cost recovery to price discrimination.

For a change between models in the opposite direction to that indicated, the welfare change is equivalent but of the opposite sign.

6.1.2 Qualitative analysis

Table 25 summarises the qualitative costs and benefits of changing between the cost recovery, price discrimination and free fundamental data models.

Table 25: Costs and benefits of changes in pricing and access policy

Impact	Cost recovery to free fundamental data	Cost recovery to price discrimination	Price discrimination to free fundamental data
Choice of quality	Price signals as to value to consumer lost	Price signals as to value to government consumer lost	Price signals as to value from private consumers lost
Public goods and positive spillovers	If fundamental data products have public good characteristics, allows benefits to be realised Maximises positive spillovers	If fundamental data products have public good characteristics, allows benefits to be realised in non-commercial sphere Allows realisation of positive spillovers arising from increased use by government and other non-commercial users	If fundamental data products have public good characteristics, allows benefits to be fully realised May increase positive spillovers from commercial use
Equity	Equitable if public good characteristics or positive externalities leading to large class of beneficiaries	Issue of equitable distinction between commercial and non-commercial use	Promotes equity between users but may be inequitable to taxpayers if beneficiaries a narrow group
Complexity	Reduction in pricing complexity Possible issues with selection of free data	Potential complexity around identification of non-commercial use Possible issues with selection of free data for non-commercial use	Reduces pricing complexity (i.e. licensing, billing, administration and user differentiation)
Raw data accessibility	Under cost recovery model, making raw data available will increase competition in processing and improve better signal as to quality. If raw data accessible under free fundamental data model, unlikely to be any competition in processing as fundamental data also available for free.	Under cost recovery model, making raw data available will increase competition in processing and improve better signal as to quality. Under price discrimination model, if high government share, accessibility of raw data may not increase competition as processed product available to major customer.	Under price discrimination model, if high government share, accessibility of raw data may not increase competition as processed product available to major customer. If raw data accessible under free fundamental data model, unlikely to be any competition in processing as fundamental data also available for free

For the Commonwealth / State model, the costs and benefits listed in Table 25 apply within each jurisdiction according to the model applied.

6.2 Comparison of full cost recovery and free fundamental data models

This section reviews the costs and benefits of moving from a cost recovery model to free fundamental data. Under the free fundamental data model, all users gain access to fundamental data at marginal cost (free online).

6.2.1 Static welfare analysis

When an agency shifts from the full cost recovery to free fundamental data model, the land information agency has a decrease in welfare equivalent to the level of fixed costs that they are now required to fund themselves (Equation 5). Government consumers gain, however, with government agencies that use the data no longer having to pay the purchase price, and some additional government use occurring at the marginal cost price (Equation 6).

Equation 5: Change in land information agency surplus from change to free fundamental data model from cost recovery

$$\Delta LIAS = -F$$

Equation 6: Change in government consumer surplus from change to free fundamental data model from cost recovery

$$\Delta GCS = gDWL + gF$$

Accordingly, the gain by government from this change in pricing policy is equivalent to government's share of the previously foregone deadweight loss, while it loses the proportion of fixed costs that the private sector previously funded.

The gain by the private sector is equal to those fixed costs that the private sector is no longer required to cover and the private sectors share of the deadweight loss. This change, weighted by the cost of public funds, is shown in Equation 7.

Equation 7: Change in private consumer surplus from change to free fundamental data model from cost recovery

$$\Delta CS = \frac{(1-g)(F+DWL)}{1+\beta}$$

When summed, this gives a total change in welfare that is positive where the gain through the removal of the deadweight loss (weighted for the share gained by government) is greater than the loss incurred by the requirement that government cover some fixed costs that were previously funded by the private sector (Equation 8 and Equation 9).

Equation 8: Total change in welfare from change to free fundamental data model from cost recovery

$$\Delta W = \Delta LIAS + \Delta GCS + \Delta CS$$

$$= gDWL - (1-g)F + \frac{(1-g)(F+DWL)}{1+\beta}$$

Equation 9: Conditions for positive change in welfare from change to free fundamental data model from price discrimination [4]

$$(1+\beta g)DWL > (1-g)\beta F$$

Whether the total change in welfare is positive depends on the level of fixed costs, the size of the deadweight loss, the government share and the cost of government funds.

Linear demand curve

With an assumption of a linear demand curve, the deadweight loss can be calculated, giving the following condition for whether a change from cost recovery to free fundamental data is welfare enhancing (Equation 10).

Equation 10: Conditions for positive change in welfare with a linear demand curve

$$(1+\beta g)\frac{1}{2}\varepsilon\frac{F^2}{TC} > (1-g)\beta F$$

If we adopt the conservative assumption that the share of government purchases is zero (favouring average cost pricing), the marginal cost of public funds is 0.25 and marginal cost equal zero (equivalent to free online, some feasible combinations of the multiplier and elasticity give the results in Table 26. In this and the subsequent tables, MC indicates that marginal cost pricing is preferred, while AC indicates higher welfare for full cost recovery. MC/AC indicates that the welfare from either policy is the same.

Table 26: Linear demand curve: preferred pricing model

	Multiplier (λ)				
Elasticity (ε)		1	1.5	2	3
	0.3	AC	AC	MC	MC
	0.5	MC/AC	MC	MC	MC
	0.75	MC	MC	MC	MC
	1.0	MC	MC	MC	MC
	2.0	MC	MC	MC	MC

The results shown in Table 26 are effectively the same as the results of Pollock et al, as shown in Table 7 in section 4.3. Once the elasticity is above 0.5, marginal cost pricing is generally preferred. Marginal cost pricing is also preferred at lower elasticities where there is a high multiplier effect.

[4] See Appendix A for the derivation of this equation.

It is also worth considering various mixes of fixed and variable costs (i.e. a non-zero marginal cost). Allowing a multiplier of one but varying the ratio of fixed to total costs, we obtain the results in Table 27.

Table 27: Preferred pricing model: preferred pricing model

	Ratio of fixed costs to total costs (F/TC)				
Elasticity (ε)		0.75	0.9	0.95	1
	0.3	AC	AC	AC	AC
	0.5	AC	AC	AC	AC/MC
	0.75	MC	MC	MC	MC
	1.0	MC	MC	MC	MC
	2.0	MC	MC	MC	MC

Under these conditions, there is a broader range of circumstances where average cost pricing is preferred. For all elasticities of 0.5 or less, average cost pricing is the welfare enhancing option.

Constant elasticity demand curve

If we examine demand functions with constant elasticity, we obtain a similar welfare result to that obtained with the linear demand curve, although with a stronger leaning to favour marginal cost pricing. For the scenario of a government share of zero, zero marginal cost and a cost of government funds of 0.25, we get the result in Table 28.

