Allocation of joint costs and environmental impacts: a review of literatures in management control and LCA

Nicolas Antheaume
Professeur des Universités
IEMN-IAE, Université de Nantes
LEMNA
nicolas.antheaume@univ-nantes.fr

Youcef Bouzidi
Enseignant-Chercheur
Université de Technologie de Troyes
youcef.bouzidi@utt.fr

RÉSUMÉ :

Les co-produits qui sont issus à l'origine d'un seul produit posent des difficultés à la fois aux comptables (allocation des coûts joints) et aux spécialistes de l'analyse de cycle de vie (allocation des impacts environnementaux joints). Nous explorons la littérature économique et comptable ainsi que celle, plus récente sur les analyses de cycle de vie (ACV). Nous nous posons les questions suivantes. Existe-t-il des éléments pertinents, dans les questions que se sont posés comptables et économistes sur les coûts jointes, qui peut être utile pour améliorer l'allocation des impacts environnementaux joints. Réciproquement, la littérature sur les impacts environnementaux joints peut-elle être une source de renouvellement pour l'allocation des coûts joints. Ces deux champs de la littérature, qui n'ont jamais été comparés, ont-ils divergé ou convergé sur les méthodes employées.

MOTS CLÉS :

Contrôle de gestion environnemental (CGE), Analyse de Cycle de Vie (ACV), calcul de coût, coûts joints, impacts environnementaux joints.

ABSTRACT :

Co-products, which originate from a single previous product pose challenges both to accountants (allocation of joint costs) and to LCA specialists (joint environmental impacts). We explore the economics and accounting literature and the more recent LCA literature. We ask ourselves the following questions: Is there something relevant in the questions that accountants have asked themselves to allocate joint costs that can help improve allocation of joint environmental impacts? Reciprocally, can the literature on the allocation of joint environmental impacts help renew the joint allocation of costs? Have these two fields of literature, which have never been confronted, diverged or converged on the methods used?

KEYWORDS:

Environmental Management Control (EMC), Life Cycle Analysis (LCA), calcul de coût, coûts joints, impacts environnementaux joints.

JEL CLASSIFICATION: M10, Q50

Introduction

This article takes its origins in the encounter of two researchers; one in the field of engineering and the other one in the field of management. They worked on projects which involved both LCA and costing issues and they discovered that there was an interest in crossing the respective literatures they used for one specific issue: the joint allocation of costs and environmental impacts. Examples of products for which this issue arises abound in many different sectors of activity. For example, skimmed milk and cream generate joint costs and environmental impact because at one stage in their life they have not yet been separated from one another. Choosing a method to allocate joint costs and impacts to each of the two products is of considerable importance as it will determine both the profitability and the environmental impact of each product. It will also have consequences when the environmental impacts of one these products will be compared to a competing product (example skimmed milk vs. soya milk). The comparison will depend on how the impacts of milk were allocated to the joint products, respectively to skimmed milk and to cream.

Also, due to the increasing application of the polluter pays principle, allocating environmental impacts will, in the end have an impact on the full cost of each co-product.

The concern for the allocation of joint environmental impacts is more recent than the one of joint costs. Concerns for the allocation of joint costs can be traced back to agricultural accounting manuals, some of which are more than two hundred years old. Concerns for the allocation of joint environmental impacts dates to the emergence of a specialized literature in the field of LCA in the 90's.

We set out to explore both the accounting literature and the LCA literature with the following questions in mind.

Can the accounting literature on joint costs bring insights to the literature on joint environmental impacts?

Reciprocally, can the more recent literature on the joint allocation of environmental impacts help renew the joint allocation of costs?

Have these two very separate fields of literature, which have never been confronted with each other, diverged or converged on the methods used for joint allocation?

This is what this paper will set out to explore.

We will start with a review of literature on the allocation of joint costs in view of identifying which solutions are proposed and what is the state of the art today. The following section will proceed in the same way with the allocation of joint environmental impacts. We will then compare the solutions proposed in both fields and see in which way they diverge or converge.

