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Accounting for Externalities in Agriculture and Food Sector Value Chains

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Abstract

Agricultural and food networks have become increasingly private and powerful, closely coordinated or fully vertically integrated, self-regulated, global and experience-based. A new cohort of wealthier consumers is demanding new and different goods and services. Delivery of this consumer food experience requires a very well-coordinated value chain or value system. Coordination and cooperation among chain partners involved in these networks are mandatory if they are to be profitable and sustainable. The economic issue is: How should all the chain or system partners be aligned to deliver food experiences that maximise consumer willingness to pay, and also be efficient? And what if any is the role of government in organising or facilitating these systems? To answer these questions we reviewed the literature across a number of discipline areas as well as a variety of published evaluations of red meat innovations. We used this review to develop, outline and explain a new theoretical framework relating to value chain failure and the provision of value chain goods. We illustrated how this framework could have been applied to past red meat investments, and we proposed a procedure for assessing future RD&E proposals within this framework. All red meat stake holders should benefit from a greater appreciation of these issues in RD&E funding.

Executive Summary

Agricultural and food networks around the world have become increasingly private and powerful, closely coordinated or fully vertically integrated, self-regulated, global and experience-based. A new cohort of wealthier consumers is demanding new and different goods and services, and this has driven a series of changes in the way the new products are supplied and delivered. This consumer food experience requires a very well-coordinated value chain or system with closed information sharing. Coordination and cooperation among chain partners involved in these agricultural and food networks are mandatory if they are to be profitable and sustainable. The economic issue is: How should all the chain or system partners be aligned to deliver food experiences that maximise consumer willingness to pay, and also be efficient? Is there still a role for government in organising or facilitating these systems in the new world of private, coordinated, vertically integrated, self-regulated, global and experience-based value chains and value systems. Is there still a type of market failure?

To answer these questions, we reviewed the literature across a number of discipline areas including micro-economics, welfare economics, value chain analysis and public finance, as well as a variety of published evaluations of red meat innovations. Based on this review, we then developed, outlined and explained a new theoretical framework relating to value chain externalities, value chain failure, and value chain goods. We illustrated how this framework could have been applied in the past to red meat investments/interventions that we now know to be corrections for chain failures, and we proposed a procedure for assessing future research, development and extension (RD&E) proposals within this framework.

The development of the chain failure, chain externalities and chain good framework rests on the premise that the ability of red meat producers to benefit from value creation is constrained by the potential for misalignment between the financial incentives for individual firms and their collective incentives when they are part of a value chain or system. Value chain and system participants maximise their private net benefits, and this could lead to suboptimal performance of the whole chain because of underinvestment in what we term “chain and system goods” and the presence of “chain and system externalities”. A chain good comes from the broader concept of a club good - a sub-type of a public good, without the condition of non-excludability - and is related to the concepts of “local public goods” and “local club goods” in the local government literature. Chain goods are those types of goods and services that allow effective coordination across value chain partners. They resemble what used to be called the facilitating functions of agricultural markets - standardisation, financing, risk-bearing, and market intelligence. If chain goods are absent or poorly functioning, this leads to chain failure, due to either externalities or high transaction costs. A negative chain externality is a cost incurred by a participant in the value chain that is imposed on a third party who is not directly engaged in producing, trading in or consuming the good causing the cost, but this participant does not compensate the third party. A positive chain externality is a benefit received by a third party who is not directly engaged in producing, trading in or consuming the good providing the benefit, but this third party does not compensate the participant in the value chain who provides the benefit.

We expect the governing agency in a value chain or system (such as the dominant firm or an industry body) to have a potential role to play in counteracting many different types of chain failure. To apply this framework to red meat RD&E investment decisions, we suggest that the

following checklist of areas prone to chain failure provides a useful means to assess where intervention and/or investment is needed to correct for this failure:

- Meat RD&E
- Regulation of markets within the meat value chain
- Enhancing consumer and channel knowledge
- Chain sustainability
- Education and training
- Inventory aggregation
- Transportation policy
- Exploiting scale and scope economies in capital investment through joint action
- Risk sharing.

The first five of these forms of intervention/investment should be accorded highest priority as they offer the greatest scope to increase chain surplus and net social benefits. The other potential roles are important but tend to be less prone to chain failure. In addition, a sixth key role of the chain governing agency is governance and managing relationships.

Meat RD&E leading to process and product innovation (new or better tools and technologies for use in the value chain), new product development and systems/logistics innovation needs to be assessed on a whole-of-chain basis, particularly in integrating livestock genetics and production research with other activities in the chain. Evaluating RD&E activity using formal methods such as benefit-cost analysis is fraught with difficulty because often the expected net benefit is unknowable and/or the probabilities of different outcomes is unknowable. In these situations, a consumer-oriented heuristic approach can be more effective, using demand-pull techniques to ascertain where the greatest value can be added to the chain, especially as product differentiation is an area of increasing importance in the markets for meat products.

In relation to financing red meat RD&E activity, we suggest the following four approaches to determine who funds RD&E activities in meat value chains:

1. A private goods solution should be selected where there is a reasonable expectation that private net benefits from a research activity will be positive – whether for an individual firm or for a group of firms acting collaboratively – regardless of spillovers.
2. A public finance solution is recommended where an RD&E activity is expected to result in a net social benefit but net chain loss, and (a) the ideal chain goods solution converges to the public finance solution but is costlier to implement and (b) transaction costs are high and the only viable chain goods produce undesirable solutions.
3. A pure chain goods solution is recommended where a net chain benefit is expected from a research activity and spillovers to society as a whole are expected to be outweighed by the transaction costs of the chain governing agency engaging with governments.
4. A hybrid public finance/chain goods solution should be adopted to fund RD&E activity within a value chain where a net chain benefit is expected and spillovers to society as a whole are expected to be significantly greater than the transaction costs of the chain governing agency engaging with governments. A decision on the relative contributions of public and chain funding in these circumstances can be approximated using a four-step Delphi process to establish a scoring system, such as 10:90 funding contribution, etc. Where it is considered impossible or too costly to judge the distribution of benefits of an RD&E activity, the current system of a 50:50 split between the national government and the meat value chain should be maintained.

All red meat stakeholders should benefit from a greater appreciation of these issues in RD&E funding.

Table of Contents

Background

Each of us involved in writing this report has trained as traditional agricultural economists. That means we have areas of common professional interest, instilled during our training. One such area of common ground is in describing and analysing the markets for agricultural and food products. This is traditional price analysis, as outlined in texts such as Tomek and Robinson (1972), Kohls and Uhl (1980) and Campbell and Fisher (1982). Some of this work has been descriptive, in both Australia and developing countries, but much of it has been empirical. That is, specifying and estimating economic models of these markets, based on time series or survey data. This knowledge about how markets work has been applied to evaluate proposals for changes in these markets. Such proposals could be for new or different policies, new or different products, or new or different technologies or systems. This body of work has included analyses for and on behalf of the Australian and state governments and their agencies such as the Productivity Commission and the Australian Centre for International Agricultural Research, a number of different Cooperative Research Centres including the Beef, Wool, Sheep, Dairy, Seafood, Weeds and Salinity CRCs, a range of primary industry research and development corporations such as Meat and Livestock Australia, Australian Pork Limited and Dairy Australia, and a variety of international agencies. These evaluations have been based on empirical models, specified on the basis of standard microeconomic theory about how markets work.

In almost all cases, the proposals or projects evaluated have been at least partially financed from government funds, so a second primary focus for us has been on whether the proposed projects have been an appropriate avenue for government investment, and if so, what is the best mix of taxpayer and other funding. In undertaking such evaluations we have to date relied on the traditional distinction between public and private goods and on the rules which emerge relating to market failure as a justification for intervention (and thus investment) by government.

A third general area of common ground is in describing and analysing particular groupings of firms and households within these markets – input suppliers, food and agricultural product producers, processors, wholesalers and distributors, retailers and consumers – that interact commercially jointly to provide food, fibre and beverage products that are demanded in the market. These groupings are variously referred to as supply chains, value chains, value networks or value systems[1]. We have done a lot of work on marketing margins and price transmission processes. More recently, we have jointly developed value chain subjects at undergraduate and postgraduate levels and taught them at our respective universities, we have promoted the idea of efficient and profitable value chains as a key determinant of the competitiveness of the agricultural sector (UNE Business School 2014), and we have undertaken a number of studies of particular value chains across a number of products and regions (e.g. Grant et al. 2013). In so doing we have referred to some of the modern supply chain management texts such as Chopra and Meindl (2013).

[1] We use the terminology “value chains” and “value systems”, where a value chain is defined as the value producing activities of one organisation, and a value system is defined as the network of organisations and value producing activities involved in the production and delivery of an offering to the end customer. We use the generic term “value chain” to refer to both unless we specifically wish to distinguish between them. In Appendix 1 we define the terms we use and provide a rationale for why we have chosen them.

In recent years, our interests in these three broad areas have merged. We have noticed the changes that have occurred in the nature and organisation of global agricultural and food markets away from the commodity approaches, as described in the standard texts, towards the value chain experience approaches evident in modern retailing environments. We have hypothesised that in this new world, the traditional rules for the rationale for interventions to address market failures may not hold as tightly, if at all. We have also found that modern text treatments of supply chain management do not adequately deal with the complexities of agriculture and food sector product chains and systems.

In this report we discuss these changes, we propose a new way to classify agriculture and food sector products related to their delivery via value chains, and we draw some conclusions about whether there is a need to modify the traditional rules for interventions in these chains. Wherever possible, we attempt to provide examples that are drawn from the Australian red meat industries.

Project Objectives

The objectives of this project were threefold: (1) to develop, outline and explain the theoretical framework relating to chain externalities, chain failure, chain goods and chain bads; (2) to illustrate how this framework could have been applied in the past to investments/interventions that we now know to be corrections for chain failures; and (3) to propose a procedure for assessing future research, development and extension (RD&E) proposals within this framework.

Methodology

To do this we review the literature across a number of discipline areas including micro-economics, welfare economics, value chain analysis and public finance, as well as a variety of published evaluations of red meat innovations. We also review the recent developments in global agriculture and food sector value chains and how they differ from traditional commodity markets.

Results

The results of our endeavours are reported below in four sections. In Part I, recent developments in global agriculture and food sector value chains and concepts of private and public goods and market failure are explained, and a theoretical framework relating to chain externalities, chain failure, chain goods and chain bads is developed. In Part II, three case studies are provided to illustrate how this framework could have been applied in the past to investments/interventions that we now know to be corrections for chain failures. In Part III, implications are drawn for Meat and Livestock Australia and a procedure for assessing future RD&E proposals within this framework is proposed. In the fourth section, six appendices are provided on terminology and on related issues to do with value chains, networks and systems in food and agriculture.

PART I: THEORETICAL CONCEPTS

1. The Increasing Importance of Value Chains as a Unit of Inquiry

Agricultural markets worldwide have become increasingly deregulated over the past couple of decades. This has been most apparent and most rapid in Southern Hemisphere countries such as Australia and New Zealand, and in the so-called Cairns group more generally, but the Northern hemisphere trading blocs are gradually responding (Cahill and Legg 1989). Based on 2009 OECD data, Australia and New Zealand have the lowest levels of support of the OECD countries (see Figure 1).

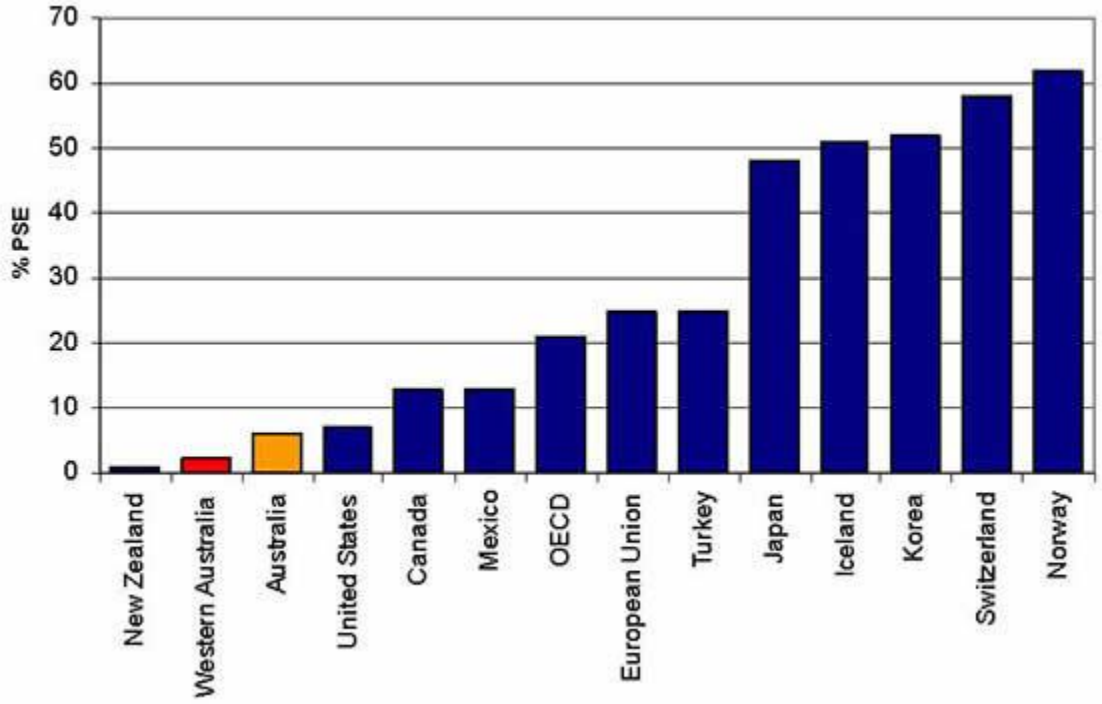


Figure 1. Estimates of the value of government support for agriculture as a percentage of the value of agricultural production.

