# Australian Institute for Business and Economics (AIBE)

# Teachers as health workers; a consideration of the economic impacts

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# Abstract

Teachers face a multiplicity tasks in undertaking their work. Some of these tasks are not primarily educational and may be described as health-related. In the provision of these services, there is a net transfer of economic benefit from the Education Sector to the Health Sector. Disentangling the net amount of this transfer is difficult and depends largely upon the substitutability between teacher initiated health-work and "market" based health work which might reasonably be carried out by health professionals. This study is one of the first to attempt to disentangle these links and place a value on the extent of the net subsidy provided by teachers. It uses a unique data set compiled by MacDonald (et al.) and combines this with an economic impact model developed at the University of Queensland, Faculty of Business, Economics and Law. The results of this study influence both teacher training and remuneration and well as highlighting the important role played by teachers in student health.


# Introduction

The modern teacher has a multiplicity of roles in which traditional instruction is only part of the job. Teachers in modern classrooms are no longer instructors, they are facilitators, their main task is to set goals and organise the learning process accordingly[1]. Consequently, in conducting their work, teachers become aware of heterogeneity among students, not just in terms of learning ability but also regarding mental and physical health.[2] Common health-related problems among students include mild physical and intellectual disabilities, issues relating to nutrition and personal care issues.[3] There is likely to be school-based or generalised procedures and guidelines in place to assist teachers in dealing with these issues. For example, the Victorian Education Department website advises:

"It is never the job of a teacher to diagnose medical conditions. Do not make assumptions, but once a diagnosis is made by appropriate professionals, you are in a position to seek further targeted assistance if necessary" (Victorian Department of Education, 2014).

However, there are likely be student-specific and unexpected health-related issues that teachers face in and out of the classroom that requires judgement on a case by case basis. This paper is not about the specific instances where teachers may be required to assist in health-related issues but instead examines the economic implications of educators devoting some of their time to what is essentially non-teaching related issues.[4] It highlights a number of issues;

- How much of the paid for the time of the teacher are devoted to issues that are primarily health-related as opposed to those that are primarily education related?
- To what extent does this diversion of education time impact on the overall effectiveness of the provision of educational services?
- Are all, or the majority, of in-classroom health issues, better left to health professionals of an appropriate skill level?
- What is the economics of the current system of mixing education and health responsibilities within the portfolio of the classroom teacher?

The paper uses a unique dataset compiled by the University of Queensland, School of Education and combines this with a non-linear economic impact model (QNLMRM) operated with the Australian Institute for Business and Economics (AIBE).

## Some Economic Considerations

The UQ study has established that teachers routinely undertake activities that may be classified as health-related. The extent of this health work (or the propensity of each teacher to undertake health work)

[1] See, Szucs, E (2009) "The Role of Teachers in the 21st Century" Sens Public Review Web, http://www.sens-public.org/article667.html?lang=fr

[2] Alperstein, G and Egan, M (2012) Education and Student Health; The Big Picture, The Department of Education, Employment and Workplace Relations (DEEWR), Canberra

[3] See, Victorian State Education (2014) "Student Health and Well Being" for a discussion of health issues among students commonly faced by Victorian Teachers. http://www.education.vic.gov.au/school/teachers/health/Pages/default.aspx?Redirect=1

[4] There is some over simplification in this statement. Clearly the effectiveness of teaching in an educational sense will be impacted by the health of the student and so, indirectly, an effective teacher cannot operate in an environment where students are health impacted.

varies by school type, student characteristics and by the characteristics of the individual teacher. Like all human activity, these have economic consequences which may be quantified along as appropriate data are available and some modest simplifying assumptions are made to the likely consequences of teacher behaviour in the health-related area. For example, it is valid to assume that the health interventions are neutral or net- positive (that is the intervention is not harmful or reduce the welfare of the student). Even with this simplifying assumption, the economic factors that come into play through health-related teacher activity are quite complex. There are a number of potentially counterbalancing economic trade-offs, based on the concept of opportunity costs and cross-subsidisation. By way of definition, opportunity costs in economics may be defined as;