Table 28: Preferred pricing model – constant elasticity demand curve

	Multiplier (λ)				
Elasticity (ε)		1	1.5	2	3
	0.3	MC	MC	MC	MC
	0.5	MC	MC	MC	MC
	0.75	MC	MC	MC	MC

For the lowest multiplier of one, cost recovery pricing is only preferred for any elasticity less than 0.2 (i.e. very low elasticity). For all other pairs of parameters considered, marginal cost pricing is preferred.

If we examine a range of alternative proportions of fixed costs relative to total costs, for the case of a multiplier of one, average cost pricing is preferred for any elasticity less than 0.2. It is also preferred for an elasticity of 0.3 where fixed costs are 75 per cent or less of total costs (see Table 29).

Table 29: Preferred pricing model – constant elasticity demand curve

	Ratio of fixed costs to total costs (F/TC)			
Elasticity (ε)		0.75	0.9	0.95
	0.3	AC	MC	MC
	0.5	MC	MC	MC
	0.75	MC	MC	MC

Interpretation of results

As is noted in section 5.1.4, most modern estimates of elasticity are above one, with the lowest measured elasticity of any dataset examined in this report, 0.3, being from 10 years ago. It is also likely that fixed costs are the predominant portion of costs, with a near zero marginal cost of production. With those parameters, even with no multiplier effect, marginal cost pricing is generally preferred.

Limitations of analysis

As is noted in section 3.1.2, this welfare comparison is one-dimensional and does not incorporate factors such as public good characteristics, funding and changes in quality. The subsequent sections seek to incorporate these and other factors.

6.2.2 Dynamics

Funding and quality

To incorporate the implications of pricing decisions, such as changes in funding and quality, a dynamic analysis over a number of years is required. While the evidence on the nature of dynamic changes in response to pricing policy is ambiguous, we can explore plausible scenarios for changes in quality or funding. However, given the nature of the assumptions made, the examples below are illustrative only.

A change from the cost recovery to free fundamental data model results in a significant change in the funding base for the land information agency, with production of fundamental data dependent upon public funding. If government does not fully replace the revenue lost by a land information agency in the shift to a free fundamental data model, the level of expenditure by the agency will decline. This will affect the quality and availability of fundamental data products.

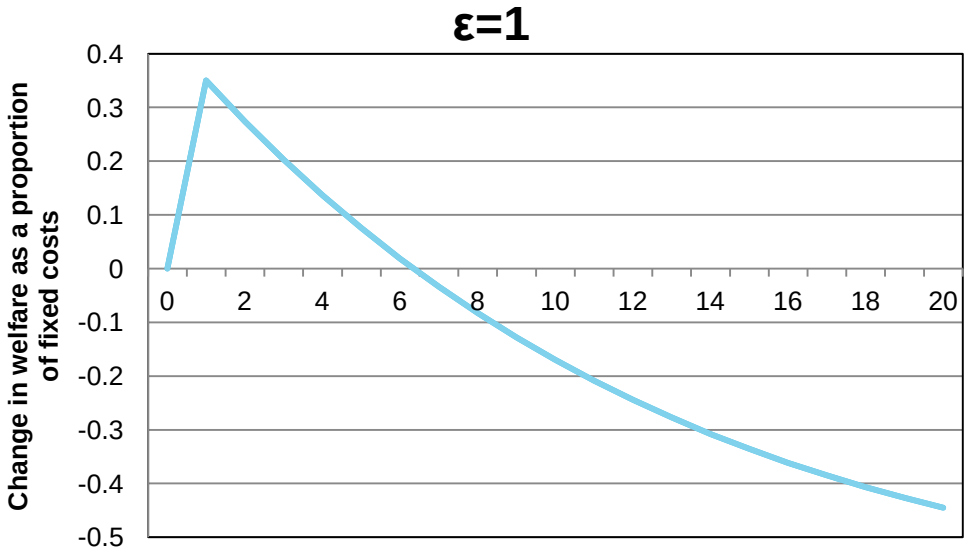
The move from the cost recovery model to marginal cost pricing also removes price signals as to quality. The land information agency is required to rely on other demand signals such as communication with customers, which may be less reliable as there is no requirement for the customer to pay the full value of what they request. This could result in an agency supplying a product of too high or low quality.

As an illustration of the funding and quality issues, suppose that after a shift from a cost recovery to free fundamental data model, the agency reduces expenditure by 3 per cent (real) each year. This might represent difficulty in obtaining funding for production of the

fundamental data, or a misspecification of the appropriate level of quality in the absence of a pricing signal. If this decline in quality results in a corresponding 3 per cent decline in demand (represented by the demand curve moving left by 3 per cent each year), the initial welfare gain from the move to the free fundamental data model is eroded over time. This erosion occurs as the consumer surplus decreases at a faster rate than the savings from lower government expenditure on fundamental data production and maintenance. This erosion of surplus includes consumers who would purchase at prices at or above average cost.

A graph of what this scenario might look like over a 20 year period is shown in Figure 6. This particular scenario utilises a government share of consumption of 50 per cent, a marginal cost of public funds of 0.25, a multiplier of one, a marginal cost of zero and an elasticity of one. The scale on the left hand side is representative of the change in welfare as a proportion of fixed costs.

Figure 6: Change in total annual welfare as a proportion of fixed costs over 20 year period: ε=1

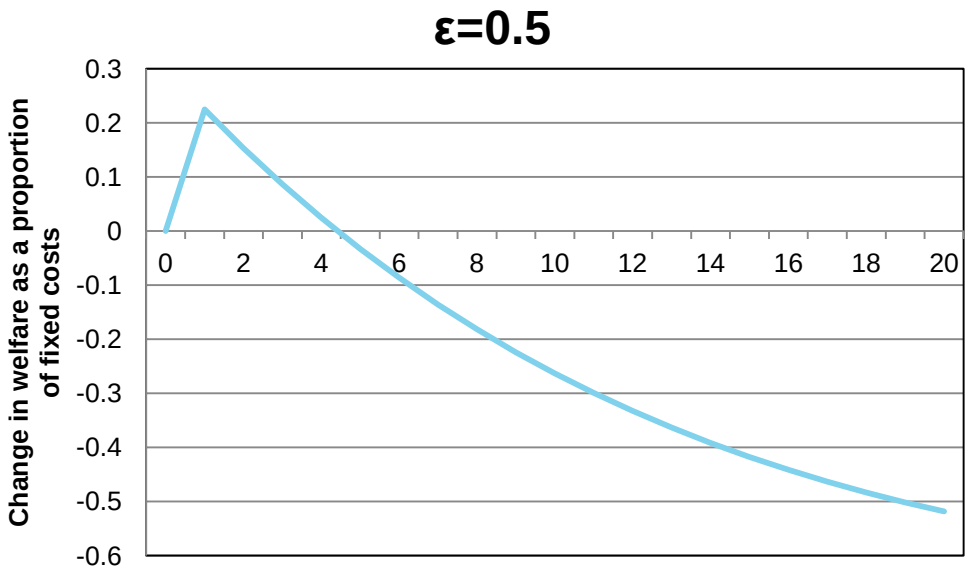


This example shows an initial increase in welfare in the first year of the free fundamental data policy followed by a gradual decline in welfare as the quality of the data product deteriorates. From year eight, welfare is below that attained under a cost recovery policy.