Source: OECD (2009)

Domestic regulations have been reduced, trade barriers have been lowered, and in Australia at least, agricultural RD&E funding has also been reduced (Mullen 2010) (and will be reduced further under Productivity Commission (2011) recommendations).

At the same time, and not unrelatedly, food networks around the world have changed. It is now well accepted that food networks have become increasingly private and powerful, closely coordinated or fully vertically integrated, self-regulated, global and experienced-based (see for example Burch and Lawrence 2007, Burch, Dixon and Lawrence 2013, OECD 2007, and various publications from FAO, World Bank and European Commission). These changes

towards global value chains are being driven by the large food retailers, processors and trading companies (Australian Food and Grocery Council 2010). The major Australian food retailers have numerous domestic value chains and systems for fresh meat offerings and for other products, but also numerous global value chains and systems for fresh produce, fish products and the whole spectrum of canned and packaged foods.

But, it is difficult to define the appropriate role for government assistance in these new environments. A priori, standard market failure arguments are no longer as strong. That is, private underinvestment relative to the social optimum cannot be claimed when the gap between private and social outcomes is ever decreasing (Griffith et al. 2012).

Here, we review what has been happening and what that means for analyses of agricultural and food sector markets.

1.1 "Old World" Commodity Markets and Their Characteristics

What do we know about so-called "old world" commodity marketing systems? These systems are populated by large numbers of small players who are predominantly price takers and so do not have sufficient individual incentive to invest in more efficient outcomes. Characteristics of such systems are:

- Arms-length governance
- Open coordination
- Free but aggregate information
- Spot markets
- No excess rents
- Profit driven by on-farm efficiency in terms of reducing costs
- Supply-driven innovation
- Food experiences created by the consumer "cook" (requires time and effort).

Governments' role in the "old commodity-oriented" world is therefore:

- Provide public RD&E
- Provide public information systems
- Provide public extension systems
- Advocate for free trade
- Establish common (global) regulations and standards
- Establish cooperatives/ single trading desks/ industry boards (sometimes referred to as "parastatals") to facilitate a "level playing field".

1.2 The World has Changed

Consumer markets have changed radically in the past couple of decades. These changes have been driven by a wide range of external forces including rapidly rising incomes in some of the key Asian markets, greater participation by women in the workforce, greater urbanisation especially in developing economies, further globalisation, the rise of the internet, policy deregulation of capital flows, policy deregulation of exchange rates, further moves toward free

trade regions, fewer restrictions on foreign direct investment, development of new stock exchanges, the breakup of the former Soviet Union, and a transition from public to private pension schemes.

These new and wealthier consumers demand new and different goods and services, and this has driven a series of changes in the way the new products are supplied and delivered. Private firms have collaborated through market innovation and RD&E to solve the market needs. The result has been a progression from the old style commodities to products and services, and now to experiences. It is no longer sufficient to provide differentiated products – the new experience market must have credence attributes, services combined with the product, and community service requirements. These bundles are increasingly delivered by closely coordinated value chains, which have the following characteristics:

- Private
- Excess rents
- Imposing transaction costs
- Disaggregation
- Differentiation
- Segmentation
- Governance by relationships
- Closed systems
- Fee based
- Exclusion
- Investment
- Value.

It is evident that this list of market characteristics is very different from that of the old style commodity markets, and in some cases diametrically opposed.

1.3 Implications of These Changes

The strong implication is that the agricultural and food sector is no longer selling/marketing a commodity or even a product but rather a consumer food (beverage and fibre) “experience”. The consumer seeking a food experience demands the bundle of attributes they have selected, delivered precisely when, where and in the form required, guaranteed to be the same every time. This ***consumer food experience*** therefore requires a very well-coordinated value chain with closed information sharing. Agricultural and food markets therefore are no longer populated by large numbers of small players who are predominately price takers and so do not have sufficient incentive to invest themselves as individuals in more efficient outcomes; they are populated by a system or network of private, consumer-driven value chains. Thus value chains are the new unit of enquiry when analysing and evaluating agricultural and food sectors (Baker et al. 2014).

Coordination and cooperation among chain partners involved in these agricultural and food networks are mandatory if they are to be profitable and sustainable (Carter and Easton 2011). This co-ordination demands a certain standard of relationship amongst the partners due to the inevitable trade-offs of benefits between them (Mueller et al. 2007). Chain governance has widely been identified as key to overcoming challenges such as the complexity of transactions

and the facility for information to be codified (Gereffi et al. 2005), facilitating innovation, and reconciling retail market power with the pursuit of competitive advantage by firms at other chain stages (Simmons et al. 2003; Soosay et al. 2012).

The economic issue then is how do we align all the chain partners to deliver that food experience that maximises consumer willingness to pay, and also be efficient? And what if any is the role of government in organising or facilitating these systems?

We will come back to these questions later. First, let us review the traditional approach, and then see whether we can develop a different economic framework to assist us in formulating the answers.

1.4 Summary

Agricultural and food markets worldwide have become increasingly deregulated over the past couple of decades. At the same time, and not unrelatedly, agricultural and food networks around the world have become increasingly private and powerful, closely coordinated or fully vertically integrated, self-regulated, global and experienced based. A new cohort of wealthier consumers is demanding new and different goods and services, and this has driven a series of changes in the way the new products are supplied and delivered. This consumer food experience requires a very well-coordinated value chain or system with closed information sharing. Coordination and cooperation among chain partners involved in these agricultural and food networks are mandatory if they are to be profitable and sustainable. The economic issue is: How should all the chain or system partners be aligned to deliver food experiences that maximise consumer willingness to pay, and also be efficient? And what if any is the role of government in organising or facilitating these systems?

2. Concepts of Public and Private Goods and Market Failure

The ability to capture the benefits of developing and introducing innovations in supplying goods or services is a function of the nature of the innovation. Economic theory explains how this ability determines whether or not sufficient investment in particular innovations will be made by individuals pursuing self-interest to maximise their contribution to social welfare. That is, it determines whether the market works or fails in supplying the welfare maximising quantity of a good or service.

One explanation of the causes of markets failing centres on the nature of the good or service. Theory holds that markets work well and add to social welfare when the goods or services producers supply have the characteristics of being excludable and rival in consumption. That is, others cannot benefit from the good or service unless they pay for it, and their use of the good or service prohibits others from gaining the benefits of it. This is a pure private good. Markets fail when neither of these two characteristics exist: suppliers cannot prevent others obtaining the benefits of the good or service, and consumption by one party does not diminish the availability of it to others. These characteristics are called being non-excludable and non-rival in consumption[2]. This is a pure public good. In these circumstances insufficient, or too much, of something is supplied, and social welfare is sub-optimal. This theory is detailed in modern microeconomics texts such as Gans et al. (2012) and Hubbard et al. (2012).

The case for government having a role to play in economic activity rests on both of the following two occurrences:

(i) The market fails to supply the desired quantity of something because insufficient incentive exists for potential suppliers to provide it; or the market supplying too much of something undesirable because there is insufficient incentive for those supplying this unwanted phenomenon not to do so.

(ii) The benefits of government acting to change this situation exceed the costs of such action.

This latter requirement – benefits exceeding costs – leads to an alternative explanation of the cause of too many ‘bad’ things and too few ‘good’ things being supplied. It is commonly referred to as the “transactions cost explanation”.

This explanation for markets failing holds that market failures abound because only some are worth fixing. If the cost of some action to supply a potential desired state of affairs is less than the benefits, then the potential desired state of affairs will not become an actual state of affairs and the undesirable state of affairs will, and should, prevail. Boiled down to a case by case investigation of transaction costs versus benefits, the transaction costs explanation of market failure offers less abstract, more practical, guidelines for action than does the standard explanation of market failure.

[2] There is sometimes a third criterion proposed: non-rejectability in consumption (Bannock et al. 1984, p. 335). Non-rejectability means that no individual can abstain from consuming the good.

2.1 Necessary and Sufficient Conditions Justifying Public Intervention

First, we provide the standard explanation. The criterion for investment by an agency of state or federal government should be based on a *single* objective of *maximising net benefits for the constituency of the government*. Government intervention in economic activity aims at two objectives – efficiency and equity. Efficiency is using resources to produce the greatest net benefits for the community. Net benefits are broad, and include directly measurable economic benefits as well as environmental and social benefits that may be difficult to express in monetary terms. Equity is the way benefits and costs are shared among the community. Economic analysis does not resolve equity objectives. The discussion that follows focuses primarily on efficiency considerations in investing in economic activity by the public, while recognising that equity issues are an important concern of government.

Governments intervene in markets when the results of the operation of firms and individuals in markets fail to provide satisfactorily for the needs of society. There are four Necessary Principles and two Sufficient Conditions that justify the public providing goods and services[3]. These principles and conditions relate to public goods; externalities; scale; and risk, and are all about efficiency. There are three Guiding Principles as well, two about efficiency – equi-marginal returns and comparative advantage - and one about equity – beneficiary pays. When contemplating public funding of economic activity, the starting point is to ensure there is adequate, rigorous consideration of the principles and conditions that justify governments intervening in markets.

As well as understanding these principles of public intervention in economic activity that are well-established in economic theory and public practice, it is also important to appreciate the complexity and subtlety involved in applying these concepts. They are difficult to apply in practice because in most cases public intervention delivers a mix of public and private goods, as shown in Table 1.

Table 1. Private and Public Goods

	Excludable	Non-excludable
Rival	Pure private goods: Rump steaks, lamb chops	Common resource goods: Public parks, tuna in the ocean
Non-rival	Quasi-public goods: Toll roads, cable TV	Pure public goods: National defence, street lighting

Source: Adapted from Hubbard et al. (2012, Figure 15.7).

Necessary Principle One: The Public Good Principle

Public goods and services have the characteristics that they are goods and services whose costs would exceed benefits if private suppliers tried to supply them. An individual supplier cannot capture sufficient of the benefits to justify the investment in supplying the good or

[3] The same principles and conditions apply to public investment in research to achieve direct environmental outcomes.

service. This is because public goods and services are non-rival in consumption and non-excludable. The classic example is national defence.

Another example is agricultural RD&E, whose output, such as knowledge, can be widely available and freely accessible, and not diminished by use. Some new knowledge will be embodied in a product that is an input to production, making it rival and excludable. Knowledge that is disembodied (not incorporated in a product) is a public good, meaning it is difficult to exclude farmers who do not pay from enjoying the benefits of the public investment in agricultural RD&E. It is also non-rival in that it can be shared (re-used) by many. The direct benefits of disembodied knowledge flow to farmers in the form of increases in productivity; sometimes processors and consumers within the industry benefit too from lower costs and/or better quality products. Direct benefits do not go to people who have no market relationship with the industry.

Necessary Principle Two: The Externality Principle

Externalities arise when an economic activity "spills over" to affect others unintentionally. An obvious example in the context of agriculture is positive and negative environmental impacts of changing practices that are externalities beyond the boundaries of the private firms in the industry, but with no economic consequence at the source. There is always too much of an activity causing a bad externality and too little of an activity causing a good externality. If the benefits exceed the costs, government can act to achieve a better balance from society's viewpoint between economic activity in the industry and associated externalities.

Public investment that enhances productivity also inadvertently delivers external costs and benefits that have environmental and human dimensions, such as bad and good environmental externalities, or beneficial additions to the capacities of scientific and other communities to perform tasks and meet challenges. A positive externality would be improved efficiency (reduced costs) of using an input in production resulting in less pollution. Examples of externalities with positive social effects are benefits to people in communities in the form of improved capacity of local institutions to adapt to change from new and better information and skills.

