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USING INPUT-OUTPUT ANALYSIS TO DEVELOP 'TRIPLE BOTTOM LINE ACCOUNTS' FOR THE AUSTRALIAN ECONOMY

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ABSTRACT

Triple Bottom Line accounting is widely advanced as a way in which firms can realise broader societal objectives in addition to increasing shareholder value. In our analysis of the Australian economy, we integrate financial input-output tables that describe the inter-dependencies between economic sectors, with national social and environmental accounts to construct numerate 'triple bottom line' accounts for 135 discrete sectors. The accounts are portrayed against the numeraire of 'one dollar of final demand'. Thus for a sector of the economy, financial aspects of performance can be expressed for example as dollars of export earnings per dollar of final demand. Social aspects such as employment can be portrayed as minutes of employment generated per dollar. Greenhouse issues can be portrayed as kilograms of carbon dioxide emitted per dollar. Since these indicators of 'triple bottom line' performance are referenced against financial units and are consistent with the System of National Accounts, they can be applied to financial accounts of a firm, a service or a product, and allow a robust triple bottom line account to be developed across a range of scales. In this study we use the approach to compare eight aggregated sectors of the Australian economy eg agriculture, food manufacture, mining, non-food manufacturing, construction, transport and communications, privates services and public services. The analysis highlights triple bottom line issues for each of these aggregated sectors, many of which do not have feasible solutions under the conditions of incremental and marginal change that characterise modern economic systems. Finally this analytical approach is seen as only a first step. To be fully effective, there are at least five technical developments required to complement the current analytical status.

1. INTRODUCTION

Governments at all levels, corporations, non-governmental organisations and the general public are all engaging with the concept of sustainability. The environmental movement first brought the issue of tensions between economic development and environmental quality to the attention of the public over 30 years ago. More recently the developed world has been struggling with expanding the original concept of sustainable development from one of meeting environmental concerns whilst maintaining economic development to a more holistic concept where economic, environmental and social considerations are given more equal weighting.

The broadly agreed definition of sustainability is: practices and development that meets the needs of the current generation without compromising the ability of future generations to meet their needs. Although this definition has been widely accepted, applying it in a meaningful way to all levels of society is a major intellectual and governance challenge. Sustainability is ultimately an absolute condition: a country, community or company is either sustainable or it is not. However, un-sustainability may be less recognisable over immediate or short time scales that are at odds with the accepted principle of sustainability defined in terms of future generations. Therefore, in an operational sense and with our current limited knowledge, sustainability is best viewed as a process. It is likely therefore that the sustainability 'goal posts' will be continually moved as our understanding of the importance of social and natural capital increases. Whilst it is difficult to make an absolute assessment of what sustainability

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means, proxy indicators of sustainability, many of which are currently in use, are essential for determining relative performance.

Corporations are beginning to apply the concept of sustainability at a practical level in terms of corporate citizenship or corporate social responsibility (CSR). CSR is currently dominated by the notion of the triple bottom line. Triple bottom line (TBL) was a termed originally coined by John Elkington [1] in the late 1990s to describe corporations moving beyond reporting only on their financial "bottom line" to assessing and reporting on the three spheres of sustainability: economic, social and environmental . The notion of the triple bottom line has many meanings to many people, and can be applied at different levels in society by different stakeholders. However, there is general agreement that the triple bottom line principle is a useful approach for examining the operations of an entity, from a local council to a major corporation. International protocols for triple bottom line reporting are being developed by the Global Reporting Initiative [2], an international collaboration supported by many leading companies, non-government and government organisations. Regular comparisons are now made by company governance firms such as Standard and Poors [3] on the breadth and depth of sustainability reporting by corporations. Many writers now speak of the 'triple bottom line plus one' or the quadruple bottom line where the extra dimension is one of cultural integrity or corporate governance.

There are two common problems in all these reporting activities, firstly the problem of consistent and defensible data, and secondly the issue of defining a boundary around the analysis. Using the analytical techniques for energy analysis in the 1970s developed by Herendeen [4] and others, Foran et al. [5] have applied an approach to triple bottom line analysis for financial, social and environmental indicators for whole Australian economy at the level of 135 economic sectors. This paper presents a brief overview of the analytical approach and then applies it to eight aggregated grouping of economic sectors such as mining, manufacturing and services.

2. ANALYTICAL APPROACH

In this study, the principle of the triple bottom line is assessed using input-output analysis (IOA). Input-output analysis is a top-down economic technique, which uses sectoral monetary transactions data to account in a "snap-shot"-like manner for the complex interdependencies of industries in modern economies. The result of generalised input-output analyses is a $f \times n$ matrix of TBL *factor multipliers*, that is embodiments of f TBL indicators (such as exports, labour, energy, etc) per unit of final demand of commodities produced by n industry sectors. A multiplier matrix $\mathbf{M}$ can be calculated from a $f \times n$ matrix $\mathbf{F}$ containing sectoral TBL indicator scores, and from a $n \times n$ *direct requirements* matrix $\mathbf{A}$ according to

$$\mathbf{M} = \mathbf{F}\,(\mathbf{I}-\mathbf{A})^{-1} \,, \quad (1)$$

where $\mathbf{I}$ is the $n \times n$ unity matrix.

