HIGHER EDUCATION AND RESEARCH GROUP
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Higher Education and Research Group 'Explainer Series'

MEASURING UNIVERSITY COSTS:
SOLVING THE JOINT AND COMMON COST PROBLEM

The joint and common cost problem arises where there are two or more outputs that arise from costs that are shared in the production of these outputs.

In many situations, the ability to assign costs to these two or more outputs is not complex. But there are instances where it is highly complex. In these situations, there is a need to use advanced analytics to provide a valid and reliable estimate of costs.

There are reasons why the higher education sector is, arguably, an extreme case of the joint and common cost problem. To help explain the complexity of the problem, the following is an introductory 'journey' through the joint and common cost problem story.

Part 1: The Starting Point - the Case of the Oil and Gas Extractive Industry

As a first example consider the situation where an oil well produces not only oil but also natural gas. The US Federal Government Energy Information Administration (EIA) tells us that more than half of all drilling in the extractive industry involves wells that produce both oil and natural gas.

In the situation of a single output – such as the production of oil only - the cost of the product is easily and precisely calculated. One can simply assign all the costs of production to that one product. Contrast that to where both oil and natural gas are disgorged from a single well. The products can be separated in a physical sense, but how do you separate the costs of extracting the two products?

This dilemma is not hypothetical. The costs of drilling and the extraction of 'product' can be significant. But how does one decide to assign these costs between the two products – oil and gas? The question is not a trivial one. There are situations where the profit on each of the two products is taxed at differential levels. There are other instances where the production of oil and gas involves two joint venture arrangements with profit from each output going to different parties. In these cases, the size of the profit is heavily dependent on the allocation of costs.

One can simply make a series of largely arbitrary decisions to allocate costs; these could involve allocating the costs between the oil and gas based on the volume of output; or relative weight or retail value of each product. Whichever method is used, a producer will only be able to observe the costs from a narrow perspective, and decisions as to how to allocate costs are, invariably, largely arbitrary. These decisions can be made using 'cost drivers' but those too are rarely, if ever, fully validated.

These 'cost drivers' can be and sometimes are derived from survey data from the parties involved. There are two key issues here. First, there can be incentives that impact the objectivity and impartiality of those surveyed. If the tax on gas is low and oil high, what is the incentive to make choices that increase the costs for oil and lower the costs for gas. The net result is lower total tax payable than in the absence of these incentives.

The second issue is that those surveyed may simply not have a valid view of the true drivers of cost. Therefore, even where participants are well-intentioned and prepared to be objective, they simply may not have a perspective upon which to make sound observations on costs and related matters, such as cost drivers. This point is taken up in the following section: the beef industry example.

Part 2: The next level of complexity - the Case of the Beef Cattle Industry.

In this part, the concept of how the measurement of costs can be achieved where the joint and common cost problem is presented. This case involves the case where the costs of a beef cattle carcass must be partitioned between different cuts of meat. In this case, all the costs are joint and common. The carcass is presented as a total unit cost. To simplify the example, it is assumed there are only two types of meat on the carcass.

A butcher (shop A) might purchase a beef carcass for around $2,000, and from that carcass she or he may be able to extract 200 kg of saleable meat. For simplifying purposes, let's assume only two types of meat on the carcass. One is a premium cut; the other is suitable only for burgers. Let us assume that 10% of the meat is the premium cut, with the remainder for hamburgers.

Now ask that butcher 'what is the cost per unit of weight of each type of meat?' Is there a clear-cut answer? At the level of the individual butcher shop, the problem is intractable. No unambiguous and *evidence-based* solution appears to be available.

One might be tempted to say $10 per kilo, being $2,000 divided by 200 kg. The arithmetic is precise enough, but there is obviously something missing – the different retail values of the two categories of meat. Many would agree that this 'answer' has precision but would also agree that it is not the 'right' answer. In fact, one can argue that it is precise but may be precisely 'wrong'.