*Opportunity Cost = $Return of Most Lucrative Option - $Return of Chosen Option* (1)

It defines the cost of devoting resources to one activity in terms of the potential loss of benefits from using the same resources in an alternative use(s).[5] For example, an opportunity cost of a teacher devoting part of work time to health-related activities is the value of that time devoted to normal teaching activities. Cross-subsidisation is a slightly more complex term, and its outcome in terms of net benefit is difficult to judge. In a case in point, a teacher responding to a health issue reduces the need for intervention by the school of government based health services, either proportionally or more than proportionally (if the early intervention reduced the eventual health consequences). In this situation, the employer of the teacher has cross-subsidised the health providers but at the cost of lost work time frothier employee. As a further complication, there are opportunity costs associated with various forms of cross-subsidisation.[6] In the case of teachers engaged in health work there are a number of potentially counterbalancing flows;

1. The element of teacher time diverted from "education" to health work represents an economic transfer from the employers of teachers (State Government, Private organisations) to providers of health services( Within Schools or to Health authorities)[7]- if the students would have sought alternative help from heath providers and/or if the teacher intervention prevented a subsequent and possible more costly call on the health services at a later date (i.e. early prevention effect) in other words there is both a current and future net transfer from education to health. This in effect is the shadow price for teacher services devoted to health-related activities. There may also be a private beneficial transfer between the School and parents who are either neglectful or unable to cater for the health benefits of their children fully.[8]

2. Teacher productivity impacts. These are complicated. If substantial amounts of teacher time are diverted from planned class activities, there are likely to impact on the productivity of the teacher (in terms of quality delivery of teaching services), and these will impact disproportionately on "healthy" students who did not require attention but have now had less formal learning time. In other words, students that do not require health assistance are cross-subsidising those that did. A further complication is that the well-placed health activities of teachers may help them connect better with some students and improve teaching productivity for the class as a whole over time.[9]

3. Teacher production frontier implications. Following on from point (2) to this point it has been assumed that teachers are fully occupied in providing educational services and that any diversion from that schedule to undertake non-teaching activities will represent an economic cost. In economic terms, we assume the teacher is on their

[5] See, http://www.investopedia.com/terms/o/opportunitycost.asp

[6] See, Heald, D (1996) " Contrasting Approaches to the Problem of Cross Subsidy" *Management Accounting Review* 7, 53-72

[7] This introduces the concept that the School employees both teachers and has health infrastructure (staff, equipment, space). School management may have a formal or informal system whereby they as an operational policy plan for cross over between the two.

[8] Severson, H (2007) et.al "Pro-active, early screening to detect behaviourally at risk students: Issues, approaches, emerging innovations and professional practices" *Journal of School Psychology* 45, 193-233

[9] National Eating Disorder Collaboration (2012) "Eating Disorders in Schools" http://www.nedc.com.au/files/Resources/Teachers%20Resource.pdf

production function.[10] This may not be the case. If a teacher is below their production function (and fulfilling all required duties), then any additional tasks that do not detract from their primary role is a net benefit, divisible between all stakeholders. Finally, the issue is further complicated by synergy effects- teachers are often in the "right place" to administer health work, they have the trust of students, and by administering this health work, they may enhance the value of the current and future educational services. In economic parlance- this will either move them closer to their production frontier or move the frontier itself to the right[11].

Within School transfers. School management is responsible for all aspects of school operations, they may arbitrage between those resources primarily dedicated to teaching and those dedicated to school welfare including health issues to achieve overall cost minimisation[12].

# Quantifying some economic considerations

Economic quantification, especially where both private and social costs are involved requires some simplification to be used. There is also likely to be some data related issues and two important issues; economic value/cost and its distribution. For example, it is relatively straightforward to calculate the potential value of health-related work by equating it to the opportunity cost in terms of lost paid-for teaching time. However, it is much more difficult to disaggregate that benefit between the potential beneficiaries. For example, the potential beneficiaries of such a transfer include

- The student
- Parents
- Other teachers who may teach the student concerned
- The School
- Governmental health services

The exact distribution of these benefits between the above will depend upon the nature of the health issue, family circumstances and the relativities between school provided and the public provided health facilities, and in the absence of a longitudinal unit record, data would prove very difficult to estimate with any degree of accuracy. Consequently, this section limits itself to examining the potential transfer of economic benefit from schools to the above in aggregate. This, by itself, represents important new information which will have implications for teacher training, teacher remuneration and the case for widening the considerations of the social and economic benefits of schools.