The $f \times 1$ TBL *inventory* $\mathbf{\Phi}$ of a given sectoral final demand represented by a $n \times 1$ commodity vector $\mathbf{y}$ is then simply

$$\mathbf{\Phi} = \mathbf{M}\,\mathbf{y} \,. \quad (3)$$

The direct requirements matrix $\mathbf{A}$ can be compiled from the Australian Input Output Tables published by the Australian Bureau of Statistics [6].

Input-output theory was pioneered by Nobel Prize winning economist Wassily Leontief in the 1940s and applied by Herendeen and others (Herendeen [4] [7] [10]; Herendeen et al. [8] [9]), to many energy analyses problems from the mid-1970s to today. It was always Leontief's intention that IOA be extended from purely financial considerations to a range of social and physical elements (Leontief et al. [11]). However, such methods have not been widely employed in government planning and policy circles, except for the European NAMEA movement, in which physical tables are set up as satellite accounts to the National Accounts (de Haan et al. [12]; de Haan [13]). The NAMEA accounts as well as our work aim at integrating the structure and function of the financial economy (as described by the national IO tables) with other national social and physical accounts such as energy, greenhouse emissions, water, land disturbance, employment and so on.

There is a well-known precedent for IO analysis techniques improving assessment processes: In life cycle assessment (LCA), which aims to calculate the total environmental burdens associated with a product, IO has experienced a significant role in overcoming what is known as the boundary problem, or the problem of incompleteness of an LCA inventory due to the arbitrary truncation of the system by a subjectively set boundary (Suh et al. [14]), thus preventing decision-makers from overlooking important hidden upstream impacts.

We have compiled national economic sector level data for 135 sectors of the Australian economy, using input-output tables and additional data from the ABS. These Australian sectoral TBL accounts contain information on the aggregate and average performance of each economic sector for ten TBL indicators together with their main data sources (Table 1). The synthesis of disparate data sources is a major component of the development of a generalised IOA framework.

Table 1. Brief list of the 10 macro TBL indicators developed in this work and their data sources

Macro Indicator (and unit)	Brief description	Data Source
Primary energy (MJ)	Combustion of all non-renewable fossil fuels	ABARE Energy Statistics
Greenhouse gas emissions (kg CO_2-e)	Carbon dioxide equivalent impact of all gases affecting climate	National Greenhouse Gas Inventory
Water use (L)	Consumption of all mains and self-extracted surface water	ABS Australian Water Accounts
Land disturbance (hectares – ha)	Land use, weighted by intensity of impact	Various, including CSIRO
Imports (m$)	Value of all goods and services purchased from foreign residents	ABS Input-Output Tables
Exports (m$)	Australian production destined for consumption outside Australia	ABS Input-Output Tables
Surplus (m$)	Operating profits and expenditure on fixed capital	ABS Input-Output Tables
Government revenue	All taxes less subsidies	ABS Input-

(m$)		Output Tables
Employment (hours)	Full time equivalent employment	ABS Australian Labour Statistics
Income (m$)	Total compensation for employees	ABS Input-Output Tables

By applying the IO formalism to the Australian TBL accounts we are able to allocate TBL loadings from producing industries to final demanders of commodities in a mutually exclusive and collectively exhaustive way, that is, without double counting of any flows. We are also able to describe in hard numbers a number of economic, social and environmental outcomes against a common unit of one dollar of final demand (Table 1). The latter constitutes a convenient and meaningful numeraire, because it is the destination of GDP, the common measure of national economic performance, and as Adam Smith concluded already in 1776, it is “the sole end and purpose of all production”. Thus economic indicators of surplus, exports and imports can be reported as "dollars of surplus per dollar of final demand". Social indicators such as employment, wages and government revenue can be described as "the minutes of employment generated per dollar of final demand". Environmental indicators such as greenhouse gas emissions, water requirement and land disturbance can be described as "kilograms of carbon dioxide equivalent emissions per dollar of final demand" or the like. The quantities reported here are referred to as intensities and can be described and discussed for each of the 135 sectors analysed. The presentation of such complex analyses is always fraught with the tension between simplicity and complexity. Two graphical methods are currently in use (Figure1). The first reduces all indicators to a common scaling in one radar or ‘spider diagram. The second displays a summation of the direct and indirect effect in one bar diagram for each indicator. The spider diagram approach is used in this paper.