Some butchers might want to 'adjust' their answer to allow for the differential selling price – but how much of an adjustment should be made? What if different levels of time, skill or effort are involved in cutting each type from the carcass, or there is more wastage with one type than the other?

Any single butcher is going to introduce an element of subjective estimating – that is guesswork - if she or he were to estimate the 'cost' per kilo of burger meat as opposed to the premium cut of meat. The core cost – the beef carcass - is a joint and common cost of both types of meat.

There is no naturally occurring or intuitive way of separating the cost of one type of meat from the other when one is 'up close' to the issue. If, instead, one were to survey numerous butchers via a questionnaire across the region in search of a 'better' answer, all respondents would face the same difficulty in responding with any degree of precision. The survey would involve only a collection of the 'up close' observations.

Let us assume that there are 40 butchers across the city. Butcher A purchases a 200 kg carcass for $2,000 and extracts 20 kg of premium meat and 180 kg of lower-grade meat suitable for hamburgers. Butcher B purchases a slightly larger carcass. It yields 40 kg of premium meat and 180 kg of hamburger meat. The price for this carcass is greater at $2,800.

In other parts of the region, there are many more butcher shops, all of which purchase carcasses with different relative proportions of premium and hamburger meat. They all pay varying prices that are significantly affected by the expected mix of the types of meat in the carcass purchased.

By looking at the variability between the mix or intensity of premium and hamburger meat and comparing that with variations in the cost of carcasses, one can impute an individual cost of each of the two types of meat. This empirically based estimate is possible because we can use the variability of the total carcass cost and the meat type weights to estimate the relative costs of the types of meat.

This touches on the second issue about the use of survey data. An individual butcher shop will not have the perspective to look across the whole industry to see the cost 'drivers' in play for all shops. They will only see their own total carcass cost and what outputs come from it.

Obtaining an estimate of the cost of premium and hamburger meat is best calculated across all the shops and not by survey, as each butcher will know only their small part of the puzzle. The cost estimation is best done by an industry peak body, a sector association or an industry regulator that can collect data from across the entire sector. When one can see the sector as a whole, a sharper focus on costings can be achieved using empirical data that is sector-wide.

In this simple example, we used only the data from shops A and B to represent the 'whole-of-sector'. We know the outputs (the type cuts of meat) for the two shops and the total (joint and common) cost of the carcasses. Using this empirical data, the sector average cost per kilo of fillet steak comes to $40 for the premium cut of meat, with the hamburger meat costing $6.67[1].

Part 3: The Measurement of Teaching and Research Costs in Universities.

Over the decades, there have been statements, including by Education Ministers, that imply or even state that valid and reliable data exists that measures the costs of education. As just one example, on June 19, 2020, then Education Minister Dan Tehan announced "... we will address the misalignment between the cost of teaching a degree and the revenue that a university receives to teach it. We will reform the system so that the student contribution and the Commonwealth contribution actually equals the cost of teaching that degree."[2] This policy statement makes clear the importance of costing university teaching and separating it from the other principal activity in universities - research.

Present policy settings are likely framed on the basis of being able to unambiguously separate the costs of education from research and the cost of one type of education from another. By definition, all costs need to effectively deal with the classic joint and common cost problem because so many of the costs are shared (that is 'joint and common') – not least of which is the significant cost of academic salaries.

Surveying individual universities on the matter of separating out the costs of research from the costs of teaching, like surveying individual butcher shops, will likely not be an optimal solution. Indeed, worse still, if this approach is assumed to be valid and credible, we might generate a range of estimates that regulators, governments and others might treat as 'correct' estimates without fully appreciating the range of (sometimes) potentially arbitrary or subjective allocation decisions and assumptions involved in these estimated cost measures.