This illustration is dependent upon a number of assumptions. These include a reduction in demand commensurate with the reduction in expenditure and the absence of substitutes (such as a private sector party commencing supply of the product at a higher quality).

As for the welfare analysis generally, this illustration is heavily dependent on parameters such as the elasticity of demand. For example, where elasticity is lower, the initial increase in welfare is lower and followed by a decline that leads to a negative impact on consumer welfare by year 5, as shown in Figure 7.

Figure 7: Change in total annual welfare as a proportion of fixed costs over 20-year period: ε=0.5



Competition and innovation

The natural monopoly characteristics of the production of fundamental data do not foster competition, although there are some data that do not fit this mould. A decision to provide fundamental data for marginal cost will destroy any potential for competition in the production of the fundamental data products. Unless a private sector party develops a significantly different business model, they will be unable to compete at a price of zero.

The absence of competition will potentially reduce cost efficiencies and innovation in the production of these products. Cost efficiencies increase the welfare of government through reducing expenditure and increase the welfare of taxpayers by reducing the need to raise government funds. In a dynamic sense, this absence of competition could erode the initial welfare gain under a free fundamental data model.

However, the free fundamental data model might positively affect competition in downstream use of the data and in the production of value added products. By supplying the data to the largest possible group, the free fundamental data model provides a low (no) cost platform for innovation, with the absence cost allowing experimentation with the fundamental data products. As was the case with the introduction of Google Maps, the products and services that may arise are unlikely to be foreseeable before the fact and may result in significant benefit.

6.2.3 Qualitative analysis

This section qualitatively analyses issues concerning public good characteristics, positive spillovers, equity and hard constraints to access for the shift from cost recovery to the free fundamental data model.

Choice of quality

The cost recovery model facilitates choice of quality to the extent that the agency will receive a signal whether the total willingness to pay of customers is sufficient to cover the cost of any extra quality the agency chooses to add to the data. However, this does not ensure that the agency chooses the efficient level of quality. The addition of extra quality to a data product may be of no value the customers, but as they need the underlying data, they are willing to pay for the data regardless. The cost expended in adding the extra quality is a deadweight loss.

One safeguard against this in the cost recovery model is that those customers who do not require the extra quality have an incentive to inform the agency of their desired level of processing so that they can avoid paying for excess quality. The agency can take this as a reliable signal and use this information to determine whether the additional expenditure on quality is welfare enhancing.

More serious problems are faced with the free fundamental data model, as there is not even the safeguard that the total willingness to pay of the customers will be sufficient to recover costs. The agency must be guided in its quality decisions by information gathered under previous pricing policies, unreliable customer demands and other information gathering methods such as surveys.

Public good characteristics and positive spillovers

Each fundamental data product considered in this report could have public good characteristics. They are non-rival as they are information products, with excludability dependent upon the nature of the licence. As discussed above, an agency should consider the desirability of excludability to assess whether a product is a public good.

The welfare analysis above would suffice for a decision whether to provide or not provide a specific fundamental data product as a public good. Where there is a positive change in welfare from a shift to the free fundamental data model, provision of the public good will increase welfare. However, the welfare analysis is of less use in assessing the level of provision (i.e. quality) of the public good. As noted in section 3.3.1, information on the sum of the marginal rate of substitution of consumers is required (i.e. the change in their willingness to pay based on a change in quality).

An agency should conduct a dataset by dataset analysis of whether each is a public good to determine the breadth of any free fundamental data model.

The shift to the free fundamental data model allows for full realisation of any positive spillovers from the fundamental data, whether derived from commercial or non-commercial uses. Government decision-making and service delivery can make full use of the data and benefits from other non-commercial users can be realised without any pricing barriers to access.

Equity

Under the cost recovery model, direct users pay. Given they are willing to pay the purchase price, they also benefit to a level greater than the cost of production of the data.

However, if there are significant positive externalities from their purchase of this data or they are not able to exclude other consumers from accessing the data, there might be a

broader set of beneficiaries. In such circumstances, a broader funding base such as taxation may be appropriate.

Neither the cost recovery of free fundamental data policy makes any distinction on ability to pay. As such, neither policy addresses horizontal equity issues.

Complexity

The cost recovery and free fundamental data models each have areas of complexity. There is complexity associated with determining appropriate pricing and access for fundamental data under the cost recovery model, while the free fundamental data model has complexity associated with the assessment of which fundamental data products an agency should release under the free data policy.

Raw data accessibility

On implication of failing to make raw data available under the cost recovery model is that where further processing is not required for some purchasers, those purchasers are effectively subsidising the processing of the data for those users that do want the processed product. This also has the effect of distorting the signals for demand for the processed product. What appears to be demand for a certain degree of processing may be the need to access the underlying data.

To estimate the welfare implications of raw data availability would require information on the demand for raw data. This information is not available for the fundamental data products examined in this report. The United Kingdom Office of Fair Trading (2006) suggested that there was a more elastic demand curve for raw data than for processed products, suggesting that failure to provide raw data could be causing a material decline in consumer surplus. From raw data demand data that it had available, the Office of Fair Trading report quantified those losses.

A further implication of raw data availability under a cost recovery policy is competition in value adding market to produce fundamental data products. This may drive efficiency and innovation, although it creates the potential for duplication to the extent there is a natural monopoly in this area and there is duplication as opposed to customisation.

Under the free fundamental data model, we would only expect the private sector to engage in the processing of raw data where the value added is significantly greater than that added by the land information agency or they are creating discrete customised products. To the extent that there is a market for uniform fundamental data, the free processed product from the land information agency will dominate. In the absence of a radically different pricing model, it is not possible for the private sector to compete against a price of zero.