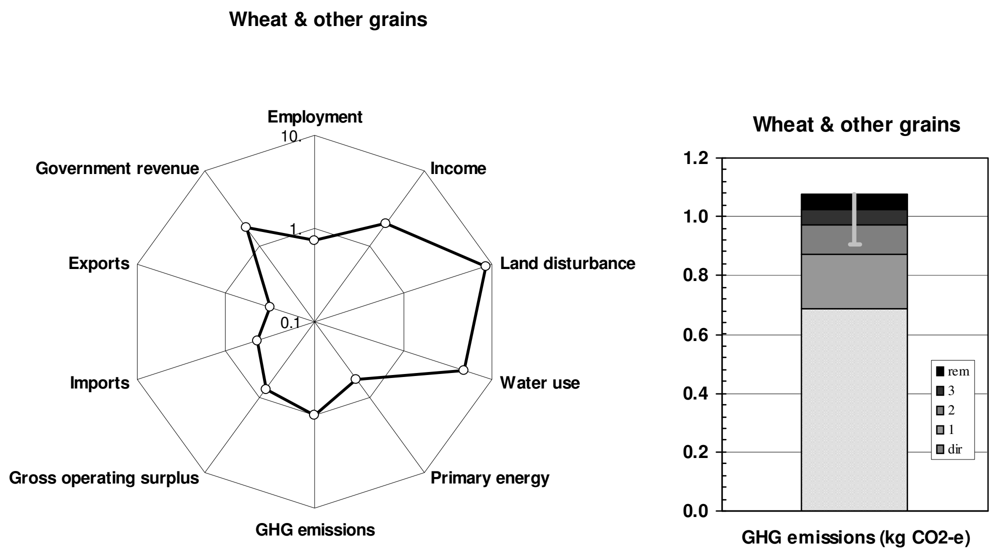


Figure 1. Data presentation devices per dollar of final demand, used in whole-economy triple bottom line analyses: the ‘spider’ diagram (left hand side) where all ten indicators are scaled to unity, presented on a log scale, and referenced against the ‘economy wide average’ (average = 1); the bar graph (right hand side) presented in absolute units for

each indicator with direct within-sector effects shown in lighter shading, and first, second, third and n^{th} order indirect effects, shown as increasing density of greys

3. TRIPLE BOTTOM LINE ACOUNTS

3.1 The Sectors of 'Agriculture Forestry and Fishing' and 'Food Manufacturing'

3.1.1 Interpretation

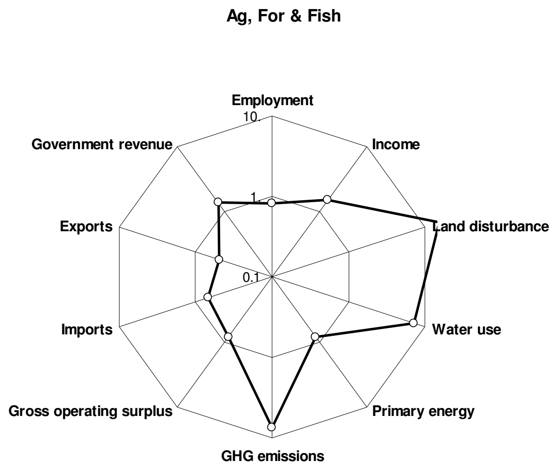
The sectors form part of a strongly linked value adding chain where for example wheat grown in the primary sector is manufactured into flour and then into bakery products for final consumption, although wheat grain for export and flour for home baking are also dispersed through final demand. The primary and secondary sectors contribute 3% and 2.5% of GDP respectively, but have substantially higher proportions of national land disturbance, water use and greenhouse emissions than their value adding chain would suggest (Table 2).

Table 2. Contribution of aggregated macro-sectors to national GDP, employment, land disturbance, water use, energy use and greenhouse emissions

Name of the macro-sector	Number of sectors included	% of GDP	% of emplo-yment	% of land distur-bance	% of water use	% of energy use	% of greenhouse emissions
Agriculture forestry and fishing	15	3.0	2.4	30	14	2	**14**
Food manufacturing	11	2.5	6.3	45	44	5	**25**
Mining	13	4.4	1.7	<1	1	3	**5**
Non-food manufacturing	50	10.7	9.9	10	6	19	**15**
Construction	2	5.6	11.9	<1	2	8	**6**
Transport and communication	11	8.7	4.3	<1	1	7	**4**
Private services	12	26.1	9.9	<1	3	4	**3**
Public services	8	16.7	25.8	1	3	8	**6**
Remainder	13	22.3	27.8	12	26	44	**22**
TOTAL	135	100	100	100	100	100	100

The spider diagram for the 'agriculture forestry and fishing' sector portrays extreme outliers for the environmental indicators of land disturbance, water use and greenhouse emissions (Figure 2). This is due to the nature of modern agriculture in general, and to the infertile soils, variable rainfall and extensive nature of production technologies in Australia. The land disturbance indicator is due mainly to extensive rangeland production for beef cattle and wool growing. However even grain growing is relatively extensive with large areas planted but per hectare yields about one third of European and North America levels. The water use indicator is inflated by irrigated rice production but also includes water intensive activities such as dairy cows on irrigated pastures, cotton growing, and sugar cane. The greenhouse emissions indicator is due to carbon dioxide emissions from land clearing for beef cattle and forest harvesting, methane emissions from livestock, and nitrification processes in sown pastures and fertilised crops.

The value added sector of food production reveals a strong echo from its primary production inputs, as the environmental loadings are passed through the production chain (Figure 2). However the process of value adding, turning milk into cheese, butter and yogurt for example does dilute the physical inputs and thus reduces the intensity measures used in this analytical approach. However further physical inputs occur at this stage where in wine making for example, two tonnes of water are required for each tonne of grapes crushed, mainly to clean processing vats and pressing equipment. In social terms per dollar of final demand, this sector has similar employment multipliers, slightly better income and a significant addition in the generation of government revenue. For the financial indicators, export propensity is higher than the primary production sector, import penetration is lower, while operating surplus is similar.