The body of literature we have covered is both academic and professional. It covers research articles in journals, teaching manuals, professional standards or best practices when they exist, Master's degree dissertations of students who have carried our internships in companies which encountered joint cost and joint impact issues. The aim of this research is not of a statistical nature. We do not set out to quantify how frequent each allocation method is, or which is the most widely used one. We set ourselves the objectives of making as complete as possible a list of existing methods. With this in mind we reviewed the literature and wrote down each new method which was identified, until we reached a point when reviewing extra materials did not bring anything new but only methods which we had already identified. Of course we can never be 100% sure that we have not missed out on something, but we can safely assume that we have identified a number of methods in each field which make a comparison relevant. In this process we were also helped by interviews with experts in their respective fields who helped us gain time in identifying the most relevant literature.

Part 1. A review of literature on the allocation of joint costs

1.1. Methodology

When starting this project we interviewed three experts in their respective fields.

The first one is a specialist in the history of accounting. The second one is the current head of the MSc in Management Control at the University of Nantes in France. The third one is the former head of the MSc in Management Control at the University of Nantes who also works as a consultant in the field of management control, with contracts with French organizations. For ten years, he also had been responsible for a management control course, for economists specialized in the agri-business industry. The allocation of joint costs was a part of his course.

We asked the first expert questions about when the allocation of joint costs started becoming an acknowledged issue. He referred us to agricultural accounting manuals and helped us select four representative ones to help us address the subject with a historical perspective.

We asked the second expert to identify among the more than 100 internship reports and dissertations which he had archived, to select those which concerned the allocation of joint costs. The condition was that this subject had to be a significant element of the document and not a secondary one which was just mentioned briefly. We ended up with three internship reports and one dissertation.

We asked the third expert to help us make a selection of the most significant academic articles related to the subject studied. We then carried out a research in the Ebsco database, using the key words identified in the first articles. We ended up with a selection of slightly less than 25 relevant academic articles.

Finally, we went to the University Library and we reviewed the management control manuals, in French and in English which were available on the shelves so as to identify how the issue of joint allocation was dealt with.

1.2. Results obtained

In the field of accounting the first mention of the issue of joint costs is raised in agricultural accounting manuals as early as 1840 (Royer). The issue which is most often raised is that of agricultural manure produced by livestock on the farm, and used on the fields as a natural fertilizer. Most farmers in France, up to the mid 20th century, both raised livestock and operated fields which produced a variety of cereals, vegetables and fruit. Thus costs of raising livestock were considered as joint costs for at least two products. One of them was meat, the other one was manure, used as an input in the fields. Another issue which is raised is that of straw, which is used as an input for the production of manure or, also, to feed livestock. For example, the cost of producing wheat can be considered as the joint cost of two products: wheat grain on one side and straw on the other. We will focus on the case of manure and explain briefly the methods discussed in the agricultural manuals we reviewed.

- The first method is to set a price for manure based more or less on how much a cart of manure would cost locally, if the farmer had to buy one. This estimate would lower the cost of raising livestock on one side, and increase the cost of growing cereals on the other side (if we assume that the manure is spread on cereal fields). A specific variant proposed by De Meixmoron (1864) or Convert (1920) is to set a fixed price

which would not change from year to year and which would correspond to a conservative estimate of an average long-term market value.

- This first method and its variants had been known for a long time and were criticized in by Royer (1840) for relying on an arbitrary value and also because, according to the author, the value of the straw produced is presumed, as an average, to have a market value which is more or less equivalent to that of the manure which is finally produced. Therefore, the straw which is used to produce manure and the manure which is used as an input for cereal production compensate each other and should be ignored. Only of the specific costs of transporting and spreading manure should be taken into account and not the joint costs.
- De Granges (1857) disagrees with the idea of ignoring the cost of manure. He proposes that the price of manure be evaluated based on the work of draught animals. In essence, the value of manure would be equal to a proportion of the total expenses of maintaining and using draught animals. The other proportion would be allocated to the value of the actual work carried out by the animals. The value of manure, as calculated from draught animals can then be used for other types of manure, produced by other livestock. However the author proposes no practical recommendation to estimate the proportions needed to separate the cost of manure on one side and the cost of the work carried out by draught animals on the other side.
- A fourth method would be to consider that livestock is used on a farm for the main purpose of producing manure. Since, as mentioned by the manuals, the cost of raising livestock is usually not offset by sales of some of the livestock, the deficit from this activity is presumed to be the cost of producing manure. However this method is criticized as the price of livestock, as well as the price of their food can vary considerably … and so would then the cost of manure. Furthermore, if ever the activity of raising livestock makes a profit, this method cannot be used. This method is discussed but not recommended by any of the manuals which we read.
- A fifth method would be to evaluate, at market value, the increase in production that is enabled by the use of manure. But then, a year's crop is due to so many factors (type of soil, weather conditions and so many other reasons) that the specific influence of manure cannot be isolated. None of the manuals reviewed recommend it.