## Quantifying the shadow benefit to society of Teachers providing un-costed for health work

The methodology used below is in three stages;

1. Arithmetic estimation of the wage costs of time diverted to health-related issues across Queensland Schools- This will provide the most important element of the direct costs. Which can then be used to shock the economic model through the Education sector
2. Consideration of other benefits (such as early prevention benefits) for possible inclusion in the direct costs

Application of the direct costs to the Queensland using the Non-Linear Multi-Regional Model (QNLMRM) developed at the University of Queensland.[13] This model will allow the full economic

[10] Coates, D (1998) "Education Production Functions Using Instructional Time as an Input" paper presented to Public Choice Society, New Orleans, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.501.1725&rep=rep1&type=pdf

[11] Todd, P and Wolpin, K (2003) "On the Specification and Estimation of the Production Function for Cognitive Achievement" *The Economic Journal* 113 F3-F33

[12] Fraser Institute (2007) "Why do Private Schools Exploit Their Employees?"
And Hanushek, E. (2007) "Education Production Functions" Palgrave, Harvard.

benefits of the implicit health sector subsidy to be quantified

## The direct (first round) benefits

Calculation and monetisation of the direct benefit are based on the following assumptions and uses the survey data across the 386 surveys to generalise about the Queensland teacher workforce in aggregate. This of course has its dangers. To this point, no formal testing of the randomness of this survey has been taken and results achieved should be considered under this caveat. In defence of our use of these data it is recognised that due to extensive (in contemporary terms) unionisation among the teacher workforce, the wages paid across the sector, irrespective of type (State, Catholic or Independent) are constrained within a relatively narrow band.[14]

- On average (mean), teachers (n=386) reported spending 592 minutes per week (9 hours 52 mins) undertaking health work with their students or 380.8 hours per year
- The current average wage of teachers is set at $86,032 per annum. This is based on a Band 3, Step 4 salary for QLD teachers as at September 2015 – basically, an experienced teacher that doesn't hold any additional position of seniority within a school. Teachers with 7 or more years teaching experience made up 75.9% of our sample
- These data suggest an average wage per hour based on 36.5 hours of $45.32
- If all that time were devoted to teaching the economic value (and hence the shadow price of health work diversions) [15] would be $17261 per year, per teacher.
- Queensland schools employed the equivalent of 51,258 full-time teaching staff in 2011. Of this total, 28,332 were employed in primary schools and 22,927 in secondary schools (OESR, 2012). However, the number of number of active FTE (Full-time Equivalent)[16] teachers in Queensland, making allowance for non-active teachers at approximately was approximately 45,000
- This suggests a very large potential total diversion cost estimate (shadow cost of teacher administrated health work) of $776, 745,000

This amount would form the direct exogenous shock to the QNLRM in order to estimate the total societal benefit from the additional health services provided by teachers.[17] However, it cannot be assumed that all activities nominated as health-related are totally divorced from "active teaching. Some of the actions are synergistic to the teaching role and may even be a net benefit to the overall teaching performance. As well, some tasks are of a nature that they could not realistically be transferred to health professionals, in that they may be one-off tasks and they arise at random times (although there would be a concentration of incidents in the morning and before school) and require immediate attention. While these incidents may represent a cost in terms of lost teaching they represent part of the pastoral care expected by teachers and not a function where health professionals could easily substitute for teachers. Effectively there is no shadow price for these activities.

The issue of shadow costing then becomes how much of the total amount of time teachers devote to health-related work represents a cost to the potential economic value of their teaching if it was conducted in a manner not interrupted by health-related work.