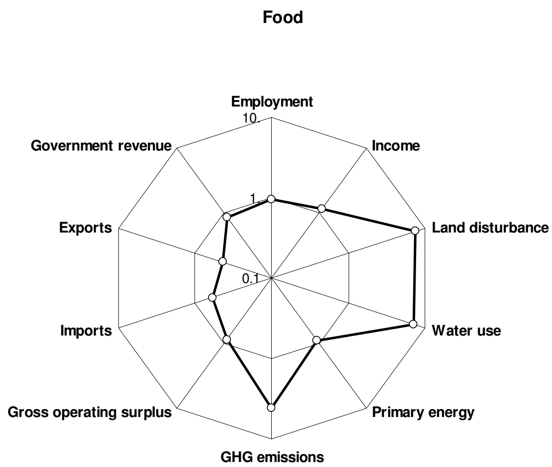


Figure 2. A spider diagram representation of triple bottom line performance for financial, social and environmental indicators, in the aggregated macro-sectors of 'agriculture, forestry and fishing' (15 sectors), and 'food manufacturing' (11 sectors). The economy-wide scaled average (=1) is the regular polygon in the centre of the diagram. Indicators with above average performance are closer to the centre, while below average indicators are positioned closer to the outside boundary

3.1.2 Options for Incremental Change

Most of the issues that lie behind the high environmental indicators are open to technological and management improvement. In the next decade, it is possible that land clearing will decline in the northern beef cattle industry, but the biomass decay profile is a lengthy one and emissions will still continue for a decade after clearing stops. However emissions from forestry due to the harvesting process will continue and even increase, as national forest policies stimulate planting rates in an attempt to reduce the national wood products deficit. Other emissions are more difficult to control. A solution to methane from grazing animals will be a combination improved nutrition which can reduce methane production, and some type of within-animal methane controller. Controlling nitrous oxide emissions is more difficult but will include parsimonious and knowledge intensive use of nitrogen fertilisers, the application of nitrification inhibitors, and careful control of pasture and crop rotations to ensure that nitrogen is tightly controlled in soil stores. Land disturbance and water use have similar management options for reduction.

3.1.3 Options for Substantial Change

To some world views, a review of Figure 2 and Table 2 may suggest that as well as technological improvement, society may have to modify the divisor in these intensity indicators i.e. divide the gross amount of water, land and emissions by an increased amount of final demand. For about 6% of GDP, these sectors together are responsible for 75% of land disturbance, nearly 60% of water use and nearly 40% of greenhouse emissions. From a traditional economic perspective it is clear that the resource content of production is not internalised in the costs of production especially given the degree of media attention and science effort devoted to issues such as 'water crises', 'land degradation' and 'greenhouse emissions and the Kyoto Protocol'. A doubling or tripling of basic food prices might bring the intensity indicators within reach of a technical solution, but solutions must be found for three key challenges. The first is the societal shock that such changes would bring and distributional innovations would have to ensure that poorer people received an adequate amount and appropriate composition of food. The second requirement is that farm gate or basic prices are the ones increased and institutions put in place to ensure that monies are pledged or hypothecated directly to the farm production systems thus ensuring that the technological improvements noted in the former section are actually implemented, and that increased financial flows are not re-routed to the wholesale and retail sectors of the economy. The third requirement is that this effect is harmonised with a wide range of other policy innovations that will have to take place over the next two decades. Issues such as population ageing, health costs, pensions, carbon taxation, oil replacement and many more issues will have to be intertwined in a complex and forward-looking policy mix.

3.2 The Sectors of 'Mining' and 'Non-Food Manufacturing'

3.2.1 Interpretation

The primary mining sector has positive outcomes for the environmental and financial indicators, but below average performance for the social indicators of employment generation, income and government revenue (Figure 3). The export propensity indicator is four times the average reflecting the industry's contribution in reducing the international trade deficit. The lower than average contribution to government revenue may be an overestimate since resource rents paid for mineral and petroleum extraction to state and federal governments are not included as 'payments to government' in the internationally implemented 'System of National Accounts,' and thereby the national input-output tables. The lower than average indicators for employment generation and income are essentially structural due to the scale, capital intensity, and economic efficiency, required by each mine exporting its product to a competitive international marketplace. However there is some justification to claims from mining regions, that a significant component of resource rents be pledged to long term structural investments in those regions from which minerals are extracted, rather than being directed towards the maintenance of major urban centres where commercial and political power lies.

The manufacturing sector portrays a number of expected issues such as higher than average energy use and greenhouse emissions, good outcomes for the environmental indicators of water use and land disturbance, but below average outcomes for the social indicators of employment generation and income (Figure 3). The financial indicators of export propensity and import penetration are both higher than average, but in absolute terms are balanced, reflecting the typical globalised pattern of high imports of specialised intermediate inputs to production, that are required for the assembly of the final product. The operating surplus indicator is below average reflecting the aggregation across many sectors, some of which are performing well, and others bearing the full force of globalised competition particularly from low wage countries specialising in textiles, electronics and basic manufactures.