The books we reviewed have in common is that they all advocate methods which should be based on a careful measurement of actual flows on the farm.

With the evolution of technology and the progressive specialization of farms, manure ceased to be a joint product of raising livestock and an issue for agricultural accounting. For these farms with only livestock, manure gained the status of waste product. For other farms just growing cereals, artificial fertilizers, purchased at market rates replaced manure which stopped being an input.

The issue of joint costs was raised again in the field of industry (Mill, 1848) but it is not before the end of the sixties that it was conceptualized by Shubik (1962) and Thomas (1969, 1974). Thomas (1969) proposed three criteria to evaluate a given allocation method. These were (1) additivity (2) defensibility and (3) unambiguity. Criteria 1 and 3 require that the joint costs be allocated in a unique way, so that the sum of the proportions is equal to 1. As for criteria 2, Thomas argues that since most allocation methods are arbitrary, full defensibility is not possible. However partial defensibility is attainable through any explanation that "an intelligent man" would accept for an allocation procedure. He also argues that principles of economics should also be used to defend allocation methods.

Moriarity (1975) takes conceptualization one step further by arguing that, in a market economy, joint costs are incurred as a cost saving measure. Although it possible to buy individually any given product or service, it makes sense, in some cases to incur joint costs to make a group of products / provide a group of services, rather than to purchase them individually. They define the total cost of a product /service as being the sum of the total joint cost (JC) and of the incremental specific costs (I) that are needed to make it. They also define Y as the cost of making /purchasing one product or service independently from the others. As long as Y > JC + I, there is an incentive to incur joint costs. This is because it saves money, or at least Y is at least equal JC + I.

These developments gave rise to a doctrine called the theory of the core, derived from game theory techniques. Shubik (1962) was the first to suggest the use of economic game theory, followed by Loehman and Whinston (1971), Littlechild and Owen (1973), Littlechild and Thompson (1973), Louderback (1976), Hamlen (1977, 1980), Jenssen (1977), Balachandran et Ramakrishnan (1981), Moriarty (1981). Beyond the early eighties, little was published on the subject.

Core theory assimilates products within a corporation to divisions which are responsible for making and marketing the products. Each division is responsible for one product / one service. These products / services have joint costs. The notion that an economic situation possesses a core is related to the fact that circumstances allow two or more parties to reach a mutually acceptable solution in which each party is at least as well off as if it had been on its own.

In order to determine the allocation of joint costs between divisions, one must assume that each division can function independently from the others and provide on its own the product or service for which it is responsible. Given this assumption a corporation can be understood as a "coalition" of divisions which find an interest in being together because sharing joint costs is more interesting that functioning independently from each other.

In this context core theory stipulates that it is important to allocate joint costs in a way that will avoid division managers to behave in a way that would harm the corporation as a whole. For a division to find the allocation satisfying two conditions must be met. The first condition is that the allocation saves costs compared to a situation in which the division would be out of the "coalition". The second condition is that a given allocation will also keep other divisions within the coalition.

Thomas (1982) illustrates this concept with the example of a taxi ride that two people must share. Each passenger will be interested in sharing the costs of this joint taxi ride on condition that his contribution is less or at least equal to what he would have paid if he had taken the taxi on his own. The savings (one shared taxi ride instead of two individual taxi rides) should be shared proportionally to the cost of the two individual taxi rides. For example, suppose that one individual taxi ride costs 60 Euros and the other one 40 Euros. The joint ride would cost only 80 Euros, thus generating 20 Euros of savings. Thus 60% of the savings should go the first passenger and 40% to the second passenger, resulting in payments of respectively 60 -12 = 28 Euros and 40 – 8 = 32 Euros.