6.2.4 Australian application

From the cost data for individual jurisdictions (described in Chapter 5), it is possible to give a sense of magnitude to the changes in welfare discussed above. Table 30 shows estimates of welfare changes for a change from cost recovery to marginal cost pricing for Victorian, Landgate and Geoscience Australia topographic data products and the Landgate aerial photography products. These estimates are derived using the equations described in section 6.2.1.

Table 30: Changes in welfare from adopting the free fundamental data model, relative to the cost recovery model

	Victoria's Department of Sustainability and Environment topographic data	Landgate topographic data	Landgate aerial photography	Geoscience Australia topographic data
Total cost	$9.0 million	$2.9 million	$3.1 million	$13.3 million
Marginal cost	0	0	0	0
Elasticity	1	1	1	1
Government share	0.55	0.9	0.4	0.5
Multiplier	1	1	1	1
Δ land information agency surplus	-$9.0 million	-$2.9 million	-$3.1 million	-$13.3 million
Δ government consumer surplus	$7.4 million	$3.9 million	$1.9 million	$10.0 million
Δ total government surplus	-$1.6 million	$1.0 million	-$1.2 million	-$3.3 million
Δ private consumer surplus	$4.9 million	$0.3 million	$2.2 million	$8.0 million
Total Δ in welfare	$3.3 million	$1.4 million	$1.0 million	$4.7 million
Total Δ in welfare in year 10	-$1.5 million	-$0.4 million	-$0.6 million	-$2.3 million

These changes in welfare in Table 30 are indicative only as they rely on a number of assumptions that may hold to varying degrees. First, we used a linear demand curve with an elasticity of one. If the demand curve changes in slope, and in particular, becomes flatter as price approaches zero, the welfare change associated with a shift to a free fundamental data model may be lower.

Second, we have assumed that there is adequate demand to operate a cost recovery policy. Given the gap between current revenue and the scale of revenue required to fully recover costs, this is not a certain proposition. For example, even if government had paid

for its share of Landgate's aerial photography, there still would have been a revenue shortfall of over $1 million. For Landgate's topographic data, Landgate would cover its costs if government paid for its share, although we would expect that the quantity consumed by government would reduce if they were required to pay, leaving a revenue gap. If there is not sufficient demand to recover costs, welfare will be lower than calculated for all of the pricing policies.

Finally, as shown in section 6.2.2, there is potential for a decline in any initial welfare gain as quality declines. Under the scenario of a 3 per cent decline in expenditure and a corresponding 3 per cent decline in demand as quality falls, the potential welfare gains for Western Australian topographic and aerial photography have deteriorated by year 10 of the marginal cost pricing policy to losses of $0.4 million and $0.6 million per annum respectively. The gain in welfare for Victorian topographic data has deteriorated to a $1.5 million reduction in welfare after 10 years, while the loss of welfare is $2.3 million for Geoscience Australia's topographic data after that period. As for the general analysis of funding deterioration above, these figures are illustrative only.

Given these limitations, however, we can make some interesting observations. The change in total welfare at the time of the pricing change is larger where there is a larger share of government use. In this case, the improvement in welfare for Western Australian topographic data, which has a larger share of government users, is greater than that for aerial photography. This is because there is a reduced need for funding from taxation where government users are the beneficiaries.

The welfare change experienced by government is also more positive with a larger government share, with the change in welfare positive across government in the case of Western Australia topographic data. This pricing move for Landgate's topographic data is revenue positive across all of government, although the impact to Landgate is negative. For a smaller government share, such as for Landgate's aerial photography, the government experiences a negative change in welfare, despite the positive total welfare change.

6.3 Comparison of full cost recovery with price discrimination

This section reviews the costs and benefits of moving from a cost recovery model to price discrimination. A shift to the price discrimination model from full cost recovery sees government and other non-commercial users gain access to fundamental data at marginal cost (free online), with commercial users continuing to pay the cost recovery price.

As is shown below, the conditions for this change are in some cases stronger than the shift to the free fundamental data model as the policy maintains revenue flows from the private sector and there is no need to increase overall government funding.

6.3.1 Static welfare analysis

Under the price discrimination model, the land information agency no longer receives payments from other government agencies or non-commercial users towards the fixed costs of production. The land information agency is consequently worse off by this sum (Equation 11). However, the welfare of the government agency customers, who are no

longer required to pay the purchase price, increases by the size of the fixed costs they no longer pay. These agencies also gain a share of the deadweight loss lost under the previous policy because of the shift to marginal cost (Equation 12).

Equation 11: Change in land information agency surplus from change to price discrimination model from cost recovery

$$\Delta LIAS = -gF$$

Equation 12: Change in government consumer surplus from change to price discrimination model from cost recovery

$$\Delta GCS = g(DWL + F)$$

The net result of these changes across the whole of government is a positive welfare change. The change in policy simply shifts payment of fixed costs within government to the land information agency.

This change in government surplus has not incorporated any lost revenue from purchases by non-commercial non-government users. We adopted this simplification as the data provided by the land information agencies indicated a low level of non-government, non-commercial use. This assumption is balanced by not providing to non-government, non-commercial users a share of the deadweight loss eliminated by the change in pricing policy. This leaves the gain in private consumer surplus at zero.

These conditions result in a total change in welfare that is always positive, as shown in Equation 13. The rationale for this is that the land information agency is not required to make up the loss of the payment for fixed costs by through taxation. Rather, there is a reallocation within government. As a result, there is no loss through the cost of public funds.

Equation 13: Total change in welfare from change to price discrimination model from cost recovery

$$\Delta W = \Delta LIAS + \Delta GCS + \Delta CS$$

$$= gDWL$$

Given the change in welfare is effectively dependent upon the elimination of deadweight loss that occurred through under-consumption by government, the benefit from a change to the price discrimination model is larger where elasticity of government demand is high.

6.3.2 Dynamics

Funding and quality

A change to the price discrimination model from full cost recovery has negligible impact on total government funding unless there is a significant level of usage by non-government, non-commercial users (which based on usage information from land information agencies, does not appear to be the case). However, there is an impact on land information agency funding, with the land information agency losing revenue previously received from other government agencies. The size of this reduction is higher as the government share increases. As government has a net gain from the policy

change through elimination of a proportion of the deadweight loss, reallocation within government could make all parties better off.

However, if funding for the land information agency decreased due to a failure to reallocate funding within government or due to budget cuts following an initial reallocation, the dynamic impacts explored for the change to the free fundamental model may be similarly applicable, with the scale of the impact dependent upon the government share of use.

If an agency reduces quality through funding constraints, the shift to price discrimination will affect the private sector more heavily than a shift to a free fundamental data model. This is because the private sector will incur the costs of reduced quality without any of the welfare gains that come from a change in pricing policy.