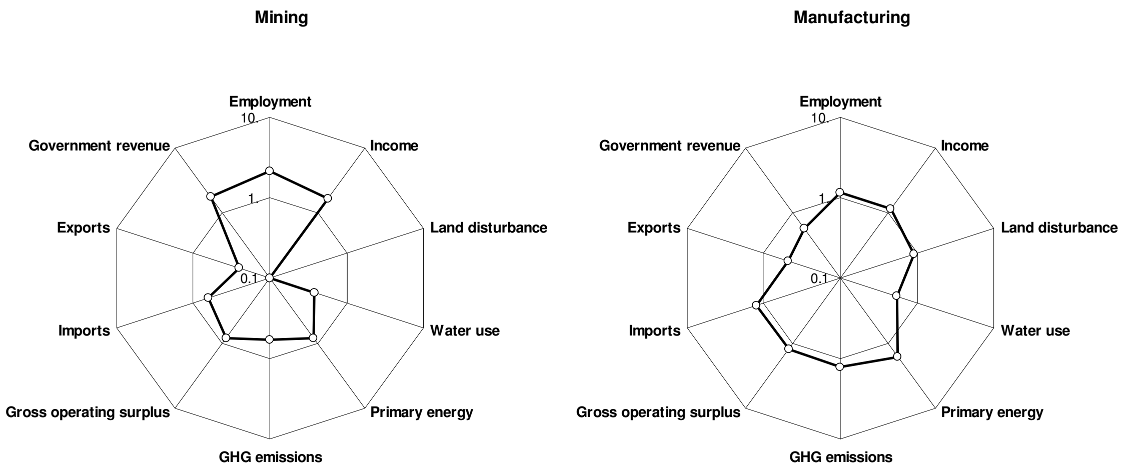


Figure 3. A spider diagram presentation of triple bottom line performance for financial, social and environmental indicators, in the aggregated macro-sectors of 'mining' (13 sectors), and 'non-food manufacturing' (50 sectors). The economy-wide scaled average (=1) is the regular polygon in the centre of the diagram. Indicators with above average performance are closer to the centre, while below average indicators are positioned closer to the outside boundary

3.2.2 Options for Incremental Change

Improvements in two areas of triple bottom line performance are already underway particularly in manufacturing industries. Although Australia has not ratified the Kyoto Protocol, there are ongoing and significant efforts at the level of individual sector to reduce within-factory energy use and thereby greenhouse emissions, but generally these are for direct emissions, rather than those of the full production chain. For the sectors included in the textiles and printing areas, there are wide ranging structural adjustments underway designed to focus on specialised niches of activity thereby improving profits and opportunities for employment. In textiles for example, there is a ready acknowledgement that Australia will never compete in price with the rapidly growing industrial capacity of China. However there are many specialised areas of industrial, corporate and lifestyle clothing which incorporate an essential 'Australianness' and where advanced design, acknowledgement of local employment, and well directed procurement focused on regional origins of the raw materials, can bring market recognition and financial success.

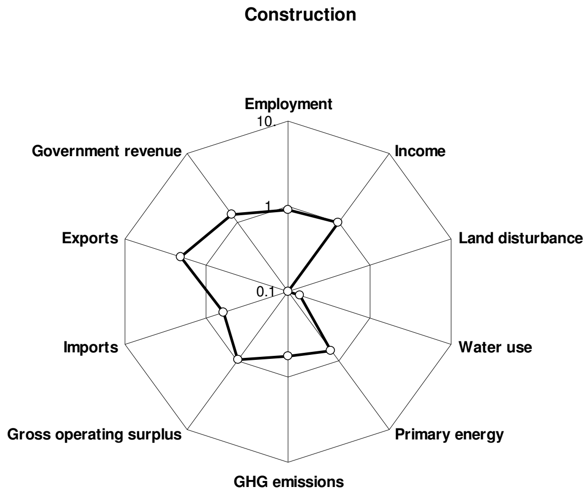
3.2.3 Options for Substantial Change

Given an emerging concern on the energy, greenhouse emissions and material transactions embodied in the acquisition of virgin metals, and their accumulation and eventual release from urban-industrial complexes, the concept of 'cradle to cradle' stewardship is moving steadily towards full implementation. The concept is already well developed for aluminium drink containers and steel recycling through electric arc 'mini mills', but is now moving into metals of environmental concern such as lead, copper, zinc and some small volume but high toxicity metals such as mercury and cadmium. A new vision might transform a typical commodity miner to a metal steward who manages a metal stock that is based on the metals embodied in human artefacts, the collection and recycling chain, and the supplementation of metal stocks from virgin ores. Implementing this wider boundary for mining will improve its social indicators and, if industry and consumers embrace the full stewardship concept, its financial indicators as well. For industry, the challenges are more complex but two issues stand out. The first is to focus procurement for intermediate inputs into production, towards items with low environmental loadings certified through established conventions of life cycle analysis. The second more challenging option is to reduce the energy and material content of manufacturing by co-location of many industries into 'industrial ecology' complexes where waste materials are inputs into other products, process heat can be shared, and lower carbon electricity can be generated, so enabling manufacturing synergies while reducing fossil carbon content.