Necessary Principle Three: The Scale Principle

When the structure of supply of goods and services in the economy is such that average cost per unit of output falls as the scale of the supplying entity increases, it is said that a natural monopoly exists. This is the principle of scale that can justify there being a sole supplier such as the public, or the public regulating the supplier of a good or service. Common examples of public ownership are power stations, energy and communication distribution networks, and emergency hospitals (although such facilities are now being increasingly owned and operated by the private sector).

Applications of natural monopoly in an agricultural context would likely be few, such as the provision of RD&E services of a specific nature involving say a large investment in a piece of equipment with a very specific use.

Necessary Principle Four: The Risk Principle

If the risk of an investment is such that private suppliers will be inhibited from supplying the quantity of a good or service that society would prefer, a public provider may have a role to play

because the public can be risk-neutral for any particular component of their total portfolio of investments. The public with capacity to invest with a risk-neutral attitude is able to have a portion of high-risk investments in their portfolio that may not fit into private investment portfolios. Various types of natural disaster insurance schemes and basic research projects such as in some CRCs would fall into this category.

If any of the circumstances to do with the supply of goods and services described above as Necessary Principles 1-4 exist in the economy, recognising that there are time and space dimensions to markets failing in the ways defined, then there exists a *prima facie* case for government intervention in the operation of relevant markets. Whether or not a government agency *should* proceed to intervene in the markets in question depends on the following two important Sufficient Conditions.

Sufficient Condition One

This condition refers to whether, given the best form of intervention, the benefits of doing so are expected to exceed the likely costs, which encompass the opportunity costs of other publicly funded investments such as health and education.

Sufficient Condition Two

This condition concerns whether the government agency proposing the intervention is the appropriate government agency to tackle the market failure. For example, depending on the situation, intervention by federal, state or local government may be best. The levels, agencies and forms of intervention are important determinants of the nature and extent of both the benefits and costs of intervention.

2.2 An Alternative Explanation: Transaction Costs

An alternative explanation for the existence of market failures such as externalities and public goods can be couched in terms of transaction costs. This explanation is less abstract, more practical. The standard explanation that externalities and public goods result from non-rivalry and non-excludability characteristics of phenomena is somewhat abstract in that little or no account is taken of the likelihood and magnitude of transaction costs that would be involved in changing a situation. The transaction cost explanation for externalities and public goods simply holds that these will occur when the transaction cost to individuals of supplying more of something that is good but under-supplied, or less of something that is bad and over-supplied, is less than the expected benefits.

2.3 Recent Extensions to the Theory of Market Failure

The public good principle for intervention in markets applies to any collective of interested parties in which no individual in that group has enough incentive to provide a good or service because costs exceed benefits due to non-rivalry and non-excludability: where members of the group act together, they can overcome these problems. For example, producers in the same industry can pool resources and fund RD&E and overcome problems of non-rivalry and non-excludability. This is called the “industry good” case in which the public good principle applies.

Sometimes the argument is put that if all the direct benefits of an investment in a particular area are confined to participants in an industry, then the amount these beneficiaries are willing to pay, such as via research levies, is the total amount of investment that should be committed and there is no role for public investment. This thinking has the implicit and mistaken assumption that (i) there are no public (beyond industry) benefits; and (ii) participants in the industry are levying themselves the amount to invest that achieves maximum economic efficiency (marginal benefit equals marginal cost). This thinking goes on to conflate efficiency and equity (beneficiary should pay) considerations – the amount beneficiaries are expected to pay is a fairness notion whereas the efficient amount of investment is the amount that maximises net social welfare. The economic efficiency approach holds that investments should be made if economy-wide benefits exceed costs, regardless of the source of funding, as this adds to national welfare. Furthermore, the efficiency criterion dictates that investments should proceed up to where the marginal benefit of the marginal investment just equals its marginal cost. Whether beneficiaries pay or not is an income distribution (equity) issue.

The over-riding idea is that if collective action to supply goods and services by the public or by an industry or by a combination of the two will provide the goods and services that are currently under-supplied, and the benefits of doing so are expected to exceed the costs, then the public intervention should be done because there will be a net gain in social welfare.

2.3.1 Principles Guiding Collective Action to Correct a Market Failure

Once the case for collective action to correct a market failure is made, the next questions are about putting these principles into practice. To do this, the three key questions are: (i) how to allocate scarce funds amongst competing uses, (ii) who should do the intervention, and (iii) how best to fund the investment. The first two questions are of an economic nature; the third question is one of equity.

These questions are answered by resort to three Guiding Principles: two principles of economics – the principles of equi-marginal returns and of comparative advantage – and a principle (or social view) about equity.

Guiding Principle One: Equi-marginal Returns

Maximising the net benefits from the portfolio of potential activities to correct market failures becomes a question of balancing activities within the portfolio. Balancing a portfolio means applying the principle of equi-marginal returns such that an additional dollar would earn the same expected benefit in each element of the portfolio. In practice, allocating resources so as to equate net benefits between alternative investments can only be applied approximately. Industry benefits can be estimated because the consequences show up in and are traded in markets, but beneficial externalities such as reduced environmental costs and improvements to human and scientific capacities are difficult and expensive to value.

Guiding Principle Two: Comparative Advantage

The economic principle of comparative advantage dictates that, as in international trade, collective action is most efficient when it is done by those who are relatively best at doing it (specialists) and outputs are traded with other specialists. In the context of an industry the principle of comparative advantage dictates that the organisations around the nation who are

relatively best able to solve problems in particular areas should do the work in those areas, and outputs traded between the firms.

Guiding Principle Three: Equity

Equity questions arise because collective action may deliver a mix of public, private and industry goods that affects parties to the action unequally. Note the preceding discussion about economic considerations – benefits exceeding costs – determining what investments ought to be done, and fairness considerations dictating that beneficiaries should pay something. There are three possible options:

(i) The public fund it fully.
(ii) Private sources of finance fund it fully, with public intervention being the regulatory means to facilitate the accumulation of private funds and allocate them to research activity.
(iii) A mix of public and private funding is used.

In practice, funding constraints apply to all government and private activities and government departments and private firms need to choose between alternative uses of funds. A fundamental tenet of taxation, albeit one that is high level and often difficult to measure and apply accurately, is that members of society should contribute to tax revenues proportionate to the share of the benefits that society bestows on them, subject to maintaining appropriate incentives to contribute to economic output. The ”beneficiary pays” principle dictates that where there is a clear beneficiary of government and private investment, governments can choose to require beneficiaries to pay a share of the benefits received. This principle of “beneficiary pays” is primarily an equity criterion and not an efficiency criterion. In Australia, in agricultural RD&E, the main mechanism to tackle equity issues has been the development of the system of Research and Development Corporations.

2.4 Summary

Public goods and services have the characteristics that they are goods and services whose costs would exceed benefits if private suppliers tried to supply them. An individual supplier cannot capture sufficient of the benefits to justify the investment in supplying the good or service. This is because public goods and services are non-rival in consumption and non-excludable. A traditional example is agricultural RD&E, whose output, such as knowledge, can be widely available and freely accessible, and not diminished by use. Some new knowledge will be embodied in a product that is an input to production, making it rival and excludable. Knowledge that is disembodied (not incorporated in a product) is a public good, meaning it is difficult to exclude farmers who do not pay from enjoying the benefits of the public investment in agricultural RD&E. It is also non-rival in that it can be shared (re-used) by many. The direct benefits of disembodied knowledge flow to farmers in the form of increases in productivity; sometimes processors and consumers within the industry benefit too from lower costs and/or better quality products. Direct benefits do not go to people who have no market relationship with the industry. The market mechanism fails to deliver the appropriate quantity of agricultural RD&E, so there is a role for government to fund some of the RD&E. An economic question is whether there is still a role for government intervention in the new world of increasingly private and powerful, closely coordinated or fully vertically integrated, self-regulated, global and experienced based value chains and systems.

3. Chain Failure: The Theory, with Reference to Meat Value Chains

The ability of meat producers to benefit from value creation is constrained by the potential for misalignment between the financial incentives for individual firms and their collective incentives. This misalignment is similar to, but different in some respects from, the typical underinvestment in public goods found in the general economy or in "old world" commodity markets. Value chain and system participants maximise their private net benefits, leading to suboptimal performance of the whole because of underinvestment in what we term "chain and system goods" and the presence of "chain and system externalities". These concepts are defined and described below.

3.1 Framework for Economic Study of Meat Value Chains

The framework we have developed for this study of meat value chains (here, both chains and systems) is based on seven elements:

1. An orientation to satisfying consumers' wants in meat consumption
2. Identifying and developing innovations that add chain value
3. A study of chain structure, governance and relationships, and how they influence the integration of productive activities across the whole chain from livestock genetics to meat consumption
4. Identification and exploitation of common interests and values among competing chain participants by internalising positive chain externalities, minimising negative chain externalities, creating chain goods and minimising chain bads
5. Specific analyses of resource allocation across the typically multiple channels in a meat value chain
6. Identification and measurement of spillovers from a meat value chain to society as a whole
7. Identification and measurement of benefits to clusters of chain participants that are best satisfied by the production and provision of local public goods.

This framework differs from the traditional studies of supply chains in respect of all these conditions to varying degrees, but the first two conditions are regarded as the flagship of a value chain analytical framework. A common thread among all elements in the economic study of a value chain is the enhancement of value in the chain, beginning with the consumer. In contrast, the traditional approach to studying supply chains typically begins with a product at the primary level of production or some intermediate stage in the chain, and the study is based on facilitating the progress of this product through the supply chain until it reaches the consumer. The initial decision to produce a meat product tends to be based on an assessment of its profitability given the farm-gate price, without regard for what the consumer wants and how additional value can be created by meeting these wants more accurately. This approach may be satisfactory for a commodity that is homogeneous, or close to homogeneous, but is found wanting for heterogeneous products such as most meats, and for any bundles of products that make up a food experience purchase.

The economic study of a value chain is complementary to other disciplinary studies, such as network design, logistics, marketing, financing, education and training, sales and operation planning, and the scientific and technical studies underpinning the production of materials and services used in the chain. Modern texts such as Chopra and Meindl (2012) include these

cross-disciplinary linkages. This complementarity suggests that it is essential to adopt an inter-disciplinary approach to studying value chains, which we support, but we consider the economic study to be first among all disciplinary studies. Our reason for asserting this primacy is that the performance of a value chain is best measured by the economic surplus (total chain profitability) it creates, as mentioned above. Any action to intervene in the chain should be measured by its ability to increase economic surplus. It is not uncommon to hear other disciplinary experts within the chain recognise the need for an orientation to satisfy consumers' wants in meat consumption yet ignore the need for an initial economic assessment of their actions in attempts to improve chain performance.

In order to assess interventions in the value chain, it is necessary to define their rationale. The concepts we use for this purpose are derived from what we define as chain failure: chain externalities, chain goods and chain bads. Let us state as a hypothesis that we believe there to be a solid basis for governments to address chain failure and thereby improve the economic efficiency of any food value chain through investment in new or better chain goods and by internalising externalities. Implicit in this approach is that private firms within a value chain are capable of maximising their own profits and contributing a maximum amount to chain surplus in the absence of chain failure.

3.2 Chain Failure, Chain Goods and Bads, and Chain Externalities

Chain failure

The concept of chain failure is analogous to the concept of market failure that is used widely in the microeconomics literature and that we touched on in Section 2 above. Bannock et al. (1984) defined market failure as a "situation in which economic efficiency has not been achieved through imperfections in the market mechanism" (p. 262), and economic efficiency as the "state of the economy in which no one can be made better off without someone being made worse off" (p. 125), commonly known as Pareto optimality.[4] These concepts are normally applied to a national economy but can be adapted to smaller economic systems such as value chains or larger ones such as the global economy.

We define chain failure as a situation in which a value chain fails to maximise chain surplus because it supplies a suboptimal level of throughput and value (Griffith et al. 2012). Using the Pareto optimality criterion in the context of value chains, an economically efficient value chain is one in which no one chain participant can be made better off without another participant being made potentially worse off. It can be determined by ascertaining where chain economic surplus (the sum of consumer surplus and producer surplus) is at a maximum. If we ignore equity concerns for the moment (but see below), the degree to which chain economic surplus is less than its potential maximum value shows the extent of chain failure.

Chain failure can occur as a result of the presence in the value chain of chain goods and bads (including merit goods and sumptuary goods), positive and negative chain externalities, and asymmetric information leading to adverse selection, moral hazard and the principal-agent

[4] It is usual to distinguish between an actual and potential Pareto improvement by applying Hicks' criterion, that gainers could compensate losers by bribing them to accept a change so that no one could be potentially made worse off (Hicks 1939).

problem. It can also arise from the many forms of market failure originating from outside the chain.