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[1] How is this calculated? Both carcasses have 180 kg of hamburger meat, so the difference between the carcasses is all in the premium cut of meat. The difference in the total carcass cost is $800 across a difference in premium meat weight of 20 kg. Thus, the premium meat has a cost of $40 per kilo ($800 divided by 20 kg). With the cost of the premium cut established, we can then calculate the cost of the hamburger meat. The cost of the hamburger meat is measured at $6.67. For Shop A, the total cost $2,000 of which $800 is the premium cut with $1,200 for hamburger meat. So, the costs are: premium $40 per kg ($800 divided by 20 kg) and hamburger $6.67 ($1,200 divided by 180 kg). For Shop B, the total cost is $2,800 of which $800 is the premium cut and $2,000 to hamburger meat. So, the costs are: premium $40 per kg ($1,600 divided by 40 kg) and hamburger $6.67 ($1,200 divided by 180 kg). This simple example is used to illustrate the principles of using empirical data in joint and common cost situations. The same principle applies in more complicated multi-institution and/or multi-output examples. The principle does not change with added shops (or universities) or more outputs; however, the complexity of the calculations does. Advanced econometrics is required.

[2] See Ministerial Speech https://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/bd/bd2021a/21bd012#:~:text=To%20do%20this%2C%20we%20will,cost%20of%20teaching%20that%20degree.

As a consequence of the incentives in the higher education sector, there is a major issue in the measurement of the cost of research. This issue is pervasive as it applies not only at an institutional level but also at individual academic staff member level. Over many decades, there has accumulated a significant body of anecdotal evidence that academics, well-intentioned and not wishing to make errors, will dramatically underestimate the time spent on, and therefore the cost of, research.

The presence of 'overspeanding' on research expenditure is not irrational at either an institutional or individual level. Indeed, it is logical because there are prestige or reputational effects of holding major competitive grants, so researchers and institutions alike are likely prepared to find the added support to undertake and successfully complete such research.

There are also other direct and indirect reputational effects of being more research active – entirely or even only partially – funded by, say, an ARC project. These include, but are not limited to, additional infrastructure funding, university global rankings at an institutional level and the improved probability of promotion at the individual academic level. The reality is that the 'true' full cost of research includes a wide range of research activities and can extend to supporting other researchers, commenting on the draft work of colleagues, supporting the editorial process of research journals and reviewing grant applications for the ARC and NHMRC. These are all part of the full cost of research.

There is also some anecdotal evidence that, in estimating the costs of research, an individual academic will tend to focus on the costs of *successful* research. Understandably, they might tend to push the unsuccessful grant applications or rejected articles to the back of their mind. So, any survey data provided by such individuals, or those who represent them, will likely have a significant validity issue. In all likelihood, research costs are significantly underestimated. Further, as it is, in effect, a zero-sum game, the other conclusion is that teaching costs are overestimated.

Part 4: Solving the University Complex Joint and Common Problem.

The university sector is a particularly complex example of the joint and common cost problem. In part this is so because of the absence of a fixed relationship between the mix (or intensity) of the presence of one output relative to the other. That is, the level of research (or teaching) intensity is not fixed across institutions nor over time within a single institution. This makes partitioning costs identified as joint and common more problematic using conventional means. It does, however, make use of an empirical approach more attractive. As shown in the beef cattle example, it is this variability that allows for the measurement of costs in an unbiased way.

The empirical approach used in HERG's methodology (known as the Research and Education Efficiency Frontier or REEF)[3] overcomes many challenges inherent in conventional means to measure costs where the joint and common cost problem is present. The existence of the complex joint and common cost problem within universities means that a 'whole of sector' empirical approach will likely provide the highest level of valid and reliable cost measures possible. The REEF approach is agnostic as to differing research/teaching intensity mixes – one key element in the complexity of the cost measurement problem in universities.

[3] See HERG 'Explainer' document titled: University Cost Measurmeent and Productivity Assessment: Introducing the Research and Education Efficiency Frontier (REEF) Methodology