3.3 The Sectors of 'Construction' and 'Transport and Communications'

3.3.1 Interpretation

The construction industry generates just under 6% of national GDP and 12% of national employment showing why cyclical declines in construction activity generate political concern (Table 2). In spite of its physical image, construction reveals a relatively positive triple bottom line account with two outliers for government revenue and export propensity, average intensities for employment generation and income, and below average intensities for all environmental indicators (Figure 4). This is in spite of the high energy and greenhouse content of many construction materials such as cement, bricks, glass and aluminium. It suggests a reasonable balance between the physical transactions and basic prices paid. By contrast, the transport and communications sector shows a more pronounced outlier for government revenue and lower employment generation than construction. The energy intensity indicator is 50% above average but greenhouse intensity is 10% lower, because higher quality petroleum fuels rather than greenhouse intensive electricity, dominate the composition of energy use. The government revenue spike is a combination of government subsidies for some railways and urban transit systems, and privately owned airlines and bus lines that are financially profitable, but still receive some measure of financial support through low excise taxes on fuels such as aviation kerosene.



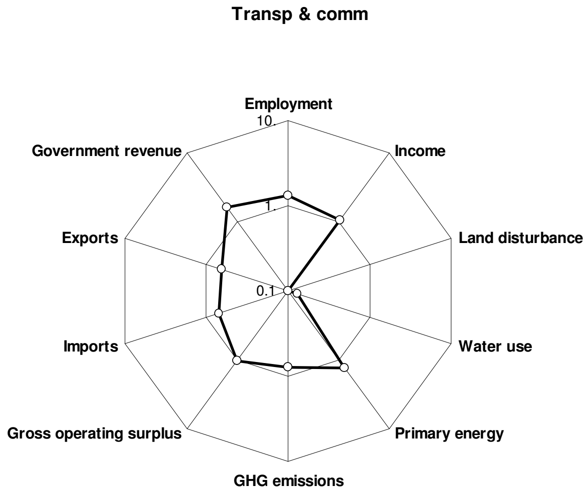


Figure 4. A spider diagram presentation of triple bottom line performance for financial, social and environmental indicators, in the aggregated macro-sectors of 'construction' (2 sectors), and 'transport and communications' (11 sectors). The economy-wide scaled average (=1) is the regular polygon in the centre of the diagram. Indicators with above average performance are closer to the centre, while below average indicators are positioned closer to the outside boundary

3.3.2 Options for Incremental Change

The construction industry has made rapid advances in the last decade in terms of its waste management and energy use practices. Many 'green building' designers are now selecting materials with lower energy and material content embodied in their production chains. In addition they are designing whole of life operational approaches that substantially reduce the yearly use of energy and water. The indicators for both export propensity and government revenue are more difficult to improve since they are structurally constrained. Construction is mainly a local industry although Australian firms are now locating overseas for major projects, and so the export propensity indicator may improve if financial activities are reported in domestic national accounts. Within cities, the transport sector has been overwhelmed by private vehicles and a reluctance to date by society to fully internalise in the cost of car operations, and acknowledge the issues of air emissions, congestion costs, accidents and so on. However some Australian cities are now preparing to move beyond tokenism in changing transport modes. Perth for example has recently begun construction of a major railway project to link all of its southern suburbs to the city, and thus advantage train travel in comparison to individual vehicle commuting.

3.3.3 Options for Substantial Change

An escalating implementation of physical taxes, particularly a carbon tax, could cause a profound structural change in both the construction and transport sectors, but probable transition pathways are difficult to quantify. It is possible for example, for buildings and transport that have substantially lower carbon emissions in operational terms per household, per office, per passenger kilometre or per tonne kilometre, to be more materially and energy intense in construction, to give high energy effectiveness and efficiency during the operational phase. This could produce a peak of emissions during the construction phase leading to a relatively rapid decline in the operational phase. Increased use of, and dependence on transport modes other than personal vehicles, may increase social indicators such as employment and income, but cause declines in those indicators linked to motor vehicle manufacturing and motor vehicle repairs.

3.4 The Sectors of 'Private Services' and 'Public Services'

3.4.1 Interpretation

Together the aggregated private and public service sectors contribute about 43% of GDP and 36% of national employment (Table 1). The environmental indicators for the private service sectors represent common perceptions of services being 80% or more below the economy wide averages (Figure 5). However the perceptions that this represents somehow a decoupling of the physical and financial economies does not stand up to analytical scrutiny since sectors such as banking, property services, accounting and marketing etc. are all important upstream suppliers to major physical sectors, and are thus locked into a mutual interdependence. In addition, security brokers, bankers and superannuation funds often decide the future and scope of major physical economy projects which ensure positive returns for the funds they manage, and so the cycle of interdependence endures. Other features of private services include employment and income intensities that are 50% below the economy wide average, and an export propensity that is 75% below average. Thus in spite of the importance of private services for a modern economy, these data highlight that the contributing sectors have intensities of employment, income and exporting that are at least 50% below average. An expanding proportion of private services in the overall economic structure thus bodes poorly for future employment opportunities and a balanced trade account.

The public services sector also concurs with common perceptions having indicators of operating surplus and export propensity that are 50% to 70% below average (Figure 5). However in comparison to private services, the employment and income indicators are 30% to 50% above average. Public services have environmental indicators that are also well below average, but not as low as private services as this sector includes defence and national parks and gardens, which respectively have energy and water use profiles that are more similar to a physical, rather than a service sector.