Data does not allow a disaggregation of the health-related work of teachers by nature of the task. As a result, our preliminary evaluation is based on discussions with teachers and those conducting the survey. This suggests that the net reduction in teacher effectiveness is conservatively estimated at 25%. On this basis the direct exogenous loss from teaching (direct subsidy to the health industry) is $194.2 Million per annum. Conversely this represents the first round social gain to society through the subsidy to the health sector. It should be stressed that this represents a conservative estimate of the net transfers currently taking place from the Education sector to the Health sector and does not take into account the accumulating value of early intervention services provided by teachers on the future costs of health

http://hanushek.stanford.edu/sites/default/files/publications/Hanushek%202008%20PalgraveDict.pdf[13]

[14] See Queensland Teacher's Union claims of over 90% membership. http://www.actu.org.au/media/349581/queensland-teachers-union.pdf

[15] the estimated price of a good or service for which no market price exists.

[16] This allows for

[17] Gross benefit, from which the loss of effective teaching time would need to be deducted.

problems or the social value to parents and society in general.

# Total Economic Benefit

Investigating the economic impacts will attempt to explain how the economic flows from one industry sector will affect on the other sectors in the economy. If teachers did not perform some health-related activities then the burden would need (now or in the future) to be taken up by components within the Health industry, this represents a direct subsidy (transfer from the education sector) and is analogous to a direct or exogenous injection of funds into the Health sector. It, therefore, can be modelled under standard economic impact methodology[18]

The economic modelling undertaken in this report makes use of a specifically constructed non-linear (marginal coefficients) Input-Output table for Queensland and the rest of Australia, The Queensland Non-Linear Multi-Regional Model (QNLRM) This type of model is well suited to modelling economic impacts in the Education and Health areas by allowing for the generation of non-proportional or non-linear results. That is, it allows us to investigate economic impacts that are expected to differ in magnitude and importance across time as the economy changes.

This model has been successfully used in a number of applications, both in a Queensland context and in a "Rest of Australia" context. The model is based on the non-linear properties of the IO-9 software developed by Guy West from the Centre of Economic Policy Modelling at the University of Queensland[19]. The model is regularly updated both by the addition of newly available data and by recalibration of the elasticity estimates that are used as external inputs into the model. The latest update of the model occurred in 2015 when data on Retail services and power usage were added to the IO table and the table constrained to the latest estimates of State GSP.[20]

In the economic modelling lexicon, non-linear modelling sits somewhere between traditional (average coefficients) input-output modelling and computable equilibrium modelling (CGE). For a modelling exercise such as this it has advantages over both alternative methods: For example, the Non-Linear Input-Output Model (NLIO) removes one of the major limitations of standard input-output analysis by removing the assumption of linear coefficients for the household sector and allowing marginal income coefficient adjustment. This is because, as is widely known, the household (consumption) sector is a leading factor of multiplier effects in an input-output table. Therefore, using marginal income coefficients for the household sector will provide an accurate and empirically valid, estimate of the multiplier effects, which will provide results closer to those of a computable general equilibrium (CGE) model. NLIO has the advantage over CGE in that it retains the flexibility and relative data parsimony of an IO model in comparison with CGE, which is structured to estimate elasticities internally and therefore, has much higher base data requirements. As well, NLIO is better suited to the evaluation of partial equilibrium (one-off projects) or events such as changes in one part of an industry sector as well as being better suited to regional evaluation.

The non-linear component is introduced into the model by the interaction of estimated and externally imposed elasticity coefficients upon the multipliers, particularly the employment and factor income multipliers. In essence, the quantification of economic impact relies on the quality of input data and the ability of the modelling process to correctly interpret that data. The Queensland Non-Linear model (QNLMRM) has performed well, in terms of accuracy of results and model diagnostics for a number of impact studies[21]

- 17 Intermediate Sectors[22]
- 4 Primary input sectors
- 3 Final demand sectors

The sector composition is shown below in Table 1

[18] See, Hagan, P. and Mangan, J. "Guidelines for Economic Modelling Using IO Analysis" Government Statistician's Office 1997, Brisbane

[19] Some assumptions had to be made concerning elasticity coefficients for some industries in the TNLM. For example, where exact data was not known published estimates from the Rest of Australia (minus NSW) estimates were used as proxies. This method has been successfully used in a number of studies relating to Tasmania.