Thus the allocation of joint costs is conceptualised as a negotiation process between individuals (the managers of the divisions) who will stay within the "coalition" as long as the allocation of joint costs serves their interest.

Other authors have argued that a game theory approach does not allocate costs but distributes them based on conventions or agreements on how costs will be shared once a strategy has been agreed on by the members of the coalition.

In parallel to game theory another stream of literature has developed which is based on linear programming and on the idea that rational production and sales decisions must be based on demand for products and be independent from the way costs are allocated. Any allocation of joint costs to a product will be irrational if it affects the quantity of products produced. Weil (1968) develops a simple example based on the production of beef and cow hides, out of cows. There is a demand on economic markets for cows, for beef and for cow hides. The author stipulates that the maximum prices a buyer will always be willing to pay for an extra unit of beef or an extra hide will always be equal to the cost of one extra cow. Weil (1968, p. 1343) claims that "*these prices which is the sum of one cow are proper allocation of joint costs*". If we look at the cost of beef (or hides) alone, this allocation can be solved using constrained optimization, Lagrange multipliers and Kuhn-Tucker theory. Further developments along this line were pursued by Kaplan and Thompson (1971), Kaplan and Welam (1974), Itami and Kaplan (1980), Cheng and Manes (1992), Moghaddam and Michelot (2008).

However, Schneider (1986) notes that the literature on joint product costing has assumed that prices must be known before allocations could be made and also, conversely, that pricing decisions could not be made without knowledge of the joint costs allocated. As a consequence of this complexity, many accounting manuals and many companies choose to allocate costs on a much simpler basis. This is what we observed based on the internship reports available to us (Nahan, 2009), Dubray (2012), Havard (2012), Cherednichenko-Verrier (2010), as well as in the accounting manuals we consulted. Overall four different proposals have been identified. They are presented in table 1 and all have in common the fact that they are, in one way or another, connected to market value.

Table 1: five different methods for allocating joint costs

Name of method	Description
Physical quantities	This method is discussed but is rejected when it is disconnected with market values. A co-product that is produced in high quantities but which has a low selling price will be penalized if such a method is used because it will bear most of the joint cost. However due to a low market value an allocation of joint costs based on physical quantities produced will not make it profitable. However, physical quantities, when connected to market value, can be used for allocation of joint costs. For example, joint costs between milk and cream can be allocated based on the fat content (grams per litre) because market value of milk or of its components is closely correlated to fat content. In some cases, in France, milk producers can be paid a bonus if the fat content of the milk they sell to the dairy producer exceeds expected standards (Dubray, 2012).
Market value	Market value enables to allocate the joint cost proportionally to the ability of the product to absorb it. The higher the market value is, the higher the proportion of joint cost of product will support. However when specific costs are also high, adding a high proportion of joint costs may also make the product appear unprofitable even though this is not justified from an economic point of view. Also, when the market value changes frequently, the allocation of joint costs also changes frequently.
Net Realizable Value Method (NRV)	The NRV is the difference between the market price and the specific costs of the product. This method requires a good knowledge of all the costs of a product after its separation point with its co-product. Joint costs are allocated proportionally to the NRV of each co-product.
Constant profit margin method	This method is based on the assumption that all products and services have a constant profit margin. Once that profit margin is deduced from the selling price, and once the specific costs have also been deduced, what is left is supposed to be the share of joint costs that the product will support. However the assumption that all products and services have a constant profit margin is contested.

Part 2. A review of literature on the allocation of joint environmental impacts

2.1. Methodology

When starting this project we interviewed the colleague with whom we had worked on previous projects which involved LCA and costing issues for reference manuals and articles. We selected two reference manuals, one in French (Blouet and Rivoire, 1995) and one in English (Weidema, 1993) which contained historical elements and which corresponded to a time at which standards for LCA were emerging.