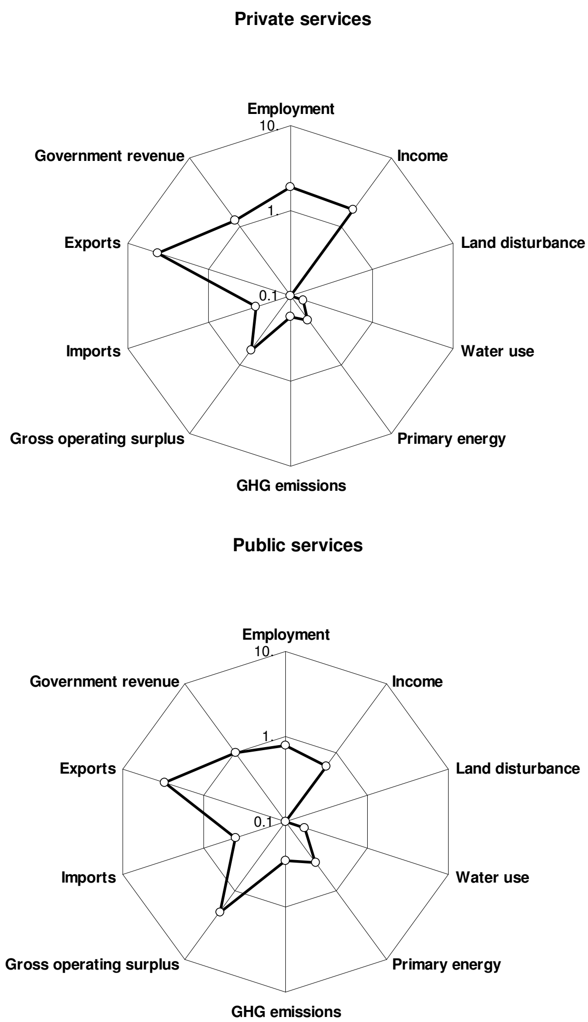


Figure 5. A spider diagram presentation of triple bottom line performance for financial, social and environmental indicators, in the aggregated macro-sectors of 'private services' (12 sectors), and 'public services' (8 sectors). The economy-wide scaled average (=1) is the regular polygon in the centre of the diagram. Indicators with above average performance are closer to the centre, while below average indicators are positioned closer to the outside boundary

3.4.2 Options for Incremental Change

The move over the last decade to a more concerted user pays philosophy for public services in many English speaking democracies is expected to continue and help reduce the extent to which indicators such as operating surplus are below average. However equalling the levels attained by private services is not structurally possible given the degree to which modern democracies, in spite of decades of unpunctuated economic growth, still have an underclass who require some form of 'social net' to help maintain social equity. Although private ownership and outsourcing have penetrated public services sometimes to a high degree, even in health and education most of the financial cost is borne by several tiers of government. Increased pressure for economic efficiency will continue to be a strong driver of change in public services, but perhaps moderated in future decades by the debate of 'efficiency' versus 'effectiveness' in the supply of public services.

There is little doubt that information and communications technologies have helped many of the private service sectors to achieve the lower employment and higher surplus indicators revealed in this analysis. The extent to which this trend saturates in the face of declining real service and consumer preference is uncertain. The more efficient services of today such as internet banking and insurance, and on-line airline bookings, are usually a time expense for the consumer rather than the purveyor of the service. There may be a move back to more face to face contact, and thus higher employment intensities. Given the current and future size of the private services sector, the key challenge is its export performance which is outweighed twofold in absolute financial terms by imports. The extent to which services, except tourism which is really a physical sector, can be exported far from the originating country is difficult to perceive from the current literature. Many global firms currently dominant in banking and insurance were dominant several centuries ago and there is to some extent a long term lock-in. Recent participation by large domestic banking and insurance companies in overseas markets have not been particularly successful, although there are numerous success stories from smaller, more agile and specialised service companies.

3.4.3 Options for Substantial Change

A new economic theory, obviously still several decades away, may reverse or reclassify the current dominance of the services sector in the economy. There is an argument that classifying wheat production as primary, flour making and baking as secondary, and restaurant meals as tertiary, represents a somewhat arbitrary dissection of a complete and fully integrated production chain in the real world. Implementing a full cost pricing through the production chain would possibly require that life cycle costs of land disturbance, water use and greenhouse emissions be internalised in each node of production, thereby increasing several fold, the value added in the primary and secondary activities. The value added by the services sectors may be substantially reduced if this unlikely sequence of changes occurs.

4. DISCUSSION

Numerate triple bottom line accounting at the whole-economy level has highlighted a number of key issues for the Australian economy. Given the high likelihood of incremental change as a policy constant in today's democracies, technological innovation faces significant challenges as it attempts to reduce the environmental intensities in many sectors. Improving the social indicators is more of a challenge since sector aggregates such as mining and private services for example, have evolved over many decades to be capital intense, skill rich and employment poor. In comparison, construction and public services have employment and income intensities similar to the economy wide average.

More radical interpretations of these aggregate sectors suggest a number of directions that will not find ready acceptance in today's policy debate. A suggestion that basic prices of food should be substantially increased to allow sufficient investment into management technologies that reduce the environmental loadings of food production challenges the trend of the last five decades where real consumer prices for most items have declined. Nevertheless there is sufficient support in statements such as 'charging the real price for water' and 'including environmental externalities in the full cost of production' to suggest that some change is possible. Improving the social indicators for mining by moving to a full life cycle 'metal stewardship' approach, may seem extreme in today's marketplace, but recycling programs for copper, lead, steel and aluminium are commonplace and the main challenge is moving to much higher levels of recycling while extraction of virgin ore may stabilises and then decrease over the next 50 years. This will allow the concept of a sustainable metals industry to bridge the current gap between rhetoric and reality.