[21] See for example, KPMG (2009) "The Economic Impact of the Ten Days on the Island Festival"

[22] As derived from the Australian and New Zealand Standard Industry Classifications, See Australian Bureau of Statistics cat 1292.0

Table 1 Sector Composition of QNLMRM[23]

| |
|---|
| • A — Agriculture, forestry, fishing and hunting |
| • B — Mining |
| • C — Manufacturing |
| • D — Electricity, gas and water supply |
| • E — Construction |
| • F — Trade |
| • G — Accommodation, Food Services |
| • H — Port Transport |
| • I — Transport , Postal and Warehousing |
| • J — Information Media and Telecommunications |
| • K — Finance and insurance |
| • L — Rental, Hiring and Real Estate Services |
| • M — Professional, Scientific and Technical Services |
| • N — Administrative and Support Services |
| • O — Public Administration and Safety |
| • P — Education and Training |
| • Q — Health Care and Social Assistance |
| • R — Arts and Recreation Services |
| • S — Other Services |

Sources of 2 Digit ANZSIC Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006 (Revision 2.0) 2013 1292.0

This structure was designed to maximise detail of each sector and its interaction with the rest of the Queensland economy and operates a number of default values that estimate the average breakup of each sector into intermediate goods, primary inputs and final demand sectors.

The specific advantages of this method are outlined in the appendix to this report, but primarily, this technique removes some of the known problems of Input-Output modelling, whilst maintaining the flexibility and relative data parsimony that have made Input-Output analysis such a popular and continuing method of economic analysis.

The primary economic impact measures derived from the model are:

- Gross Output/regional Turnover - refers to the value of increased production from an additional economic activity. Within this gross value is included the value of raw materials that, in most cases, have already been counted as part of gross output from earlier production. Therefore there is a tendency for Gross output figures to include some double counting. As a result, more concentration is placed upon incremental (additional output created) *or value added.* Nevertheless, the concept of Gross output should not be abandoned because it is a good

[23] As used for this report. The sector allocation may change depending upon the project under investigation.

indicator of the level of turnover in the economy and hence a good measure of the total level of economic activity.

- Value Added – refers to added or net output. Value Added is equivalent to the Gross State Regional Product as used by the Australian Bureau of Statistics. It is the measure usually preferred when measuring economic impact. It measures the added value placed on intermediate products (raw materials) from the productive process. It is made up of margins, wages, profits and transfers.
- Factor Income – relates to the share of value added (and gross output) which is directly paid to individuals or firms in the form of wages and or profits. By definition it is a percentage of value added and cannot exceed value added.
- Jobs – relates (usually) to the amount of labour required for the level of production. Depending upon the type of activity, job numbers measure either the use of existing labour (continuing jobs) or hiring new staff. Full-Time Equivalent (FTE's) employment refers to the number of full-time person-years of employment generated by a particular project or event. This alleviates the overstating of the level of job growth due to the stimulus. Note that employment outcomes relate to the whole period of the project and are not annual impacts.

To estimate the full social benefit of the health transfer from teachers we apply estimated health subsidy ($194.20) M as an exogenous shock to the economy through the Health Care and Social Assistance sector with the QNLMRM this produced the following results;

Table (1) Estimated total annual economic impact of Teacher Health transfer on Queensland Economy[24] $Millions

| | Final Demand | Industry Effects | Consumption Effects | Total | Flow-on |
|---|---|---|---|---|---|
| Gross Output/turnover ($m) | 194.20 | 58.57 | 161.32 | 414.09 | 219.89 |
| GSP ($m) | 97.61 | 29.80 | 104.81 | 232.22 | 134.60 |
| Factor income ($m) | 44.18 | 12.33 | 79.12 | 135.63 | 91.45 |
| Employment supported (FTEs) | 506 | 123. | 404 | 1032 | 527 |