As for a shift to the fundamental data model, there may also be quality issues in the absence of a pricing signal from government users as to the appropriate level of quality. This is particularly the case where government is the main user. The degree of misspecification arising from the policy is likely to be dependent on substitute means of determining value and the degree to which internal government pricing signals were previously representative of the value of the information. This could lead to erosion in welfare over time.

The government share of use is particularly important in this model, with a higher government share increasing the funding impact on the land information agency and creating a larger class of users from which pricing signals are lost.

Competition and innovation

It is arguable that the price discrimination model is the most deleterious of the pricing models towards competition. It removes the potential for competition in the government market, which for many fundamental data are the major market, while not providing the basis for competition in value added markets that the free fundamental data model can provide.

Therefore, the price discrimination model provides a weakened incentive for cost reductions and innovation compared to that that would occur in a competitive market.

6.3.3 Qualitative analysis

This section qualitatively analyses issues concerning public good characteristics, positive spillovers, equity and hard constraints to access for the shift from cost recovery to the price discrimination model.

Public good characteristics and positive spillovers

A decision to provide non-commercial users with access to fundamental data products may be implicit identification of the public good characteristics of these products within government and for other non-commercial users. However, it lacks the product-by-product assessment of public good characteristics that would identify which datasets are appropriate for such an approach.

Under the price discrimination model, there is no recognition of the benefits that could arise from the use of public goods by private users. Pricing for public good

characteristics should encompass both commercial and non-commercial uses, with the non-rivalry of public goods allowing further distribution for negligible additional cost (although potentially considerable revenue).

The price discrimination policy does provide for maximisation of the positive spillovers from government access to fundamental data, such as fully informed decision-making and the provision of services utilising the information. The price discrimination policy also facilitates spillovers from other non-commercial uses.

Equity

If non-commercial and government uses of fundamental data have larger positive spillovers than commercial users, a price discrimination policy might be more equitable. Price discrimination may also enhance vertical equity if commercial users have more capability to pay.

Complexity

The price discrimination model has significant implications of the pricing and access regime. Under this model there is required to be the development of pricing for commercial users, deciding which products are available to non-commercial users for marginal cost and distinguishing which users are non-commercial. The process of distinguishing non-commercial use may entail considerable complexity, particularly where an agency is required to develop criteria for non-commercial use and assess users against those criteria to determine their eligibility for non-commercial pricing.

Raw data accessibility

The consequences of raw data being available under the cost recovery and price discrimination models are largely similar as under both models commercial users with the capacity and commercial interest in creating products from the raw data face a cost recovery price under either model.

6.3.4 Australian application

A static welfare analysis with a sample of Australian land information agency data shows a positive change in welfare from the change to a price discrimination model from cost recovery (Table 31). As noted above, this is because funding lost by the land information agency is transferred within government, leading to no additional costs from taxation. A larger government share increases the scale of the benefits relative to the costs of production. These estimates are derived using the equations described in section 6.3.1.

Table 31: Changes in welfare from adopting the price discrimination model, relative to the cost recovery model

	Victorian topographic data	Landgate topographic data	Landgate aerial photography	Geoscience Australia topographic data
Total cost	$9.0 million	$2.9 million	$3.1 million	$13.3 million
Marginal cost	0	0	0	0
Elasticity	1	1	1	1
Government share	0.55	0.9	0.4	0.5
Multiplier	1	1	1	1
Δ land information agency surplus	-$5.0 million	-$2.6 million	-$1.2 million	-$6.7 million
Δ government consumer surplus	$7.4 million	$3.9 million	$1.9 million	$10.0 million
Δ total government surplus	$2.5 million	$1.3 million	$0.6 million	$3.3 million
Δ private consumer surplus	$0	$0	$0	$0
Total Δ in welfare	$2.5 million	$1.3 million	$0.6 million	$3.3 million

The cost to the land information agency decreases the lower the government share of consumption. This is due to the land information agency being required to cover a lower level of costs. However, the total gain from the policy change increases with the government share of consumption, with a larger group having the benefit of the marginal cost pricing policy.

Dynamically, the impact of this policy change is larger the greater the government share. The higher this share, the greater the level of revenue lost by the land information agency and the smaller the remaining market from which to receive a price signal. For government users, there is a probability of misspecification of quality in the absence of the price signal, with the potential for welfare decline in circumstances of continuous misspecification.

6.4 Comparison of price discrimination with free fundamental data

This section reviews the costs and benefits of a shift from the price discrimination model to the free fundamental data model. Under this change, the price paid by commercial users is reduced from a cost recovery price to marginal cost. Government and non-commercial users are not affected.

6.4.1 Static welfare analysis

The land information agency loses the portion of fixed costs previously paid for by the private sector (Equation 14). There is no change in government consumer surplus as government consumers are already receiving the fundamental data at marginal cost.

Equation 14: Change in land information agency surplus from change to free fundamental data model from price discrimination

$$\Delta LIAS = -(1-g)F$$

Equation 15: Change in government consumer surplus from change to free fundamental data model from price discrimination

$$\Delta GCS = 0$$

The private sector gains the share of fixed costs that it previously paid for. Private consumers also gain the portion of the deadweight loss eliminated through moving to marginal cost pricing for private sector purchases. This is expressed in Equation 16, weighted by the cost of government funds.

Equation 16: Change in private consumer surplus from change to free fundamental data model from price discrimination

$$\Delta CS = \frac{(1-g)(F+DWL)}{1+\beta}$$

Summing the government and private consumer surplus gives the total change in welfare (Equation 17).

Equation 17: Total change in welfare from change to free fundamental data model from price discrimination

$$\Delta W = \Delta LIAS + \Delta GCS + \Delta GS$$

$$= -(1-g)F + \frac{(1-g)(F+DWL)}{1+\beta}$$

The change in welfare is positive where the total deadweight loss avoided is greater than the total fixed costs associated with the fundamental data product. This is shown in Equation 18.

Equation 18: Conditions for positive change in welfare from change to free fundamental data model from price discrimination[5]

$$DWL > \beta F$$

This is not as strong a condition in support of marginal cost pricing as that for the change from cost recovery pricing to the free fundamental data model (which was shown in Equation 9). This is because under the price discrimination model, government is already benefiting from marginal cost pricing with no excess cost of public funds. The further change to the free fundamental model requires that government funding, which have an associated cost of public funds, cover payments previously made by the private sector.

The other factor to consider in the comparison between the price discrimination and free fundamental data models is whether the elasticity of demand differs between the private sector and government. If government elasticity is higher, more of the gain through moving to marginal cost pricing comes from the government sector, with this gain already realised in the price discrimination model. Similarly, higher private sector elasticity provides a stronger case for the free fundamental data model. Given the lack of information on this point, it is not clear which is empirically the case.