Chain goods

The concept of chain goods is related to industry goods as described in Section 2 above, but from a theoretical point of view can be considered as analogous to a club good (McNutt 1999) where the club comprises all members of a value chain. A club good is a sub-type of a public good, and populates the space between a public good and a private good. To reiterate the discussion in Section 2, a public good has three possible attributes: non-excludability; non-rivalry in consumption and (often) non-rejectability in consumption (Bannock et al. (1984, p. 335). Non-excludability means if one person consumes a good, other people cannot be excluded also from consuming it. Non-rivalry in consumption means that one person's use of a good does not diminish its availability to other consumers. Non-rejectability means that no individual can abstain from consuming the good.

The criteria of non-excludability and non-rivalry in consumption are the ones usually applied in assessing whether a good can be described as a public good. A private good is one that is excludable and rival. McNutt (1999) observed that club goods (and therefore from our viewpoint, chain goods) are essentially public goods without the condition of non-excludability. There are two other categories of goods, namely a quasi-public good, which is non-rival and excludable, and a common resource, which is rival and excludable. A typology of these goods, along with examples, is provided in Table 2.

Table 2. Six Types of Private and Public Goods

	Excludable	Selectively excludable	Non-excludable
Rival	Global private goods Examples: Rump steak Lamb chops	Private goods in a value chain Examples: Transport Warehousing	Common resources Examples: Tuna in the ocean Public park
Non-rival	Quasi-public goods Examples: Cable TV Toll road	Chain goods in a value chain Examples: Grading system Livestock selling facility	Public goods Examples: National defence Street lighting

Source: Adapted from Hubbard et al. (2012, Figure 15.7).

Thus chain goods are those types of goods and services that allow effective coordination across value chain partners. They resemble what used to be called the facilitating functions of agricultural markets (Kohls and Uhl 1980, Chapter 2, 25): "The facilitating functions are those that make possible the smooth performance of the exchange and physical functions. These

activities are not directly involved in either the exchange of title or the physical handling of products. However, without them the modern marketing system would not be possible. They might aptly be called the grease that makes the wheels of the marketing machine go around." The four key groupings of facilitating functions were stated to be standardisation, financing, risk-bearing, and market intelligence.

Some other types of goods are not explicitly included in Table 2. For example, a "merit" good is a particular kind of public good that is socially beneficial regardless of consumers' preferences: the social benefit of consumption exceeds the private benefit. Three key questions on merit goods from a food value chain perspective are: what qualifies as a merit good, how should merit goods be paid for, and should they be supplied through the public or private sector? Merit goods abound in food value chains. They are associated with the social benefits from the availability and affordability of foods that most contribute to a good diet, health, food safety, a sustainable environment and greater equity (see for example, Barling 2007).

Examples of foods that are merit goods include:

- So-called "brain foods" that are under-consumed (particularly by children) as a consequence of many important minerals and vitamins being removed from food products during processing
- Organic foods (see Mann 2003)
- Livestock products produced in a humane manner
- Products sourced through "fair trade" value chains.

Another example is a "sumptuary" good. It is a product that is socially harmful regardless of consumers' preferences: the social cost of consumption exceeds the private cost. Originally a reference to luxury goods, the term is now more commonly used in relation to products that are considered vices, notably "fast foods" and alcohol and tobacco products. Most of these products entail the processing of raw materials supplied by agricultural producers. Examples are fatty meat products, tobacco leaf, barley, hops and wine. There is an equity issue again here in that, in Australia, poor people are at greater risk of unhealthy eating habits (Burns 2004).

The literature is sparse on the use of the club goods concept in studying value chains. McNutt (1999) is one of the few to deal directly with the concept. From McNutt's observation, we can conclude that chain goods resemble club goods in that they are non-rival and selectively excludable, and often also non-rejectable. That is, members of society outside the value chain are excluded from sharing in any benefits derived from joint action[5] within the chain unless scope exists for "free riding" or because certain members of the chain do not cooperate because they feel that they are "forced riders" (McNutt 1999).

The selectively excludable condition depends on the ability of chain participants to prevent free riding by excluding those outside the chain from benefiting from actions taken within the chain. In many instances, the chain borders are porous, weakening this condition. Horizontal and vertical strategic alliances are mechanisms to internalise chain goods, formed among groups at the same level and across different levels, respectively, in the value chain. Horizontal and vertical strategic alliances are reviewed later.

[5] We follow Schmitz (1999, p. 469) in mainly using the expression, joint action, rather than collective action or cooperation as an umbrella term. Schmitz makes the points that collective action fails to capture "bilateral ventures" while cooperation has a different meaning in game theory. Collective action is used where multilateral ventures are implied.

Chain bads

As mentioned above, use of the concept of chain economic surplus to reveal the extent of chain failure ignores equity issues. Chain bads can be scrutinised at least partially to overcome this neglect, in three dimensions.

First, underinvestment in chain goods is likely to be especially damaging to the small-scale producers because of their limited ability to capture the benefits created by chain goods (Mounter et al. 2011). On the other hand, major players in food value chains such as large supermarket and food processing corporations can capture some of these benefits. There is thus an inequity dimension to the presence of chain failure that can be represented as a chain bad.

Second, the most important of the various competition issues in food value chains is arguably the so-called “undue” exertion of monopoly power or monopsony power by dominant firms – a highly emotive and subjective concept. These firms have the potential to create a chain bad, which could be a problem for small firms that have limited or no market power. Its presence points to the key role of chain governance in avoiding or limiting these negative effects.

Third, a “sumptuary product” can be an example of a chain bad. It is a product that is socially harmful regardless of consumers’ preferences: the social cost of consumption exceeds the private cost.

Chain externalities

We define a negative chain externality as a cost incurred by a participant in the value chain that is imposed on a third party who is not directly engaged in producing, trading in or consuming the good causing the cost, but this participant does not compensate the third party. We define a positive chain externality as a benefit received by a third party who is not directly engaged in producing, trading in or consuming the good providing the benefit, but this third party does not compensate the participant in the value chain who provides the benefit.

A study of chain externalities rests to some extent on the analytical framework used to study chain goods. Some economists have argued that chain goods may be treated as extreme cases of goods with positive chain externalities. Alternatively, chain bads may be treated as extreme cases of goods with negative chain externalities. When a unit of a good is produced or consumed that beneficially (adversely) affects third parties but entails no market transaction, a positive (negative) externality occurs. When this production or consumption beneficially (adversely) affects *everybody* in a given population (in our case, chain participants), the good or service has chain good (bad) characteristics. While these conditions suggest we could simplify discussions by referring simply to positive and negative chain externalities that subsume chain goods and bads, respectively, another condition suggests that this approach is unwise. Public goods (bads) do not have a market because it pays nobody to provide (eliminate) them whereas chain externalities typically occur in situations in which markets operate, albeit imperfectly from society’s viewpoint. Hence, the economic analysis of these concepts will differ.

The existence of negative or positive externalities amongst participants of a value chain too can be explained in terms of the size of the transaction costs of individuals acting to reduce negative externalities or to supply more of something which has positive externalities. It may be that only by acting jointly can the transaction costs per individual be reduced sufficiently relative to the

individual's share of benefits that it warrants something that causes a negative externality being reduced or a positive externality being supplied. The absence of uniform grading or classification schemes in the meat value chain is often considered to be a case of a chain failure, even though in recent times large individual participants in the meat value chain have experimented with their own grading systems.

Although we have been referring to a generic value chain up until now, if we wish to apply these concepts in practice we will need to decide whether we are analysing a value chain or a value system. If a value chain, then the focus is on the value producing activities of one organisation involved in the production and delivery of an offering to the end customer. This offering could be quite narrow, such as a particular type or quality of product (trellis tomatoes to a supermarket chain, micro wine bottles to airlines) or broader such as fresh vegetables to a particular restaurant. In this situation, chain failure occurs if there is a lack of or a poorly performing chain good such that the chain fails to maximise chain surplus because it supplies a suboptimal level of throughput and value. One or more of the facilitating functions of markets is not supplied or is inefficiently supplied, and coordination of exchange and transformation functions is less than optimal. An example might be the lack of a uniform and credible product description scheme for trellis tomatoes.

In this situation, positive and negative chain externalities refer to a benefit received by (cost incurred by) a third party who is not directly engaged in producing, trading in or consuming the good providing the benefit (causing the cost), through the actions of a participant in this particular value chain, but this participant does not receive compensation from (compensate) the third party.

If we are analysing a value system, then the focus is on the network of organisations and value producing activities involved in the production and delivery of an offering to the end customer. This offering is likely to be much broader, such as all fresh tomatoes or all fresh beef. In this situation, system failure occurs if there is a lack of or a poorly performing system good such that the system fails to maximise system surplus because it supplies a suboptimal level of throughput and value. One or more of the facilitating functions of markets is not supplied or is inefficiently supplied, and coordination of exchange and transformation functions is less than optimal. An example might be the lack of a uniform and credible product description scheme for beef.

In this situation, positive and negative chain externalities refer to a benefit received by (cost incurred by) a third party who is not directly engaged in producing, trading in or consuming the good providing the benefit (causing the cost), through the actions of a participant in this particular value system, but this participant does not receive compensation from (compensate) the third party.

We examine chain and system externalities in more detail in the following section.

It is worth mentioning at this point that some common themes exist in the literature on clusters and value chains. We mention the cluster literature in section 4.5 below and discuss in detail in Appendix 2. The main point is that market failure can be defined at different levels of aggregation, and in particular at a "local" as well as chain level. In the local government literature, locality is defined in space by the boundary around some disaggregated level of the national economy such as region, district, city, town or village. The local economy at this level is subject to two main forms of failure in the guise of "local public goods" and "local club goods". The former affect all the population of the disaggregated region whereas the latter affect a

specific group of the local population. The parallel between chain goods and system goods, as we have defined them, is clear.

There is also an emerging area of literature on openness in innovation (Roper et al. 2013), which covers many similar concepts. Roper et al. (2013) test for and find the presence of positive externalities of openness in innovation that are related to improved knowledge diffusion.

3.3 Summary

The ability of meat producers to benefit from value creation is constrained by the potential for misalignment between the financial incentives for individual firms and their collective incentives when they are part of a value chain or system. Value chain and system participants maximise their private net benefits, leading to suboptimal performance of the whole because of underinvestment in what we term “chain and system goods” and the presence of “chain and system externalities”. A chain good comes from the broader concept of a club good - a sub-type of a public good, without the condition of non-excludability, and is related to the concepts of “local public goods” and “local club goods” in the local government literature. Chain goods are those types of goods and services that allow effective coordination across value chain partners. They resemble what used to be called the facilitating functions of agricultural markets - standardisation, financing, risk-bearing, and market intelligence. If chain goods are absent or poorly functioned, this leads to chain failure, due to either externalities or high transaction costs. A negative chain externality is a cost incurred by a participant in the value chain that is imposed on a third party who is not directly engaged in producing, trading in or consuming the good causing the cost, but this participant does not compensate the third party. A positive chain externality is a benefit received by a third party who is not directly engaged in producing, trading in or consuming the good providing the benefit, but this third party does not compensate the participant in the value chain who provides the benefit.

4. Externalities in Meat Value Chains and Systems

4.1 Concept of Externalities

The concept of externalities, based on the principles of welfare economics, is usually described using two levels of interest: private and social (Gans et al. 2012, Hubbard et al. 2012). We use four levels of aggregation. The first level we add is the value chain (broadly defined) as an intermediate level between private welfare and social welfare considerations. We add a fourth level by distinguishing between social welfare at the national and global levels. Germane to this approach is recognition that different groups of people have different welfare concerns, and spillovers typically occur between these groups. Our analysis is particularly concerned with spillovers from actions within the meat value chain under study to society at the national level.

Four types of externalities can exist: positive and negative production and consumption externalities. Examples of each in meat value chains are:

- RD&E within a meat value chain is widely regarded as an important positive production externality.
- Pollution and the exertion of market power are typical examples of a negative production externality in a meat value chain.
- Improved dietary habits from consumption of better-quality meats are an example of a positive consumption externality.
- Any adverse effects of meat consumption on people's nutritional status would be a negative consumption externality.

With the possible exception of market power, all of the above examples are unlikely to be confined to the value chain; they can be expected to have considerable spillover effects in society at large. Given our mandate, we tend to focus on social welfare considerations at the national level.

The following exposition of externalities and their internalisation begins with a situation where activities within the value chain result in no spillovers beyond the chain border and all trade takes place in the domestic economy.[6] We then allow for spillovers and, finally, we allow for the possibility of exports. We use standard welfare economics principles as detailed in texts such as Gans et al. (2012), and Hubbard et al. (2012).