Source QMLMRM (2015)

Specifically, this suggests that expenditure by the health work subsidy provided by teachers in Queensland produces a total economic effect per annum

- Average annual Turnover or Gross Output gain of $ 414.09 million
- Annual Value added or net additions to GSP of $232.22 million
- Annual- gains to factor income of $135.63 million
- Annual support for approximately 1032 FTE jobs

In terms of our specific example, the social value of the health transfer, if injected directly into health sector budget would produce a net addition of $232.22illion to Gross State Product (GSP) and support over 1000 jobs (1032). If teaching effectiveness were not affected by this diversion in tasks, the amounts shown above would represent a net welfare increase to the state.

[24] Note that expenditure on such items as airfares have been assigned to Queensland as a proxy for "national" expenditure

# Is it Efficient for Teachers to Do Health Related Work?

While there is no doubt this type of transfer does occur and produces significant economic benefits in terms of net transfers, is this an efficient use of society's resources? The concept of opportunity costs is important here. The opportunity cost of teachers doing health work is the loss of education time, with the net trade-off being the benefits of the health work versus the cost of the loss of education time. To arrive at an initial approximation the initial direct exogenous transfer of $194.2 was applied to the QNLMRM through the Health Sector (as above in table 1) and the Education sector and differenced. The results are shown in table 2

Table (2) Net Welfare Transfers from Teacher Health Related work

| | Final Demand | Industry Effects | Consumption Effects | Total | Flow-on |
|---|---|---|---|---|---|
| Gross GSP ($m) | 15.54 | 4.69 | 12.91 | 33.13 | 17.59 |
| Value added ($m) | 7.81 | 2.38 | 8.38 | 18.58 | 10.77 |
| Factor income ($m) | 3.53 | 0.99 | 6.33 | 10.85 | 7.32 |
| Employment supported (FTEs) | 40 | 10 | 32 | 83 | 43 |

Source QMLMRM (2015) and data from UQ survey

The results shown in difference table 2 show (relatively small) positive gains in all components, indicating that there has been an across the board gain in welfare from teacher initiated health work after discounting for economic loss of standard teaching time. These net gains would be distributed across the economy but would be most concentrated in the Public Administration and Safety and Healthcare and Social Administration Sectors. The result indicates that the current system is efficient compared to the alternative of teachers doing no health work and those tasks being taken over by health professionals. However, a number of caveats attached to this conclusion. First, the results are driven by the fact that in the QNLMRM, value-added multipliers are slightly larger for Health Care and Social Assistance than they are for Education and Training[25]. Consequently, it is inevitable that any transfer of income from Education to Health will be net-positive. Within economic models, the Education and Training and the Health Care and Social Services are considered in aggregate. We have not attempted to isolate those smaller subsectors of each industry which deal with the School sector in both an educational and health-related way. It is possible that consideration of these subsectors in isolation may give a different result[26]. Secondly, some of the important potential transfers, including the present value of early teacher detected health issues have not been quantified and included in the analysis. As these would only further add to the value of the current system their inclusion would only strengthen the initial conclusions. However further quantification of the benefits would strengthen the case for improved teacher training and raise the profile of the pastoral care work carried out by teachers. Thirdly, we have not solved the distribution issue. In the analysis, the educational transfer is assigned in bulk to the Health Care and Social Assistance sector. Earlier we identified a number of stakeholders who would benefit from teachers undertaking health-related work. Benefits to parents and the budgetary position of the host schools have not been considered. It may be that some School administration is saving on operational costs by expecting Teachers to undertake essentially unpaid or under-paid tasks as well as opening themselves up to litigation risks. These considerations open up considerable scope for further research.

[25] This is a common result and is mirrored in National Economic models.