We then conducted a search using the following keywords: allocation of joint impacts/loads, joint environmental impacts/loads, allocation of joint environmental impacts/loads on the Science Direct and Springer databases. Approximately 200 articles showed up, but a closer look at their titles, and abstracts showed that very few of them actually dealt with the subject of this article. We identified three of them which reviewed the state of the art in the allocation of joint environmental impacts, all dating back to the early 90's. We then identified a dozen articles, which were sensitivity analyses, showing the impact of different allocation methods on the final environmental performance of a product.

We also read the ISO 14041 standards which relate to LCA, specifically for the part related to allocation of joint environmental impacts when open loop recycling is involved.

2.2. Results obtained

The field of LCA is not as recent as the field of accounting. It emerged in the late sixties and early seventies at a period when such issues as energy efficiency and consumption of scarce resources such as metals become an issue. Early studies focused mainly on packaging materials, comparing one way versus returnable systems, in a context where policy on such matters was being discussed. A study carried out in 1974, by the Midwest Research Institute, for the US Environmental Protection Agency is credited with laying the foundation for LCA. These US developments inspired the Swiss Federal Laboratories for Materials Testing to present a study on packaging materials for the Swiss Ministry of the Environment (BUS, 1984). This study sophisticated the US approach through the development of a relatively extensive database and a method for weighing and aggregating the environmental impacts of the flows associated with a product. In parallel a more qualitative tradition emerged in Germany, under the name of Produkt-Linien-Analyse.

According to Christiansen (1993), the European Directive on liquid food containers, which charged companies with the responsibility of monitoring the energy, raw material consumption and solid waste generation, gave LCA the opportunity to emerge as a tool of choice.

The society of Environmental Toxicology and Chemistry (SETAC) played an important role in bringing life cycle assessment practionners and users together to develop tools and common methodologies for LCA, through the creation of an LCA advisory group. In 1993 the ISO decided to create a working group on the development of a series of standards dedicated to LCA. The ISO 14040 series of standards, on LCA, were first published in 1998. In approximately twenty five years LCA turned from an emerging field into a standardized and institutionalized one. Although the allocation of joint environmental impacts has been practised in many studies (this explains why a key word search yielded so many results), most contributions on how this allocation should be done date back to the end of the 90's and the beginning of the 21st century.

A first group of studies suggested that allocation should be done according to the physical properties of the co-products, be it weight (Hunt et al., 1974) or, as identified by Weidema (1993) in his review, energy content or chemical properties. What comes out of this review is that not one method is suitable for all cases and. Different physical methods are adapted to different sectors. Weidema (1993) develops three examples: allocation by weight, for example, is not applicable in the field of energy services, such as a cogeneration plant. Allocation by energy equivalent may be suitable for products derived from petroleum, but may not be applicable to metals. Allocation by chemical properties may be suitable for processes in the chemical industry but will not work for agricultural products. Furthermore Weidema (1993) mentions that allocation through the use of physical properties may be unfair in the following conditions:

- If the physical properties of the process change as the output fluctuates. For example, in an oil refinery the mix of final products can be, to a certain extent, adjusted to better meet market demand.

- If the co-products have very different economic values, thus leading to an allocation through physical properties that will be discrepant with economic value. For example, if the main product is of a low weight and a high economic value (any given metal) and if the co-product has a high weight and a low economic value (such as heaps which can be used as construction

materials) then allocation can be qualified as unfair. The main, valuable product, may be the only reason for operating the process and, due to its light weight, it will carry a very small fraction of the total environmental impact.

This is why a second group of studies suggest that allocation should be done according to economic value. The first study identified by Weidema (1994) in his review also dates back to 1974 (Basler and Hoffman, 1974) and is in German. The method has the advantage of being universally applicable. However economic value will fluctuate over time and even with average prices over long periods of time, variations are unavoidable. This is why Weidema (1993) recommends, whenever applicable, the use of physical properties which are strongly correlated with the economic values of the co-products.