6.4.2 Dynamics

Funding and quality

As for the two other policy changes considered above, a change in pricing policy has the potential to erode the initial welfare gains through declines in funding and quality.

The shift from the price discrimination to free fundamental data model sees the land information agency lose the revenue previously received from the private sector. If the level of private sector purchases is significant (which for many fundamental data products, may not be the case), there may be material impact on land information agency and total government revenue. To the extent that government does not supplement land information agency funding, there may be deterioration in the supply of the fundamental data.

This policy shift also results in the loss of the private sector price signal as to value. While price signals from the government sector had already been lost, the removal of private sector price signals leaves the land information agency completely dependent on alternative mechanisms to determine the appropriate level of supply.

Competition and innovation

The change from price discrimination to free fundamental data could increase competition and innovation in the production of value added products by removing the pricing barrier to entry. However, it may have deleterious effects when it comes to

[5] See Appendix A for the derivation of this equation.

production of fundamental data itself as the marginal cost supply to the private sector undercuts any private players in the fundamental data marketplace.

6.4.3 Qualitative analysis

This section qualitatively analyses issues concerning public good characteristics, positive spillovers, equity and hard constraints to access for the shift from the price discrimination model to the free fundamental data model.

Public good characteristics and internal spillovers

As noted previously, the free fundamental data model fully allows for public good characteristics, giving full scope all parties to use the non-rivalrous information, not just government. The precise delineation of which fundamental data are public goods should be subject to a product-by-product analysis.

Equity

If commercial users have a greater potential to pay, it could be argued that the shift to the free fundamental data model from price discrimination would reduce vertical equity.

Whether horizontal equity is improved is dependent on the extent to which the benefits of use by commercial users are spread among the broader community. If the commercial users are able to capture all of the benefits themselves, while the benefits of non-commercial use are diffuse, then the price discrimination model may be the more appropriate pricing model from a horizontal equity perspective.

Complexity

The shift to the free fundamental data model from price discrimination reduces complexity by removing the need to distinguish between commercial and non-commercial users. It also eliminates the requirement to price fundamental data that falls within the free data threshold.

There remains a need under either model to identify the data that the agency will make available for no charge, although that is also required under the free fundamental data model.

Raw data accessibility

The implications of allowing raw data accessibility are similar to those for the shift between the cost recovery and free fundamental data models. Raw data accessibility is more likely to promote competition in the cost recovery model, as the private sector will be able to compete in the processing of this raw data. If the agency releases the processed product free, as they would under the free fundamental data model, it is unlikely that any private sector activity will occur in processing.

6.4.4 Australian application

The changes in welfare resulting from a shift from the price discrimination to free fundamental data model represents the difference in the welfare effects of the changes

from the cost recovery model to price discrimination or free fundamental data. As is noted in the analysis of the conditions, the welfare change is reduced compared to the change from the cost recovery to price discrimination model, with the cost of public funds having a major effect on the net impact (Table 32). These estimates are derived using the equations described in section 6.4.1.

Table 32: Changes in welfare from adopting the free fundamental data model, relative to the price discrimination model

	Victorian topographic data	Landgate topographic data	Landgate aerial photography	Geoscience Australia topographic data
Total cost	$9.0 million	$2.9 million	$3.1 million	$13.3 million
Marginal cost	0	0	0	0
Elasticity	1	1	1	1
Government share	0.55	0.9	0.4	0.5
Multiplier	1	1	1	1
Δ land information agency surplus	-$4.1 million	-$0.3 million	-$1.9 million	-$6.7 million
Δ government consumer surplus	$0	$0	$0	$0
Δ total government surplus	-$4.1 million	-$0.3 million	-$1.9 million	-$6.7 million
Δ private consumer surplus	$4.9 million	$0.3 million	$2.2 million	$8.0 million
Total Δ in welfare	$0.8 million	$0.06 million	$0.4 million	$1.3 million

From this analysis, a shift to the free fundamental data model from price discrimination has a limited effect where there is a large government share of consumption. For example, for Western Australian topographic data, which is predominantly used by government, the change in welfare is less than $0.1 million.

The change in policy from price discrimination to free fundamental data is more likely to generate dynamic impacts where there is a low share of government use (i.e. Western Australian aerial photography). If commercial consumers are the major user, this change could significantly reduce land information agency funding and the ability of the agency to gauge the appropriate level of quality. As for the other examples above, this could erode short-term welfare gains. However, to the extent that the policy generates innovation and competition in value added markets, there is potential for this to generate increases in welfare.

One area where the dynamic impacts may be negative is on the competition for the production of the fundamental data product itself. In the case of aerial photography, where commercial providers are emerging, a change to the free fundamental data policy will hamper the ability of commercial providers to compete in the market. This lack of competition could reduce long-term efficiencies and innovation.

6.5 Commonwealth / State model

Like the price discrimination model, the Commonwealth / State model is a hybrid between the cost recovery and free fundamental data models, but in this case, on the dimension of jurisdiction.

In the analysis of the shifts between the models, the free fundamental data model was preferred for both the Commonwealth and the States. However, there may be grounds for differences between the Commonwealth and the States that would make the free fundamental data model more highly preferred for the Commonwealth.

The first of these grounds may be a difference in the cost of public funds between the Commonwealth and the States. If the cost of public funds were higher for the States than the Commonwealth, which would be the case if the States had a smaller and less efficient tax base, this would provide a bias towards cost recovery in the States and the free fundamental data model in the Commonwealth. Given the narrower tax base of the States, this might be a reasonable assumption.

Secondly, if the price elasticities of Commonwealth fundamental data products were higher than that for products produced by the States, the welfare gains from a free fundamental data model would be greater, providing a stronger basis for the free fundamental data model for the Commonwealth than the States. From the data available for this study, it is unclear if this is the case.

A further ground is if there was any difference between the ratios of fixed costs to total costs. A higher ratio of fixed costs for products produced by Commonwealth (or alternatively, a lower marginal cost) would favour this model. This is possibly the weakest ground as electronic distribution makes marginal cost in both cases effectively zero. There may be some difference in avoidable cost, particularly if data produced by the States require more maintenance to maintain quality and currency, although that is not typically the basis for drawing distinctions in pricing.

A final ground for different pricing policies is the dynamic consequence of a reduction in funding. If a product is a one off production and not subject to ongoing maintenance and updating, a reduction in funding is not going to reduce the quality or availability of that product in itself, but rather the production of other products. If the Commonwealth produced a higher proportion of data of this nature, there is a lower probability of declines in quality eroding initial welfare gains.