[26] This is likely to be a greater problem within the Health Care and Social Assistance

# Conclusions

The UQ study confirms that teachers engage in considerable amounts of health-related work of varying degrees and intensity during their working week; approximately 10 hours per week or 360 hours per year. The teacher also serves as an effective early warning system for students that have or are in danger of developing physical and mental health issues. Assuming the basic unit of output for a teacher is instructional services to healthy students, health-related activity disrupts these tasks by the amount devoted to the health work plus any additional disruption time. This has an economic consequence for the State, the School, Parents and Friends. Importantly it also represents a windfall gain to health providers who may otherwise have been required to provide the health service input- ranging from, parents, other teachers, the school nurse, paramedics, doctors and hospitals. In other words a cross-subsidisation is occurring between education providers and health providers. In this paper we use data from a unique survey that yielded information on the extent and type of health-related interventions undertaken by teachers, combined with aggregate wage costs (on costs (fixed costs) of employment were not considered as thee are considerable variations among school types) and because these costs are fixed and are not dependent upon undertaking health-related activity) and applied as a direct subsidy to the Healthcare and Social Assistance sector. The Queensland Non-Linear Multi-regional Model was used to estimate the total economic impact of the transfer. It was found that the welfare benefits to the State economy were considerable at approximately $230 million per annum net value added. This subsidy also had corresponding income and employment benefits to the State economy. However, to this point, we have simply valued the current system under which teachers cross-subsidised the Health sector. The next question to ask was; is the current system efficient? There are a number of efficiency tests available to compare outcomes. Here we chose the efficiency test of relative opportunity cost. Put simply, which was the least cost alternative?; maintain the current system or transfer all teacher related health activity to the health sector? By comparing alternative impacts of the direct value of the transfer between the donor sector (Education and Training) and the host sector (Health Care and Social Assistance) we found that the current system had small net welfare benefits to the Queensland economy over the alternative of the cessation of teacher-initiated health work. A list of caveats emphasised that this conclusion is most likely understated. Finally, the thorny question of the distribution of benefits was essentially avoided. If teachers, through their actions are generating excess net private and social benefits then the law of marginal productivity wage payments would suggest that part of these benefits be returned to the teachers in the form of increased wages.

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# Appendix 1 Non-Linear modelling

Non-Linear Input Output Models[27]

The Non-Linear Input-Output Model (NLIO) seeks to remove one of the major limitations of standard input-output analysis by removing the assumption of linear coefficients for the household sector and allowing marginal income coefficients adjustment. This is because, as is widely known, the household sector is the dominant component of multiplier effects in an input-output table. As a result using marginal income coefficients for the household sector will provide a more accurate, and empirically more valid, estimate of the multiplier effects, which in turn, provides results closer to those of a computable general equilibrium (CGE) model. The transactions flows in the input-output table can be expressed in matrix equation form as:

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

That is, for each industry, total industry sales equals intermediate sales to other industries for further processing plus sales to final users, where T is the matrix of intermediate transactions, X is the column vector of sector total outputs and Y is the column vector of aggregate final demands. This can be rewritten as:

AX + Y = X

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

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

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

This model is a linear model in which the A matrix represents a (constant) matrix of average input propensities. Normally, the A matrix endogenises[28] the household sector so that household consumption induced effects can be measured. This is referred to as the Type II model; the alternative Type I model is where households are treated as exogenous to local economic activity. Generally speaking, the consumption-induced effects are the largest component of the total multipliers. This is because consumer driven consumption (and income) to a large extent dominates local economic activity.

Total inputs are equal to intermediate inputs plus primary inputs (labour and capital). In the conventional input-output model, the inputs purchased by each sector are a function only of the level of output of that sector. The input function is assumed linear and homogeneous of degree one, which implies constant, returns to scale and no substitution between inputs. A more reasonable assumption is to allow substitution between primary factors. If there is an expansion in economic activity, say due to a development project, employers will attempt to increase output without corresponding proportional increases in employment numbers, particularly in the short term, e.g. construction projects, where there are economies of scale in getting the existing workforce to work longer hours rather than employ additional persons. This occurs for two reasons.