A third allocation possibility, which emerged in the nineties, is based on the fact that the co-product, in some cases can become a substitute for another product, or another material. Recycled aluminium can replace aluminium made from non-renewable resources. Incinerating waste produces heat for district heating which would have otherwise been produced with oil. Therefore the production of these products which are being replaced may not be needed anymore and the environmental effects coming from this production will not occur anymore. Therefore Heintz and Baisnee (1991) were among the first to suggest that allocation should be made based on the avoided environmental effects. Following this logic the environmental impact allocated to the main product will be the total environmental impact of the process, minus the avoided impacts due to the existence of the co-product. Obviously, however, this approach cannot be used if the co-product does not replace another product or if many co-products are involved (this means that one would have to add data in the system for every substitute that is being avoided).

Part 3. Comparison of the two literatures and discussion

At this stage, our first finding is that until 1998, none of the authors we reviewed in the field of LCA mentioned or quoted the literature on joint costs. Frischknecht (1998, 2000) is the first one to have done so, referring to the work of Mills (1848) and Horngren and Foster's cost accounting manual (1991). However, one gets the impression that these authors on joint cost are just being acknowledged by Frischknecht, but that they are not necessarily being used or compared to the LCA literature on joint environmental impacts. As for the literature on joint costs, it is mostly anterior to the literature on LCA and thus it makes no reference it.

There is thus a need to compare the two literature which share a common concern as concerns joint.

3.1. Apparent similarities

If we look at the “practical solutions” developed in each literature, despite the differences noted above we can notice a number of common points and for both literature three broad types of similar methods can be identified. It is worth noting however that in the joint cost literature, methods related to economic value will be more developed and sophisticated. In the joint impact literature, more emphasis, and more sophistication will be put on physical property based methods.

Joint costs	Joint environmental impact
Cost reduction brought by the co-product	Impact avoided by the co-product
Market value, net realizable value, constant margins, physical property that can act as a proxy for economic value (i.e. fat content in milk)	Economic Value
Physical properties (mass, chemical properties, energy content, …)	Physical properties (mass, chemical properties, energy content, …)

However Reading the two literatures led us to identify a number of key parameters on which the two literatures differ. These concern the perimeter, the type of data and calculations and the conceptual framework.

3.2. Differences in perimeter

Whereas the literature on joints mostly considers a narrow perimeter delimited to a given company, the one on LCA dominantly considers a wider perimeter, from “cradle to grave”, which concerns the life cycle of a product or a service. It encompasses many processes, ranging from the extraction of raw materials to the end of life of the product/service being considered. The perimeter of LCA potentially encompasses much more than one company and also includes the user who can be a physical person of an organization.

This has implications in terms of allocation. At the level of the company, whatever the allocation of joint costs between departments, products or services, the total costs, for the company under consideration do not change. They are just being allocated internally. Even if these can cause internal tensions and debates, the top management of the company is usually considered as a legitimate authority which can decide which method should be used. At the level of the life cycle of a product or a service, the choice of an allocation method is more impactful. Depending on the method chosen, the allocation will be different, between

different economics actors who may be in competition with one another, or in competition with other actors outside the perimeter of the LCA. For example, a producer of flax based insulating material for the building industry will be in competition with other producers of the same type of products, made out from other raw materials. Flax can be used to produce flax oil on one side (with the seeds) and insulating material on the other side (with the rest of the plant). The environmental competitiveness of the flax-based material, compared to other insulating materials, may depend on the amount of joint environmental impacts allocated to it. This type of situations leads to heated controversies as different sectors of activity fight to gain an environmental edge.

3.3. Differences in type of data and calculations

Most of the data that is used for LCAs can be defined as generic, or literature based data. It comes mostly from databases associated with leading LCA software packages and it is rarely collected specifically for a given LCA study. These datasets represent, at best, industry averages. As a consequence the results obtained when carrying out an LCA cannot be used to determine the specific performance of a company or product/service but rather, an average performance. Thus allocation of joint environmental impacts is also based on generic data. As a consequence when an LCA is carried out, it usually is a once in while operation and it is not updated regularly with the objective of providing regular reports on the evolution of a given environmental performance.