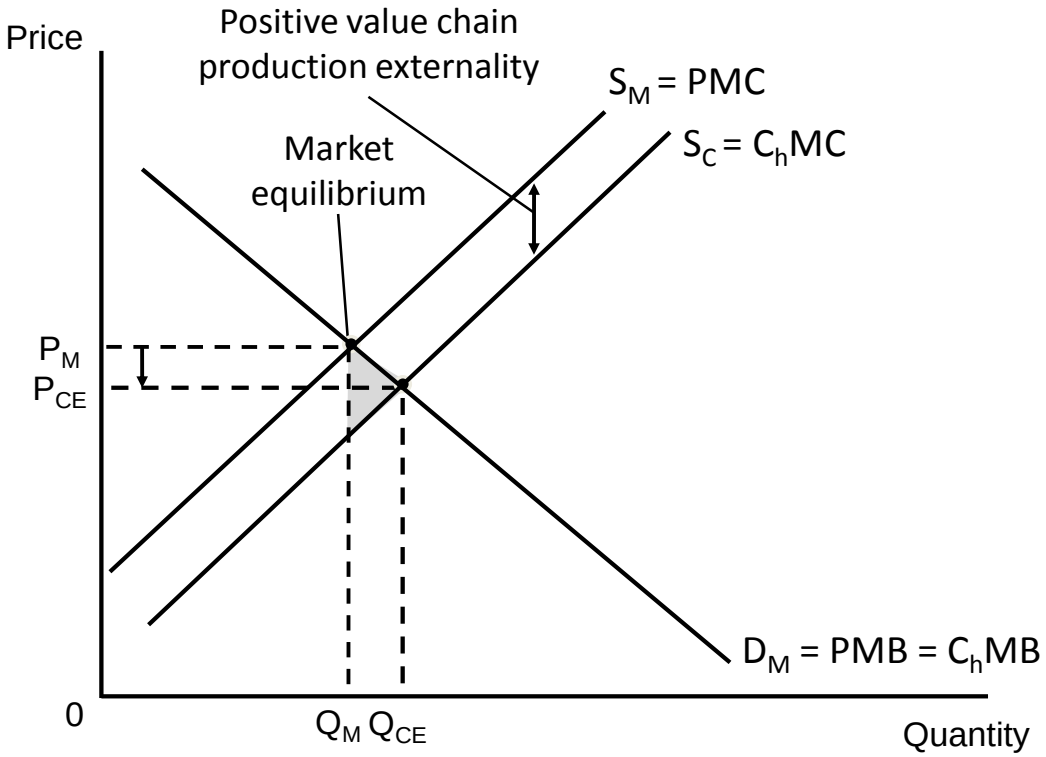
4.2 Externalities in the Domestic Market with No Spillovers

[6] Welfare changes are depicted in the diagrams assuming parallel shifts of linear demand and supply curves.

Figure 2 shows the impact of a positive production externality within a value chain without any spillovers. At market equilibrium, the price of meat is P_M and the quantity consumed is Q_M. The market supply curve (S_M) represents the private marginal cost (PMC) of supplying meat within the value chain. The market demand curve (D_M) represents the willingness to pay for the meat, which determines the value of the marginal benefit to the consumer (PMB) of consuming an additional unit of the meat.

Using RD&E as an example, this position is sub-optimal from the viewpoint of participants in the meat value chain for whom it does not pay individually to invest in RD&E. If participants were to collaborate in order to conduct the RD&E, it would be possible to shift the supply function from S_M to S_C, reducing the cost of an additional unit of product passing through the value chain to P_{CE} and increasing the quantity consumed to Q_{CE}. The RD&E outcome would be to increase the chain surplus by the plain grey-shaded triangle.

Chain surplus gain:

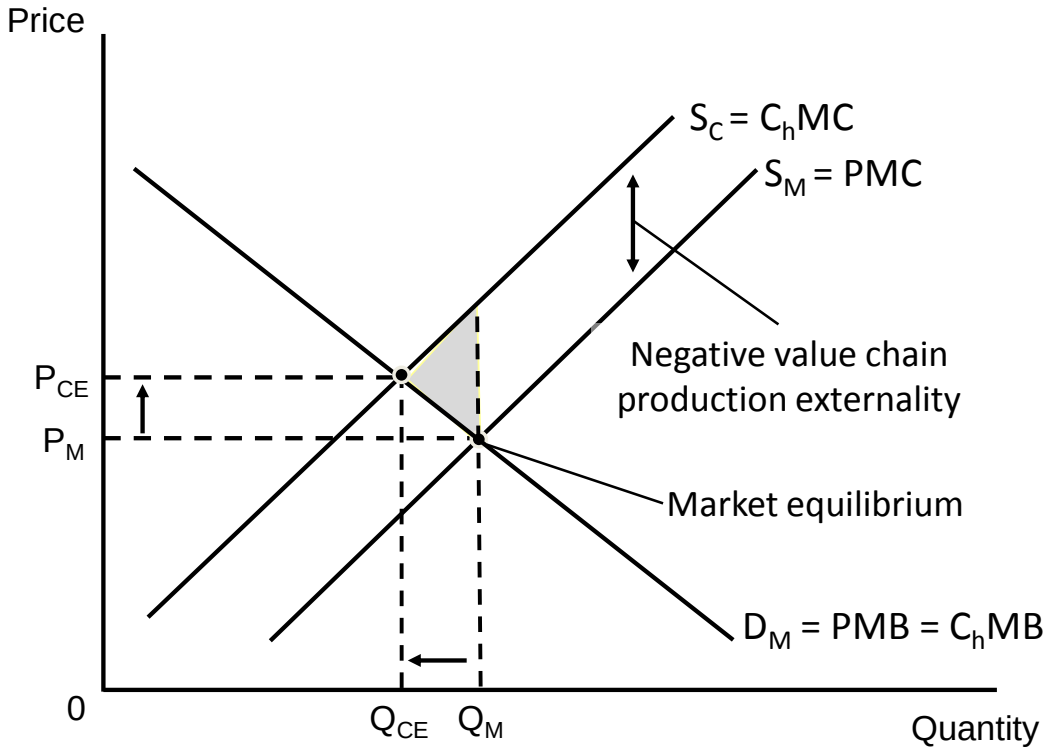


C_hMB: chain marginal benefit C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost

Figure 2. Positive production externality in a meat value chain

The impact of a negative production externality is illustrated in Figure 3. Again, the price of meat is P_M and the quantity consumed is Q_M at the market equilibrium. Using pollution created by value chain activities as an example this time, the market solution is sub-optimal from the viewpoint of participants in the meat value chain for whom it does not pay individually to do something about reducing the amount of pollution. The presence of pollution means that the chain surplus is reduced by the plain grey-shaded triangle. If value chain participants were to collaborate, it would be possible to internalise the negative externality created by pollution by shifting the supply function to the left from S_M to S_C. Quantity consumed would fall to Q_{CE} and the price of an additional product passing through the chain would be increased to P_{CE} to reflect its true value to chain members after accounting for the external cost of the pollution.

Chain surplus loss:

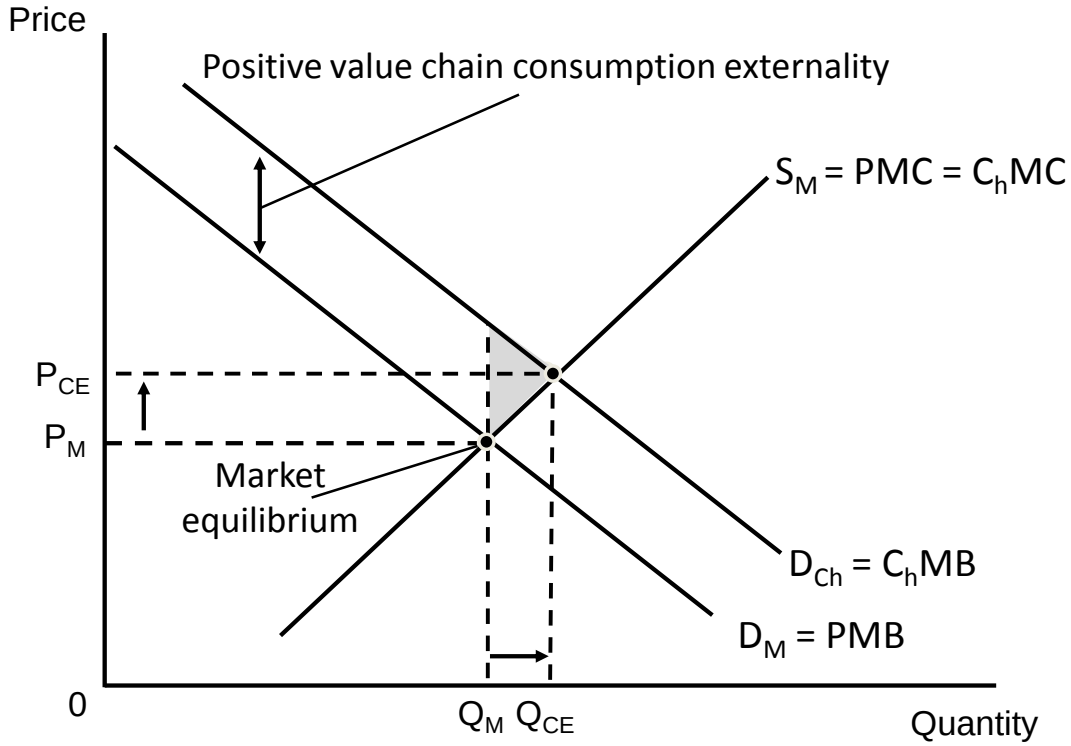


C_hMB: chain marginal benefit C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost

Figure 3. Negative production externality in a meat value chain

A positive consumption externality is represented in Figure 4, to reflect improved dietary habits by meat consumers. Internalising this form of externality at the value chain level requires a shift of the demand function from the market viewpoint of D_M to the demand function from the chain viewpoint of D_{Ch}. The price increases from P_M to P_{CE} to reflect the positive externality of improved diets. The increase in chain surplus would be the plain grey-shaded triangle, which may be achieved by chain participants collaborating to exploit the externality, engaging Australian consumers in the quest to improve their nutritional status.

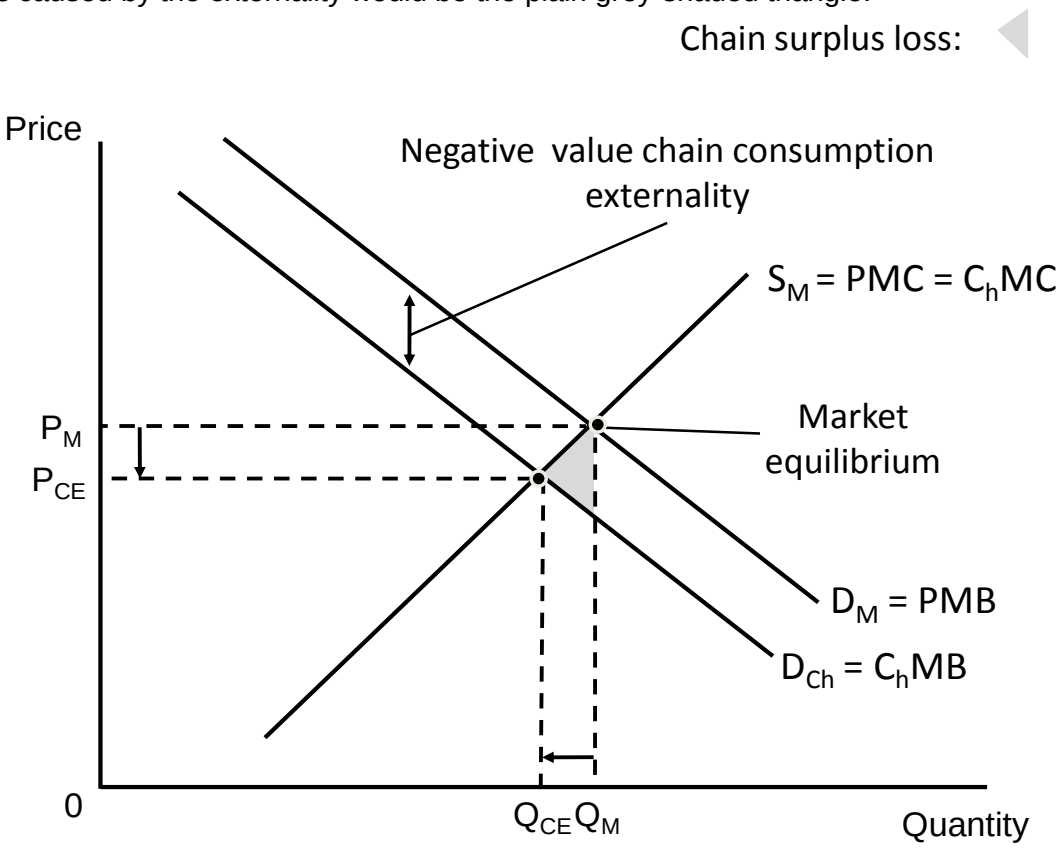
Chain surplus gain:



C_hMB: chain marginal benefit C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost

Figure 4. Positive consumption externality in a meat value chain

Finally, a negative consumption externality in a meat value chain is shown in Figure 5. This form of externality is rare although food wastage is emerging as a major environmental issue. In Australia, Foodwise (2013) estimated that Australians waste about 4 million tonnes of food each year and the average Australian household annually discards $1036 worth of food, representing up to 20 per cent of food purchased. Internalising it at the value chain level requires a shift of the demand function from D_M to D_{Ch}, where the aim is to reduce its extent. The reduction in chain surplus caused by the externality would be the plain grey-shaded triangle.