7 Delivery of agency objectives

Governments and land information agencies of governments may have a range of policy objectives and priorities that will affect the optimal choice of pricing model for fundamental data. Differences in objectives may be reason for variance between jurisdictions in the optimal pricing model.

Table 33 indicates how different policy objectives and priorities affect the optimal choice of pricing model. The number of ticks in each cell of the table indicate how well a pricing model performs against the objective, with three ticks indicating the best performance.

Differences in government objectives may be reason for variance between jurisdictions in the optimal pricing model. The Commonwealth / State model may be adopted on this basis.

Table 33: Delivery of objectives by model

Objective	Full cost recovery	Price discrimination	Free fundamental data
Economic development	✓✓ Less benefit than alternative models in short term, but may be superior in long term	✓✓ Less support to economic development than the free fundamental data model but the gap is small where the share of use by non-commercial user is large	✓✓✓ Maximises the use of fundamental data and the contribution and spillover benefits of fundamental data to economic development.
Use of fundamental data by government agencies	✓✓ Government agencies have to pay for use of fundamental data and hence are motivated to restrict use	✓✓✓ Government agencies receive fundamental data for free or minimal price and hence are motivate to maximise use	✓✓✓ Government agencies receive fundamental data for free or minimal price and hence are motivate to maximise use
Generation of government revenue	✓✓✓ Maximises revenue generation and makes data production independent of direct appropriations of government funding	✓✓ There is some reduction in government revenue where fundamental data are used by non-commercial users.	No revenue generated
Accountability of data producers to funders of fundamental data production	✓✓✓ The requirement of land information agencies to derive revenues from data sales makes these agencies responsive to the needs of data users	✓✓ Land information agencies may be responsive to the needs of commercial users of data, but less responsive to government and non-commercial users	✓ As land information agencies do not rely on revenues from data sales, there is no commercial motivation to be responsive to the needs of data users

Objective	Full cost recovery	Price discrimination	Free fundamental data
Availability of data to the community to inform public participation in public policy and government decision making	✓ Public, non-commercial use of data may be restricted by limited capacity to pay prices.	✓✓ Fundamental data are freely available to non-commercial users	✓✓✓ Fundamental data available to all commercial and non-commercial users
Promotion of competition in production of fundamental data	✓✓✓ Competition in production of fundamental data is promoted as private data production firms may compete on a competitively neutral basis with government land information agencies	✓✓ Free provision of fundamental data to government agencies and non-commercial users limits the market opportunities for private data production firms	✓ Free provision of fundamental data from government land information agencies lessens commercial opportunities for private data production firms
Promotion of competition in downstream markets for services and products using fundamental data	✓ Less use of fundamental data reduces the opportunities for competition in products and services	✓ Less use of fundamental data by commercial users reduces the opportunities for competition in products and services	✓✓✓ Free provision of fundamental data promotes competition in products and services

Appendices

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Appendix B Mathematical derivation

1 Derivation of deadweight loss (no multiplier)

Linear demand curve

$$DWL = \frac{1}{2}(p_{AC} - p_{MC})(q_{AC} - q_{MC})$$

$$= \frac{1}{2}(p_{AC} - p_{MC})^2 \frac{q_{AC}}{p_{AC}} \frac{(q_{AC} - q_{MC})/q_{AC}}{(p_{AC} - p_{MC})/p_{AC}}$$

$$= \frac{1}{2}(p_{AC} - p_{MC})^2 \frac{q_{AC}}{p_{AC}} \varepsilon$$

$$= \frac{1}{2}\varepsilon \frac{(p_{AC} - p_{MC})}{p_{AC}} (p_{AC} - p_{MC}) q_{AC}$$

$$= \frac{1}{2}\varepsilon \frac{(p_{AC} - p_{MC})}{p_{AC}} F$$

$$= \frac{1}{2}\varepsilon \frac{(p_{AC} - p_{MC})}{p_{AC}} \frac{q_{AC}}{q_{AC}} F$$

$$= \frac{1}{2}\varepsilon \frac{F^2}{TC}$$

Isoelastic demand curve

$$DWL = \int_{pMC}^{pAC} Ap^{-\varepsilon} - F$$

$$= \frac{A}{1-\varepsilon}[p^{1-\varepsilon}]_{pMC}^{pAC} - F$$

$$= \frac{A}{1-\varepsilon}(p_{AC}^{1-\varepsilon} - p_{MC}^{1-\varepsilon}) - F$$

$$= \frac{A}{1-\varepsilon}(p_{AC}^{1-\varepsilon} - p_{AC}^{1-\varepsilon}\left(1 - \frac{F}{TC}\right)^{1-\varepsilon}) - F$$

$$= \frac{Ap_{AC}^{1-\varepsilon}}{1-\varepsilon}(1 - \left(1 - \frac{F}{TC}\right)^{1-\varepsilon}) - F$$

$$= \frac{q_{AC}\, p_{AC}}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right)-F$$

$$= \frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right)-F$$

2 Change of welfare when shift from cost recovery to free fundamental data (no multiplier)

Linear demand curve

$$\Delta LIAS = -F$$

$$\Delta GS = g\frac{1}{2}\varepsilon\frac{F^2}{TC}+gF$$

$$\Delta CS = \frac{(1-g)\left(F+\frac{1}{2}\varepsilon\frac{F^2}{TC}\right)}{1+\beta}$$

$$\Delta W = g\frac{1}{2}\varepsilon\frac{F^2}{TC}-(1-g)F+\frac{(1-g)\left(F+\frac{1}{2}\varepsilon\frac{F^2}{TC}\right)}{1+\beta}$$

ΔW positive where:

$$(1+\beta g)\tfrac{1}{2}\varepsilon\tfrac{F}{TC} > (1-g)\beta$$

Isoelastic demand curve

$$\Delta LIAS = -F$$

$$\Delta GCS = g\left(\tfrac{TC}{1-\varepsilon}\left(1-\left(1-\tfrac{F}{TC}\right)^{1-\varepsilon}\right)-F\right)+gF$$

$$= g\tfrac{TC}{1-\varepsilon}\left(1-\left(1-\tfrac{F}{TC}\right)^{1-\varepsilon}\right)$$

$$\Delta CS = \frac{(1-g)\frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right)}{1+\beta}$$

$$\Delta W = \Delta LIAS + \Delta GCS + \Delta CS$$

$$= g\frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right) - F + \frac{(1-g)\frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right)}{1+\beta}$$

ΔW positive where:

$$(1+\beta g)\left(\frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right) - F\right) > (1-g)\beta$$