As opposed to that, when carrying out cost accounting, at the level of a company, the data used is extracted from the company's accounting records and is therefore representative of its economic performance relative to other organizations. This allocation of joint costs is based on specific data. Thus cost reports and allocation of joint costs can, and are regularly updated, to report on the evolution of the company's environmental performance.

3.4. Differences in terms of conceptual framework

The literature on joint costs reveals the existence of two competing conceptual frameworks.

The first one, which we call "core theory" assumes, based on the taxi ride example developed earlier that the optimal allocation is located within an acceptability zone in which all parties are better off sharing joint costs than venturing to develop their own solution without joint costs. Therefore, the role of economists is to identify this acceptability zone,

within which parties must negotiate a settlement. The outcome of the settlement can be determined based on how information is shared, or not, by all parties and on the anticipation by each party of the behaviour of the other parties. Academics can recommend settings and a level of information sharing which can potentially yield the most cooperative outcomes, but they cannot go beyond that.

The second one which we call “marginal cost theory” advocates the use of market values for the allocation of joint costs, based on the idea that the sum of the market values of the parts (co-products) cannot be greater than the market value of the whole (the value of a wow hide and of the meat from one cow cannot exceed the market value of one cow). Therefore joint costs should be allocated to a co-product based on what percentage of the total market value each co-product represents. If one adopts this approach, there is this one and only one “best way” and one optimal allocation of joint costs.

When we come to the literature on LCAs there seems to be no such recommendations in terms on conceptual frameworks. For example, no one recommends that joint environmental impacts be allocated within an acceptable zone for all parties (defined as a zone in which all the parties are better off than if they ventured on their own). There is also no equivalent to the marginal cost theory which would recommend the use of market value or of some overarching environmental dimension such as entropy. There seems to be potential for developing such a framework and for taking inspiration from the frameworks developed in the joint cost literature. However, oddly, professional standards are more developed in the field of joint impacts. Methods for allocating joint environmental impacts are the subject of the ISO 14041 standard.

Conclusion

In this article we raised the question of whether the literatures on joint-costs and joint-impacts have anything in common. Although there have been hardly any cross-references between the two literatures, we did identify a number of similarities between the two despite the fact that joint costs and joint impacts do not refer to the same perimeter and use the same type of data.

At this stage we can sum are findings as follows:

The literature on joint costs as made of two types of literatures. One is made up of professional references, and offers practical solutions. The other one is an academic literature with two competing conceptual frameworks (core theory and linear programming).

The literature on joint impacts is mainly of an academic nature, however as opposed to the literature on joint costs, there is standard which refers to the subject. It is interesting to note that part of the literature acknowledges the subjectivity of the allocation process and the need to take this into account.

As a venue for future research we suggest to develop a practical case, where both joint costs and joint impacts are involved, such as cogeneration, should be investigated.

References

Alireza Tehrani Nejad M. (2007), Allocation of CO_2 emissions in petroleum refineries to petroleum joint products: A linear programming model for practical application, *Energy Economics*, 29 (4), 974-997.

Balachandran, Ramakrishnan (1981). Joint cost analysis : a unified approach. *the Accounting review*, 56, 85-96.

Blouet A., Rivoire E. (1995). *L'écobilan, les produits et leurs impacts sur l'environnement*. Dunod, Paris.

C. Chen, G. Habert, Y. Bouzidi, A. Jullien, A. Ventura (2010)**,** LCA allocation procedure used as an incitative method for waste recycling: An application to mineral additions in concrete, *Resources, Conservation and Recycling*, 54 (12), 1231-1240.

Cheng, C.S.A., Manes, R.P., 1992. The marginal approach to joint cost allocation: A model for practical application. *Journal of Management Accounting Research*, 4 (44), 44–63.

Cherednichenko-Verrier, Irina (2010). Contrôle de gestion et parties prenantes. La perception des informations de gestion par les membres d'une coopérative agricole importante. Rapport de stage. Université de Nantes-IEMN-IAE, Nantes. 44 p.

Convert, F. (1920). Comptabilité Agricole. Baillière et fils, Paris, 468 p.