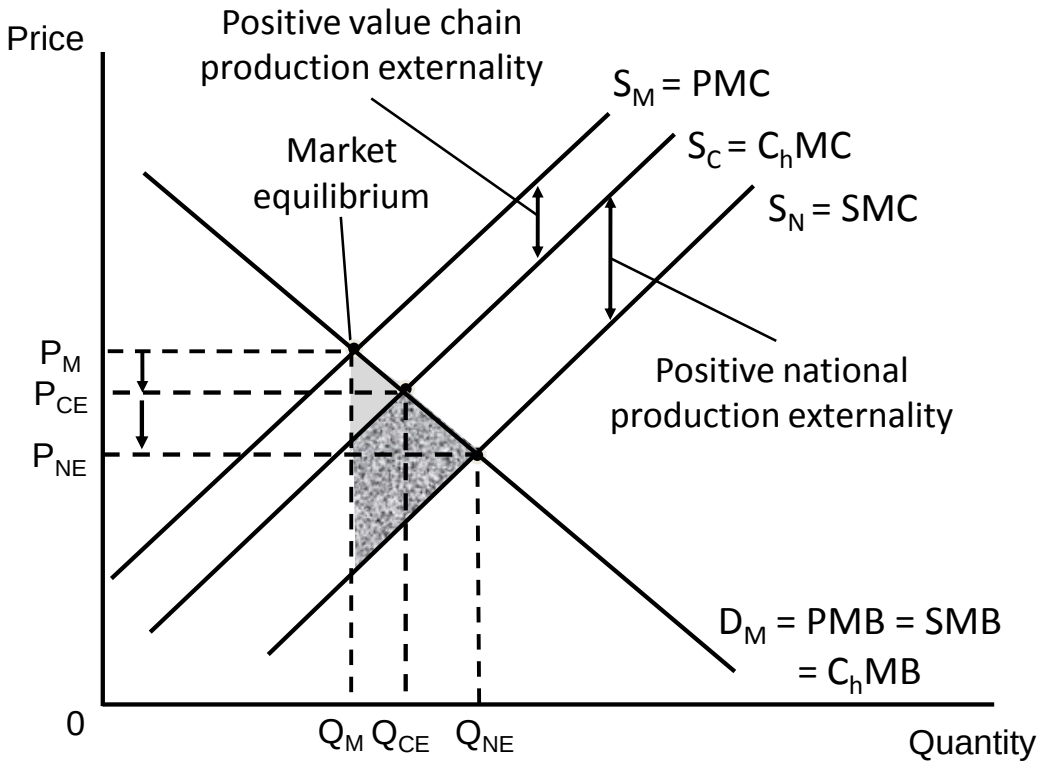
C_hMB: chain marginal benefit C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost

Figure 5. Negative consumption externality in a meat value chain

4.3 Externalities in the Domestic Market with Spillovers[7]

Figure 6 shows the impact of a positive production externality with domestic spillovers, building on Figure 2. At the value chain equilibrium, the price of meat is P_{CE} and the quantity consumed is Q_{CE}. Continuing with the RD&E example, this position is sub-optimal from the viewpoint of society as a whole given that it does not pay participants in the meat value chain individually to invest in RD&E for the purpose of providing welfare gains to people outside the chain. If participants were to collaborate in order to conduct the RD&E as in Figure 2 but extending their RD&E activities to benefit these people, shifting the supply function from S_C to S_N, the many potential beneficiaries beyond the value chain would benefit as well as the chain participants. Expanding RD&E to this level would need public finance to make it profitable. The socially optimal meat price and quantity from a national viewpoint would be P_{NE} and Q_{NE}, respectively. People outside the meat value chain would benefit by the granite grey-shaded trapezium and society as a whole would better off by the triangle that is the sum of the plain and granite grey-shaded areas.

Chain surplus gain: Ex-chain welfare gain: National welfare gain: plus



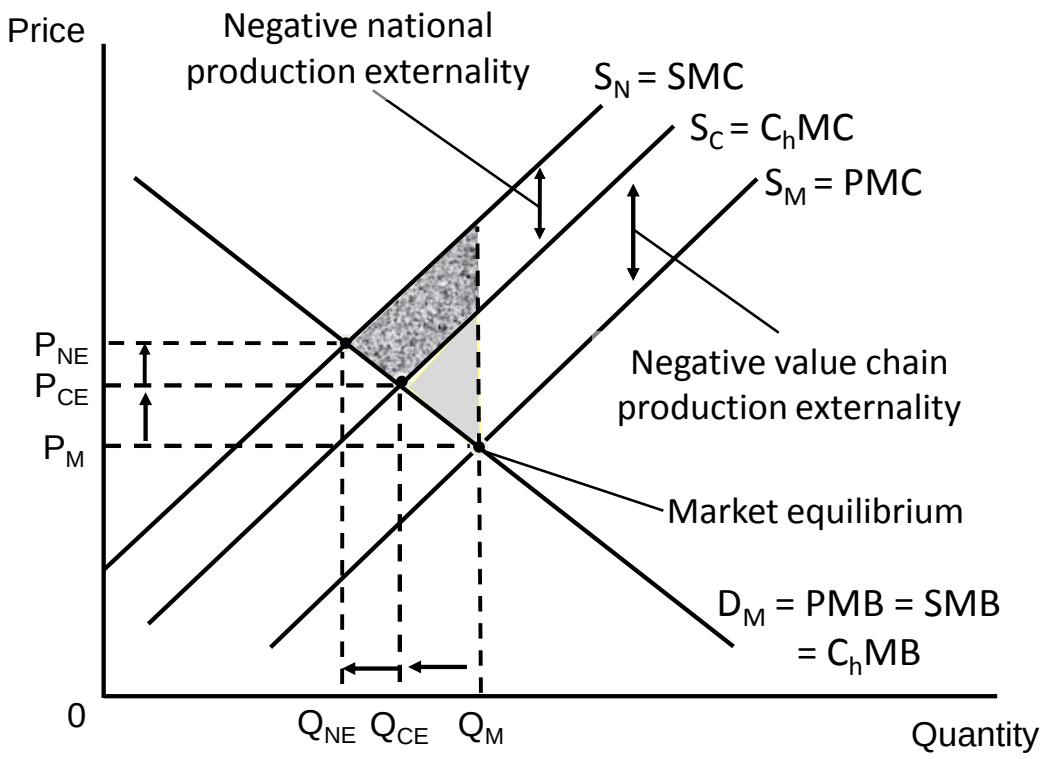
C_hMB: chain marginal benefit
C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost SMB: social marginal benefit SMC: social marginal cost

Figure 6. Positive production externality in a meat value chain with domestic spillovers

[7] Swann (2003, p. 340) made the sobering observation that "knowledge of spillovers *ex ante* (and even *ex post*) is highly incomplete". This observation needs to be kept in mind when undertaking analyses that include spillovers.

The impact of a negative production externality with domestic spillovers is illustrated in Figure 7, continuing with the example of pollution in the meat value chain used in Figure 3. In addition to the impact of pollution on value chain participants, there would also be many potential beneficiaries from pollution reduction beyond the value chain, as indicated by the shift of the supply function to S_N. The socially optimal meat price and quantity from a national viewpoint would be P_{NE} and Q_{NE}, respectively, which could be reached through government intervention at the local, state or national level using public finance to internalise the production externality with its ramifications beyond the value chain. This action would lead to a welfare gain measured by the granite grey-shaded trapezium. The national welfare gain from pollution reduction would be the triangle that is the sum of the chain and ex-chain welfare losses that would prevail were this action not to take place.

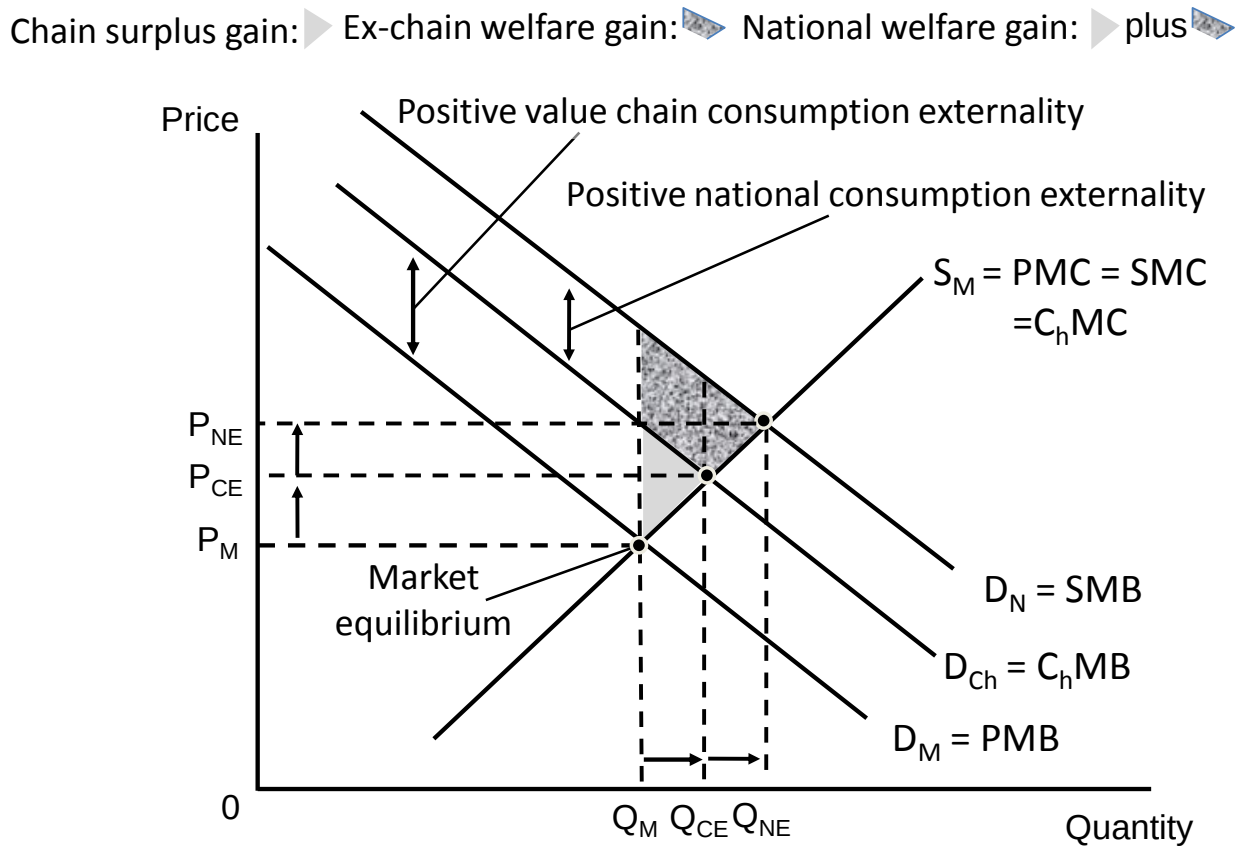
Chain surplus loss: Ex-chain welfare loss: National welfare loss: plus



C_hMB: chain marginal benefit
C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost SMB: social marginal benefit SMC: social marginal cost

Figure 7. Negative production externality in a meat value chain with domestic spillovers

A positive consumption externality assuming the presence of spillovers beyond the meat value chain is represented in Figure 8. Internalising this form of externality at the value chain and national levels requires a shift of the demand function from D_{Ch} to D_N, at a higher new equilibrium price of P_{NE}. The welfare gain to people outside the value chain would be the granite grey-shaded trapezium. The national welfare gain would be the sum of these two areas if full internalisation were to be achieved. Bringing about the welfare gain to people outside the value chain would again require some form of government intervention.