3 Change of welfare when shift from cost recovery model to price discrimination (no multiplier)

Linear demand curve

$$\Delta GS = g\frac{1}{2}\varepsilon\frac{F^2}{TC}$$

$$\Delta CS = 0$$

$$\Delta W = g\frac{1}{2}\varepsilon\frac{F^2}{TC}$$

ΔW always positive

Isoelastic demand curve

$$\Delta GS = g\left(\frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right) - F\right)$$

$$\Delta CS = 0$$

$$\Delta W = g\left(\frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right) - F\right)$$

ΔW always positive

4 Change of welfare when shift from price discrimination model to free fundamental data (no multiplier)

Linear demand curve

$$\Delta GS = -(1-g)F$$

$$\Delta CS = \frac{(1-g)\left(F + \frac{1}{2}\varepsilon\frac{F^2}{TC}\right)}{1+\beta}$$

$$\Delta W = -(1-g)F + \frac{(1-g)\left(F + \frac{1}{2}\varepsilon\frac{F^2}{TC}\right)}{1+\beta}$$

ΔW positive where:

$$\frac{1}{2}\varepsilon\frac{F}{TC} - \beta > 0$$

Isoelastic demand curve

$$\Delta GS = -(1-g)F$$

$$\Delta CS = \frac{(1-g)\frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right)}{1+\beta}$$

$$\Delta W = \Delta GS + \Delta CS$$

$$= -(1-g)F + \frac{(1-g)\frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right)}{1+\beta}$$

ΔW positive where:

$$\frac{TC}{1-\varepsilon}\left(1-\left(1-\frac{F}{TC}\right)^{1-\varepsilon}\right) - F > \beta F$$

Appendix C Summary of static welfare analysis

Table 34 summaries the results of the static welfare analysis. The changes in welfare are separated into changes in government consumer surplus (ΔGCS), land information agency surplus (ΔLIAS) and private consumer surplus (ΔCS), which when summed gives the total change in welfare (ΔW).

Table 34: Summary of static welfare analysis results

	Shift from cost recovery to free fundamental data	Shift from cost recovery to price discrimination	Shift from price discrimination to free fundamental data
ΔGCS	$gDWL + gF$	$gDWL + gF$	0
ΔLIAS	$-F$	$-gF$	$-(1-g)F$
ΔCS	$\frac{(1-g)(F+DWL)}{1+\beta}$	0	$\frac{(1-g)(F+DWL)}{1+\beta}$
ΔW	$gDWL-(1-g)F+\frac{(1-g)(F+DWL)}{1+\beta}$	$gDWL$	$-(1-g)F+\frac{(1-g)(F+DWL)}{1+\beta}$
ΔW >0 when	$(1+\beta g)DWL > (1-g)\beta F$	Always	$DWL > \beta F$

Appendix D Glossary

Term	Definition
Avoidable costs	Costs that would be avoided if production of a particular output or service of a particular customer class was ceased
Basic information (product) set	Information products characterised by a high degree of non-rivalry and non-excludability to potential users (public good characteristics) and significant positive externalities
Competitive neutrality	Policy principle that requires prices charged by government businesses to reflect full cost attribution and to account for any competitive advantages and disadvantages of public ownership
Consumer welfare	Collective benefit derived by consumers of a product or service. Typically defined as the difference between the amount they are willing to pay and the price that is paid
Cost plus	Pricing model where the price is determined from the actual cost of production and includes an agreed mark-up or rate of return
Cost recovery	Pricing model where the price is determined with regard to all costs attributed to data production, that is, equal to average long-run costs
Creative Commons	A non-profit organisation that has built a range of free licences that allow content owners to specify which rights they retain in their works and which rights they will waive
Crown copyright	A form of copyright protection claimed by government and in Australia, defined in the *Copyright Act 1968*
Custodian	The body responsible for the development and management of a dataset, including determining the conditions of use and distribution of the dataset
Deadweight loss	The loss is welfare resulting from pricing a product above marginal cost

Term	Definition
Differential pricing	Pricing model where different customer groups or uses are charged different prices for the same or similar products
Direct costs	Costs that can directly and unequivocally be attributed to an output
Economically efficient pricing	Setting prices to deliver the maximum social welfare benefit
Externality	Indirect (positive or negative) welfare effects of decisions to produce or consume on firms or individuals other than producers or consumers of the product
Fixed costs	Costs that remain unchanged irrespective of the volume of output produced. Equal to total costs minus variable costs.
Fundamental data	An authoritative source of spatial data that is maintained to well defined quality standards and cannot be derived from another dataset
Indirect costs	Costs that are not directly attributable to an output and are often referred to as overheads
Intellectual property (IP) rights	Rights granted by law in relation to copyright, inventions, registered and unregistered trademarks, registered designs, and all other rights resulting from intellectual activity in the industrial, scientific, literary and artistic fields
Marginal cost of public funds	The collection, compliance and deadweight losses associated with raising tax revenues
Marginal cost pricing	Pricing model where the price is equal to the cost of supplying one extra unit of a good or service
Marginal cost	Cost of producing one additional unit of a good or service
Market failure	Situation where the characteristics of a market lead to inefficient resource allocation

Term	Definition
Metadata	Data providing information about other pieces of data
Natural monopoly	Situation where a single firm can meet market needs more efficiently due to high fixed costs and low variable costs
Non-excludability	Where after provision of a good or service to one consumer, other consumers cannot be excluded from also using the good or service
Non-rivalry	Where provision of a good or service to one person does not diminish the availability of the good or service to others
Price discrimination	Practice of charging separate customer groups or uses different prices for the same or similar products
Price elasticity of demand	Responsiveness of the demand for a product or service to a change in its price
Public good	Good or service characterised by a high degree of non-rivalry and non-excludability
Public sector information (PSI)	Information products and services that are generated, created, collected, processed, preserved, maintained, disseminated, or funded by a public sector organisation
Ramsey pricing	Pricing regime which maximises social welfare by pricing according to the demand elasticity of different customer groups through price discrimination
Raw data	Data in its most basic state without any additional manipulation or analysis
Spatial data	Data about the location and attributes of features that are on, above or beneath the surface of the earth. Also referred to as land data or geographic data.

Term	Definition
Spillover	Indirect (positive or negative) welfare effects of decisions to produce or consume on firms or individuals other than producers or consumers of the product
Value added data	Raw or fundamental data that is manipulated, edited, compiled or otherwise processed to enhance its value and facilitate its use and effectiveness for the end user
Value added re-seller (VAR)	Business entity that resells data, after having added value to the product
Variable costs	Costs that change in proportion to changes in the quantity of output produced
Welfare	The net benefits (or economic surplus) accruing to consumers and producers