De Granges de Rancy, Edmond (1857). Traité de comptabilité agricole, Librairie Agricole, Paris, 296 p**.,** 2e edition

De Meixmoron de Dombasle, Ch. (1864), Traité d'agriculture, quatrième partie : comptabilité. Librairie agricole, Paris. 654 p.

Dubray, Xavier (2012). Le calcul des coûts des produits joints. Une question méconnue en comptabilité de gestion. Rapport de stage. Université de Nantes-IEMN-IAE, Nantes. 48 p.

Francesco Cherubini, Anders Hammer Strømman, Sergio Ulgiati, (2011), Influence of allocation methods on the environmental performance of biorefinery products—A case study, *Resources, Conservation and Recycling*, 55 (11), 1070-1077.

Hamlen, S., W. Hamlen and J. Tschirhart (1977). The Use of Core Theory in Evaluating Joint Cost Allocation Schemes. *the Accounting review*, 52, 616-627.

Havard, Virginie (2012). Mise en place d'une comptabilité de gestion au sein d'une pépinière horticole. Rapport de stage, Université de Nantes-IEMN-IAE, Nantes. 47 p.

Heintz B., Baisnee (1991). System Boundaries. Page 35-52 in Society for Environmental Chemistry and Toxicology : Life Cycle Assessment. Brussels: SETAC (Workshop in Leiden).

Hunt R.G., Franklin W.E., Welch R.O., Cross J.A., Woodall A.E. (1974). Ressource and Environmental Profile Analysis of nine beverage container alternatives. US Environmental Protection Agency, Office of Solid Waste Management Programs, Washington D.C. (EPA/530/SW-91C).

Itami, H., Kaplan, R.S. (1980). An activity analysis approach to unit costing with multiple interactive products. *Management Science*, 26 (8), 826–839.

Jensen, D. L. (1977). A Class of Mutually Satisfactory Allocations, *the Accounting review*. October, 842-856.

Kaplan, R.S., Thompson, G.L. (1971). Overhead allocations via mathematical programming models. *the Accounting Review*, 46 (2), 352–364.

Kaplan, R.S., Welam, U. (1974). Overhead allocations with imperfect markets and non-linear technology. *the Accounting Review*, 49, 477–484.

Louderback, J. G. (1976). Another Approach to Allocating Joint Costs: A Comment. *the Accounting review*, July 1976, 683-685.

Mill, J.S. (1929), Principles of Political Economy with Some of Their Applications to Social Philosophy, Longmans.

Moghaddam A. T. N., Michelot C. (2009). A contribution to the linear programming approach to joint cost allocation, Methodology and application. *European Journal of Operational Research*, 197, 999–1011.

Moriarity, S. (1975). Another approach to joint cost allocation. *the Accounting review*, 50, 791-95.

Nahan, L. (2009). Mise en place d'une comptabilité de gestion dans l'agro-alimentaire. Le cas d'une unité de traitement et de transformation de la volaille. Rapport de stage. Université de Nantes-IEMN-IAE, Nantes. 54 p.

Royer (1840). Traité théorique et pratique de comptabilité rurale. Bouchard-Huzard, Paris. 354 p.

Schneider, A. (1986). Simultaneous determination of cost allocations and cost-plus prices for joint products. *Journal of Business Finance and Accounting*, 13 (2), 187-195.

Shubik, M. (1962). Incentives decentralized control, the assignment of joint costs and internal pricing. *Management Science*, 325–343.

Thomas, A. L. (1969). The Allocation Problem in Financial Accounting Theory, *Studies in Accounting Research*, No. 3 (American Accounting Association, 1969).

Thomas, A. L. (1974). The Allocation Problem, Part Two, *Studies in Accounting Research*, No. 9 (American Accounting Association, 1974).

Thomas, A.L. (1980). *A behavioral analysis of joint cost allocation and transfer pricing*, Stipes, 1980.

W. Hamlen and J. Tschirhart (1980). The Use of the Generalized Shapley Allocation in Joint Cost Allocation. *the Accounting review*, April, 269-287.

Weidema, B.P. Ed. (1993). *Environmental Assessment of Products*. UETP-EEE, Helsinki.

Weil, R. (1968). Allocating Joint Costs, *American Economic Review*, December, 1342-45.