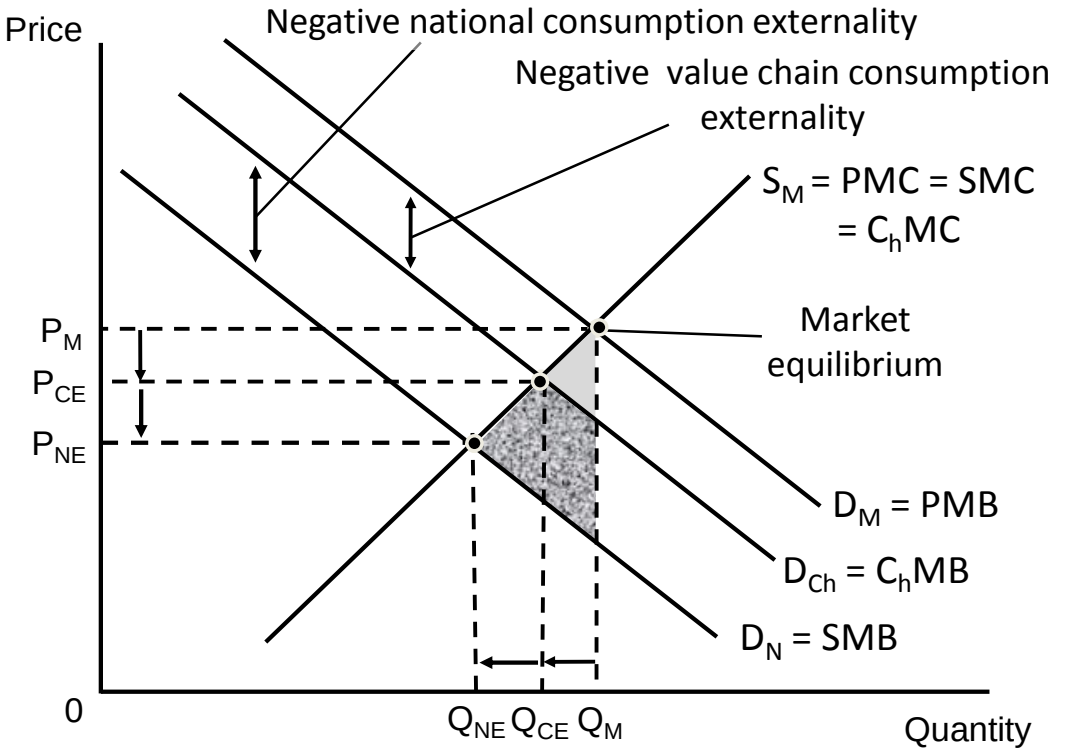


C_hMB: chain marginal benefit
C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost SMB: social marginal benefit SMC: social marginal cost

Figure 8. Positive consumption externality in a meat value chain with domestic spillovers

A negative consumption externality in a meat value chain with domestic spillovers is shown in Figure 9. The welfare loss to people outside the value chain caused by the externality is the granite grey-shaded trapezium and the national welfare loss is the sum of the plain grey-shaded and granite grey-shaded areas. Internalising the externality at the national level requires a shift down the supply function from its intersection with the chain demand function, D_{Ch}, to its intersection with the national demand function, D_N, at a lower new equilibrium price, P_{NE}. Reducing the welfare loss to people outside the value chain would require government intervention and funding, leaving chain participants to collaborate to avoid the loss of any chain surplus caused by the externality (the plain grey-shaded area).

Chain surplus loss: Ex-chain welfare loss: Global welfare loss: plus



C_hMB: chain marginal benefit
C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost SMB: social marginal benefit SMC: social marginal cost

Figure 9. Negative consumption externality in a meat value chain with domestic spillovers

As a contemporary example of this, Smith et al. (2011, 239) state categorically that "…it is becoming increasingly apparent that certain industrial-scale food processing technologies are, in part, responsible for the modern epidemic of diet-related chronic disease." They argue that this situation is a result of a market failure due to asymmetric information, and that an appropriate policy response is verifiable quality standards. A verifiable quality standard is a chain good that enables the negative externality to be reduced.

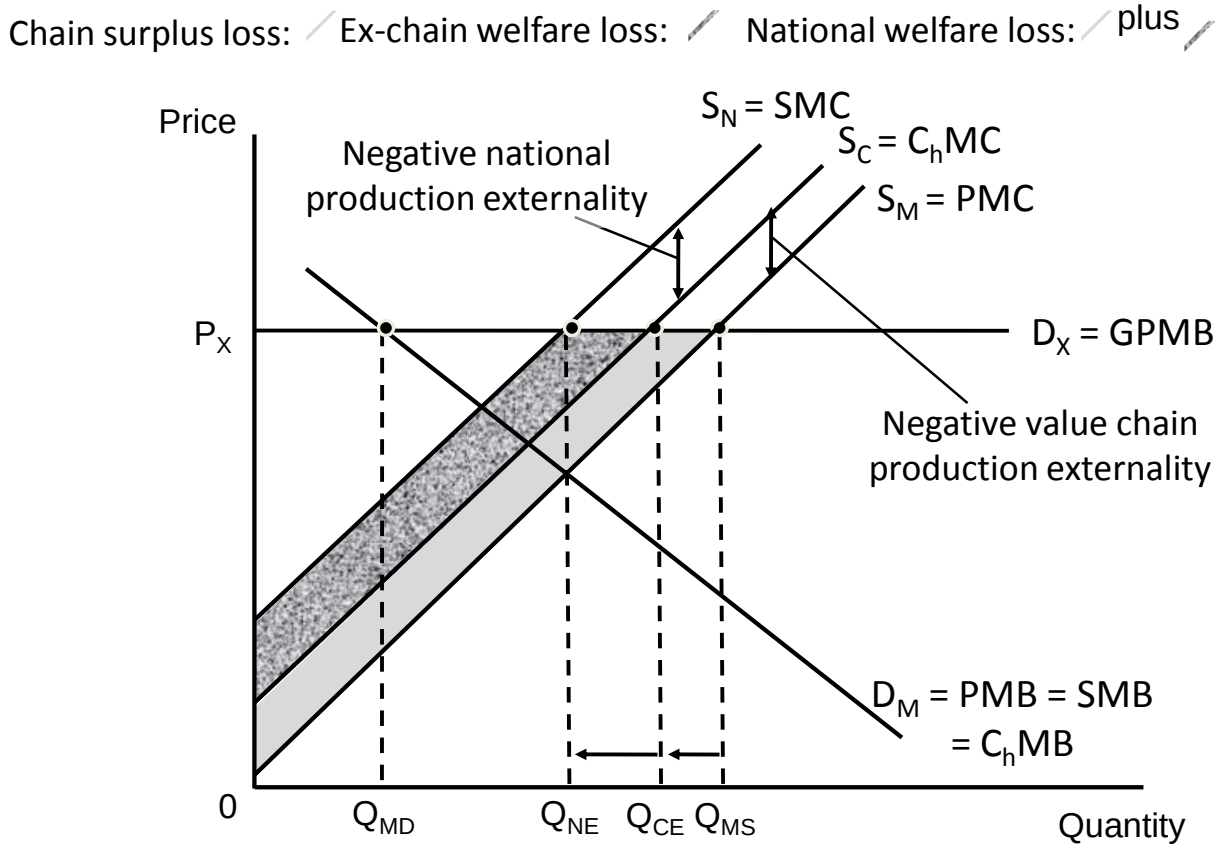
4.4 Externalities in the Export and Domestic Markets with Spillovers

The market situation facing a number of Australian meat producers and marketers is one in which a sizeable proportion of output is exported. We now alter the diagrams in Figures 6 to 9 for this situation, assuming perfectly price-elastic demand for meat exports.

Figure 10 shows the impact of a positive production externality in a situation in which there are domestic spillovers and an export market of $Q_{MS} – Q_{MD}$. The price of meat (P_X) is set by the export demand function, D_X, and $0Q_{MD}$ is consumed domestically. This position is sub-optimal from the viewpoint of Australian society as a whole given that it does not pay participants in the meat value chain individually to invest in the positive externality (assume it is RD&E once more). If participants were to collaborate in order to conduct the RD&E, shifting the supply function from S_M to S_N, the potential beneficiaries within and beyond the value chain would benefit. The nationally optimal meat price and quantity produced would now be P_X and Q_{NE}, respectively. Note that in this situation the price does not change when taking the externalities into account. Value chain participants would benefit by the plain grey-shaded trapezium. Were RD&E to be expanded with the help of public finance to exploit national benefits, people outside the meat value chain would benefit by the granite grey-shaded trapezium and society as a whole would better off by the trapezium that is the sum of the two areas. Exports would be increased from $Q_{MS} – Q_{MD}$ to $Q_{NE} – Q_{MD}$ as a result of this action.

Figure 10. Positive production externality in an export-oriented meat value chain with domestic spillovers

The impact of a negative production externality with domestic spillovers in an export-oriented meat industry is presented in Figure 11. Continuing with the example of pollution in the meat value chain, the industry supply curve after accounting for pollution is S_C and the national supply curve after accounting for spillover effects is S_N, as in Figure 7. The chain surplus loss as a result of the pollution is the plain grey-shaded trapezium and the corresponding ex-chain loss is the granite grey-shaded trapezium. The nationally optimal meat price and quantity would be P_X (the export price) and Q_{NE}, respectively, which as in Figure 7 could be reached through government intervention to internalise the production externality beyond the value chain. The national welfare gain from pollution reduction would be the trapezium that is the sum of the chain and ex-chain welfare losses that would prevail without this action taking place. Exports would be reduced from $Q_{MS} – Q_{MD}$ to $Q_{NE} – Q_{MD}$ as a result of fully internalising the externality.

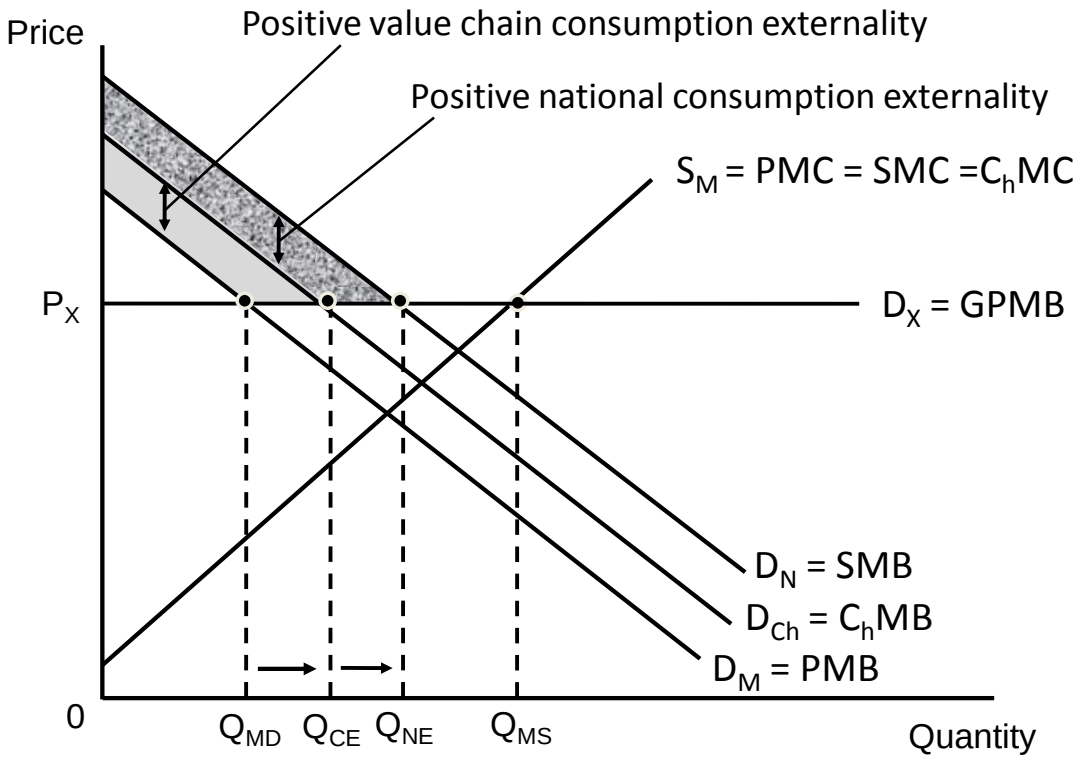


C_hMB: chain marginal benefit GPMB: global private marginal benefit
C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost SMB: social marginal benefit SMC: social marginal cost

Figure 11. Negative production externality in an export-oriented meat value chain with domestic spillovers

The most striking feature of a positive consumption externality in an export-oriented meat value chain in the presence of spillovers, represented in Figure 12, is that all welfare gains are in the form of consumer surplus. Internalising this form of externality at the value chain and national levels requires a shift of the demand function from D_M to D_{Ch}, thereby increasing chain surplus by the plain grey-shaded trapezium, and then to D_N with spillovers, increasing the ex-chain consumer surplus by the granite grey-shaded trapezium. The national welfare gain would be the sum of these two areas if full internalisation were to be achieved. It would induce the redirection of some exports ($Q_{NE} – Q_{MD}$) onto the domestic market.