The most radical challenge is presented by the tension between the higher profit and lower employment offered by 'private services' and the opposite of no profits and higher employment typical of 'public services'. There is a general perception that the GDP of any modern economy will inevitably be dominated by the services sectors and their typically low intensities for land disturbance, water use and greenhouse emissions (Figure 5). It is assumed that this offers the route to a dematerialised economy where most transactions are 'light, cool and dry' versus the 'hot, heavy and wet' signature that is typical of today's Australian economy. However the majority of employees in the service economy, being at least average and typical consumers, will require elaborately transformed consumer goods and services many of which will have to be imported. These will further the service sectors below average performance in exports, and pressure the physical sectors to expand export activity

There is a significant policy tension between implementing the changes suggested by this aggregated and macro-analysis, and stimulating those changes at a sector by sector level. The challenge of harmonising the effects across the whole economy are immense, particularly when international institutions and the global business cycle could be focused on goals that are completely opposite. The concept of fully free and open trade is still a hypothetical one in everyday practice. International litigation battles are conducted every week at the level of individual commodity and service sectors, although there appears to be more positive outcomes than negative ones in trade equity. However if, within the current international trading regimes, the farm gate price of Australian food and fibre products were substantially increased to internalise the environmental externalities, much domestically produced food could be replaced by imports, none assessed by the same full chain analyses presented here. Allowing trade officials and industry blocks access to these domestic analyses, as well as similar ones for trading partners, would allow scope for informed trade negotiations based on triple bottom line concepts.

Finally, these analyses are always subject to the challenge that they are incorrect or imprecise at a fine level of detail. At one level, this is true primarily because of the data spreading techniques that have to be used because national accounts are constructed to a budget, and lack the investigative detail required for high precision on a sector, or a commodity basis. Nevertheless they are consistent and complete in national account terms, and offer insights seldom found at a whole economy level, particularly in the environmental context. It is unlikely that any major issues highlighted in this aggregated analysis, or the 135 sector level analysed for government in a research consultancy, will be substantially incorrect. The opportunities for whole-economy improvement however, require considerable more thought, discussion and wide ranging complex analysis.

5. FURTHER WORK

Five areas of further work should be stimulated by this whole-economy and numerate approach to triple bottom line accounting. The first is that this static or one time analysis should be repeated for the sixteen national input-output tables constructed for the Australian economy since the late 1960s. This has been undertaken for energy and greenhouse [15], but unfortunately physical accounts such as water use and land disturbance are relatively recent data acquisitions, and will have to be constructed indirectly with a synthetic approach to describe the history. Nevertheless this will enable time trends over 30 years to be quantified, and to underpin more appropriately any proposal for incremental or radical change to triple bottom line performance.

It is important to harmonise this analytical approach, with its strengths of integration and lack of boundaries, with international approaches rapidly gaining headway such as The Global Reporting Initiative [2] and The Equator Principles [16]. These approaches have widespread support through many globalised companies and national governments. However they are currently orientated to a ‘within the factory fence’ approach, but do acknowledge a number of first order issues such as the origin of water and energy, and some second and third order effects particularly the labour practices used to supply intermediate inputs to production. Part of the harmonisation process will require the development of indicator datasets that match the requirements of these initiatives, as well as collaborating in the development of international software tools that enable the fluent use of whole economy accounting without boundaries.

While the current work focuses on upstream analysis or producer view of the full production chain, there is now a requirement for the analysis of downstream effects which will highlight consumption issues. While these are well known in an aggregate sense, such as water pollution from agricultural and urban runoff, human health problems from air emissions, and biodiversity loss from development of agricultural and urban land, the lack of availability of nationally scaled data and its mapping against economic sectors will limit the work initially. The mathematical solution for this analytical process will also require the enumeration of shared responsibility concept between consumers and producers. Whether to apportion for example, 70% of responsibility for downstream effects of fuel intensive sports utility vehicles to the firms who make them, and 30% to the consumers who purchase them, or the reverse, will require extensive social research.

Inevitably, today’s production chains reach across many countries and production processes and embody a wide range of positives and negatives in social and environmental areas. This current analysis focuses only on production processes that occur within the boundary of Australia’s continental shelf. To adequately represent imports of both final and intermediate demand both of goods and services, will require this level of analysis for five to ten of Australia’s main trading partners, and an aggregated ‘rest of world’ category. With appropriate collaboration between countries, this may be feasible.

Finally, many of the propositions developed in this paper can only be tested in dynamic and forward looking models that allow the technical innovations or pricing shocks suggested in the paper, to be tested within contemporary and acceptable analytical frameworks. While appropriate econometric and physical-economy models are individually available, the complexity of some triple bottom line improvements will require at least the dual methodologies to be used in tandem, or at best a fluent combination and integration of the best of both approaches. This has not yet been achieved effectively for the level of 135 sector disaggregation that forms the basis of this analysis, although the Danish Department of Energy has coupled upstream and downstream models of the same system to provide the fledgling capability that will be required to make policy deliberations more evidence based.

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