First, there is evidence in Australia that labour productivity (output per employee) is increasing over time. Secondly, as companies strive to reduce costs and satisfy the micro-economic reform processes imposed on all states by the National Competition Policy, there is evidence of a shift in primary factor use from labour to capital. This implies that the conventional input-output model has a tendency to overestimate impacts, in particular the income and employment impacts. Therefore, a more realistic approach to modelling impacts is to replace the average

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27 The description of the Non-linear model properties is taken from CEPM model descriptions (West 2003)

28 That is, household income varies with the level of inter-sectoral activity.

expenditure propensities for labour income by employers with marginal input propensities. In other words, the household income row in the A matrix, which are average input coefficients, should be replaced by income elasticities of demand. Note that, as in the CGE model, the linear coefficients assumption between intermediate inputs, and also total primary inputs, and total inputs is retained.

One problem associated with this approach is that the solution procedure is now more complex. Now the income impacts will be a function of $\Delta X$ but the income coefficients are included in the A matrix which determines $\Delta X$. Therefore the equation set becomes recursive; $\Delta X$ depends on A and A depends on $\Delta X$. Solving the input-output equation therefore requires an iterative procedure, a common method being the Gauss-Seidel method.

The income and employment flow-ons from the initial impact also need to be modified. In the conventional input-output model, income and employment flow-ons are calculated as linear functions of the output flow-ons, but in the revised model the parameters relating income to output are no longer constant. The impact on household income needs to be calculated as the difference between the base (i.e. before impact) income levels and the post impact income levels. It can be shown that this is equivalent to using the matrix equation:

$$\Delta \mathbf{Inc} = \hat{\mathbf{X}}_0^{-1}(\Delta\hat{\mathbf{X}})\hat{\mathbf{L}}\mathbf{U}_0$$

where U is a vector of household income flows and L is a vector of sectoral household income elasticities of demand. The zero subscript denotes the base level values and the hat denotes a diagonal matrix formed from the elements of the corresponding vector. This equation simply states that, for each sector, the change in household income payments equals the proportional change in output times the base level income payments multiplied by the income elasticity of demand. These income elasticities of demand can be shown to be equal to:

$$I_j = \eta_{WX} + \eta_{EX}$$

where $\eta$WX is the elasticity of wage rate with respect to output, and $\eta$EX is the elasticity of labour demand with respect to output; that is, they are made up of two components, the wage price component and the labour productivity component.

Similarly, the change in sectoral employment can be calculated as the change in the sectoral wage bill times the wage rate:

$$\mathbf{\Delta Emp = \hat{H}_0^{-1}\hat{P}_0^{-1}\Delta Inc}$$

where H is a vector of average household income coefficients and P is a vector of coefficients representing average output per employee.

There are several implications arising from the use of this model, compared to the conventional input-output model. Firstly, while the output multipliers and impacts should not be significantly different between the two models, we would expect the income and employment impacts to be smaller in the marginal coefficient model. This is because many industries, especially those which are more capital intensive and can implement further productivity gains, can increase output, particularly in the short run[29], without corresponding proportional increases in employment and hence income payments.

Secondly, unlike the conventional input-output model in which the multiplier value is the same for all multiples of the initial shock, the multiplier values from the marginal coefficient model vary with the size of the initial impact. Thus larger changes in final demand will tend to be associated with smaller multipliers than small changes in final demand. Therefore, the differential impacts of the marginal coefficient model are not additive, unlike the conventional (linear) Leontief model and CGE model.

Overall, within the confines of a static model, the major improvements brought by the non-linear model are to improve the overall accuracy of the factor income and employment impact projections.

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[29] The term 'short run' here does not refer to any specific time period; rather it will vary from industry to industry. It is used here in the conventional economic sense to mean that the full adjustment from any shock has not had time to occur, i.e. the system has not yet returned to full, long run, equilibrium

1. The simplest way of quantifying this benefit would be to calculate the amount of time allocated to health work * the average wage rate (current benefit) and apply this to a health sector multiplier devised by the Australian Bureau of Statistics. In addition to this we have the preventative issues

2. Preventive costs = $\sum_{t=1}^{n} Ci$ (future preventative benefit over time), where C equals the future discounted cost of health issues if the initial problem had not been attended to by teachers ( harder to estimate)

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