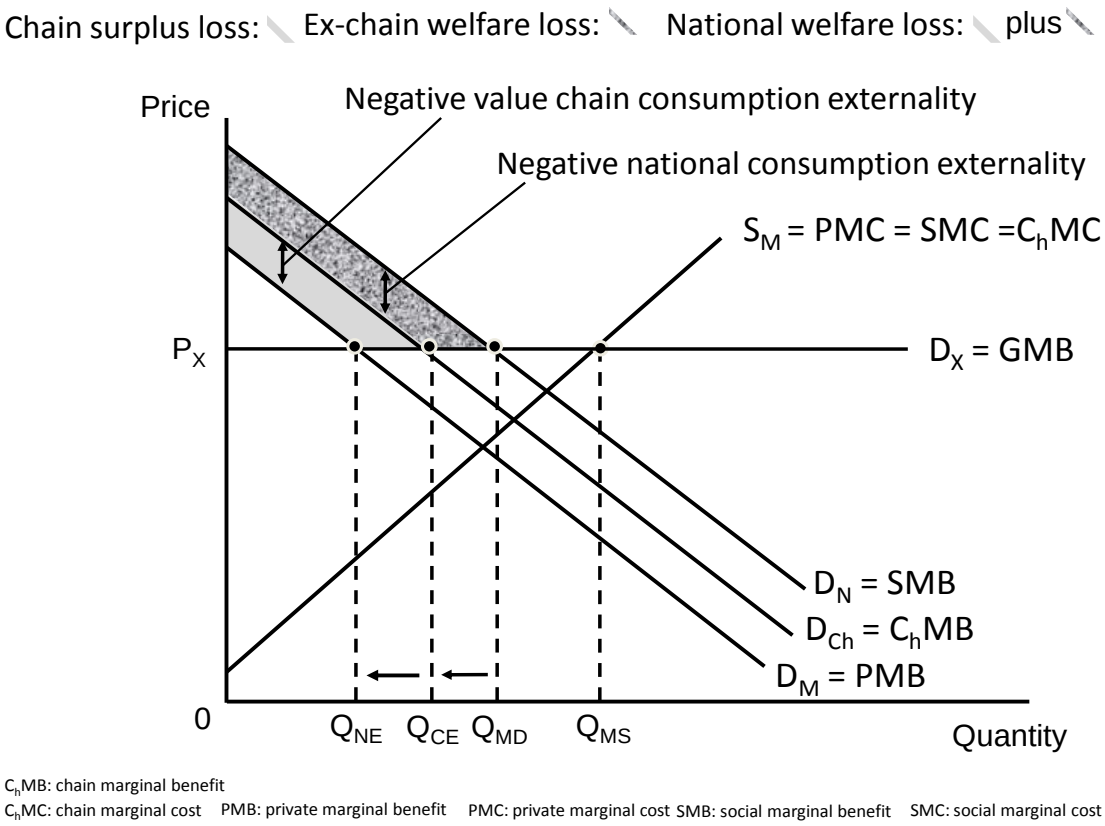
Chain surplus gain: Ex-chain welfare gain: National welfare gain: plus



C_hMB: chain marginal benefit GPMB: global private marginal benefit
C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost SMB: social marginal benefit SMC: social marginal cost

Figure 12. Positive consumption externality in an export-oriented meat value chain with domestic spillovers

The opposite situation to the impact of a positive national consumption externality, shown in Figure 12, occurs for the impact of a negative consumption externality, shown in Figure 13. Consumers suffer a welfare loss, of which part, the plain grey-shaded trapezium, affects meat consumers and part, the granite grey-shaded trapezium, affects consumers outside the chain through spillover effects. If this externality were to be internalised, domestic consumption would be reduced to Q_{ND}. This would result in a diversion of meat output onto the world market (Q_{MD} – Q_{NE}), assuming that the externality identified in the domestic market is not internalised globally.



C_hMB: chain marginal benefit
C_hMC: chain marginal cost PMB: private marginal benefit PMC: private marginal cost SMB: social marginal benefit SMC: social marginal cost

Figure 13. Negative consumption externality in an export-oriented meat value chain with domestic spillovers

Finally, Figure 14 represents a situation where a positive global consumption externality shifts the export demand function upwards from the market function to a demand function incorporating the externality at price P_{XG}. Internalising this externality has benefits to chain participants, but part of this benefit is a transfer from domestic consumers as exports are expanded from $Q_{MS} – Q_{MD}$ to $Q_{NS} – Q_{NE}$.

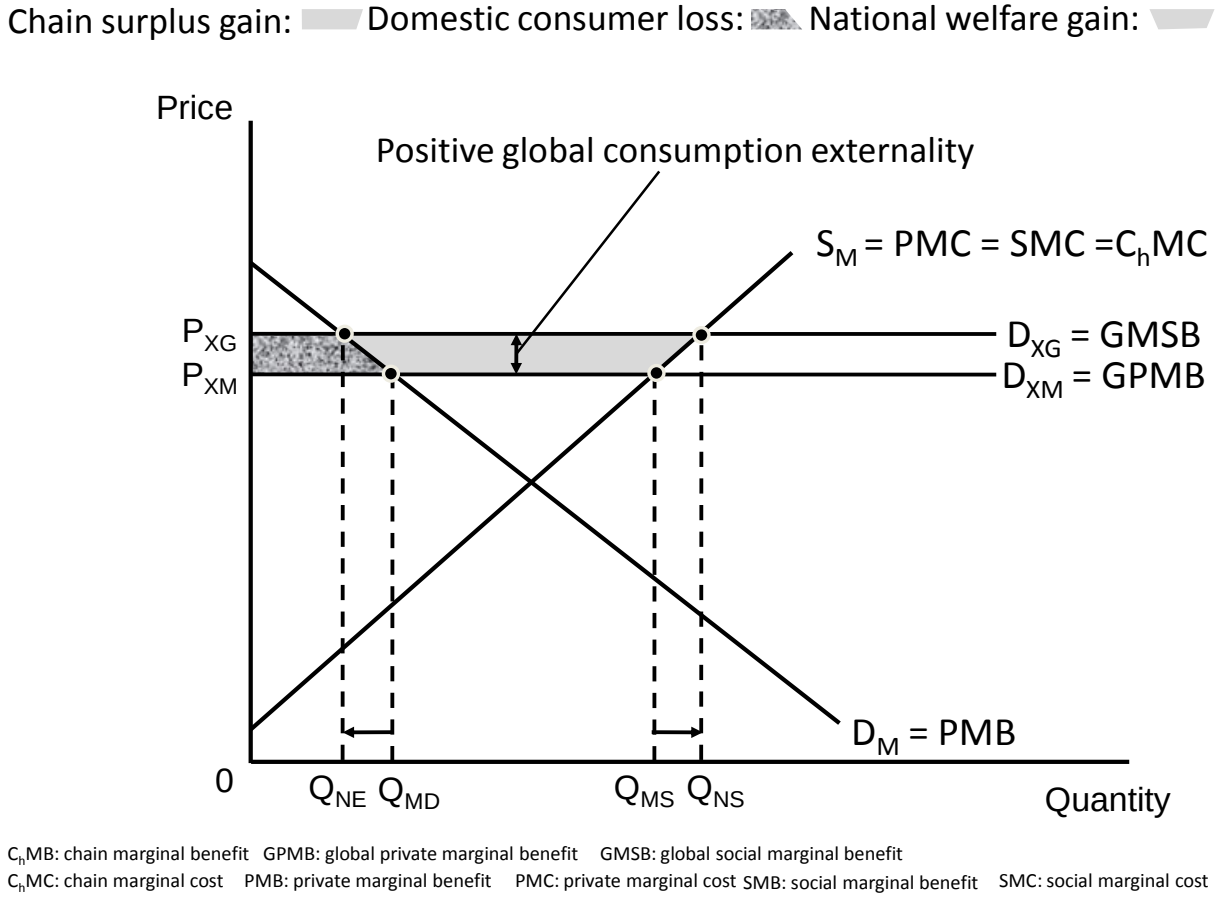


Figure 14. Positive global consumption externality in an export-oriented meat value chain with domestic spillovers

4.5 Other Literature that May Assist with Application of these Concepts

Local Collective Failure

Some common themes exist in the literature on clusters[8] and value chains that we discuss in detail in Appendix 2. In order to develop a full set of analytical tools on market failure at different levels of aggregation, it is worth defining failure at a local as well as chain level to provide a

[8] The term, cluster, is often used in a general or non-spatial sense, which differs from what we regard as a cluster. For example, Perkins (2013) referred to government funding of RD&E in the beef industry in Canada, called the "beef cattle industry science cluster", that resembles an Australian CRC rather than a spatially defined cluster. We follow the definition of clusters used by the Institute for Strategy and Competitiveness (2013) as "*geographic concentrations* of interconnected companies, specialised suppliers, service providers, and associated institutions in a particular field that are present in a nation or region" [emphasis added].

clear separation between its sources and remedy in different domains. Locality is defined in space by the boundary around some disaggregated level of the national economy such as region, district, city, town or village, more broadly local government areas (LGAs). The local economy at this level is subject to two main forms of failure in the guise of "local public goods" and "local club goods". The former affect all the population of an LGA whereas the latter affect a specific group of the local population.

"Joint action", to use the terminology of Schmitz (1999), is used to produce and provide these goods, notably from the exploitation of agglomeration economies[9] associated with proximity. Grant et al. (2013) argued that the distinctiveness of local public goods and the advantages that can be derived from their production and provision have echoes of Porter's (1998) cluster model, but there are many problems with applying the concepts in practice. Despite this, there is much in the cluster literature that assists in an understanding of, and is consistent with, the concepts of chain failure, chain externalities and chain goods. Four potential areas for enhancing the analysis of value chains by accessing this literature are listed in Appendix 2:

1. Defining the boundary between chain failure and local collective failure
2. Improving joint action among parties interested in overcoming chain failure
3. Augmenting the processes of knowledge creation and application in value chains
4. Improving the governance of value chains.

In relation to joint action, Schmitz (1999, p. 477) asserts that "It is hard to build economic theory with joint actors", but we disagree if the nature and causes of chain failure are properly diagnosed. But we do agree with his statement that game theory can aid understanding of the conditions under which joint action would be worthwhile. The literature and empirical examples that Schmitz cites have the hallmark of the sorts of intervention within the value chain that we have in mind. One area of particular interest in respect of joint action to produce chain goods and internalise positive chain externalities is in the development of the concept of "collective efficiency".

The nature of cooperation within the value chain is important to implement remedies to chain failure. Antonelli (2010, p. 5) observed that "the generative potential of a relationship depends upon the 'aligned directedness' of the agents – whether they are all interested in operating in the same region (or in neighboring regions) of agent-artifact space [or, in our case, cooperating in a value chain]; and their 'mutual directedness' – whether the agents are interested in interacting with each other". Later we discuss horizontal and vertical strategic alliances as ways of cooperating in value chains.

Collaborative Environmental Governance

Another field of research that provides useful hints as to how to govern a value chain is collaborative environmental governance. This is reviewed in Appendix 3. Concern about managing local ecosystem services in value chains has arisen relatively recently. Here again, there is a need to govern the interdependent activities of an otherwise legally independent set of actors. Costanza (2008, p. 351) used a classification system of five groups of ecosystem services, one of which he called "local proximal" services that depend on proximity. Examples include the regulation of disturbance, storm protection, habitat protection, pollination, biological

[9] We define agglomeration economies as increases in the total factor productivity of a firm that are brought about by the concentration of economic activity in a specific location or a defined geographical region. Agglomeration economies may be internal or external to a firm, with the implication that internal agglomeration economies can be fully captured by the firm and require no joint action.

control and waste treatment. Some of these services assume considerable importance in meat value chains.

Marshall (2001, pp. v-vi) is a good source of much of the material on this form of collaboration.

Negative Externalities and Sustainability in Food Value Chains

There is a huge literature on sustainability in food value chains, especially as it relates to negative externalities such as poor environmental and public health outcomes. Some of this is reviewed in Appendix 4, but see in particular Fearne (2009) and Fearne et al. (2009).

Chopra and Meindl (2013) acknowledged that the health and survival of each value chain ultimately depends on the health of the surrounding world, highlighting the importance to expand the goals of a value chain beyond the interests of its participants to others who may be affected by their decisions. According to Chopra and Meindl (2013), three factors have forced a sustainability focus on managing value chains: (a) reducing risk and improving financial performance; (b) attracting customers who value sustainability; and (c) making the world more sustainable.

Sustainability has presented a greater challenge when it requires efforts that do not provide obvious returns on investments because customers of value chains have not always backed up words about the importance of sustainability with a willingness to pay more for sustainable products (Chopra and Meindl 2013). One of the biggest challenges in building sustainable value chains is that benefits may be shared but costs may be local to a firm, creating sustainability as a chain good[10]. Alternatively, the status quo might provide benefits from the sale of goods that are local to firms in the value chain but costs that are national or global, creating a negative externality.

Regulations differ among countries in attempts to internalise negative externalities. Firms in value chains in Australia face the challenge of competing against other firms and chains that may not incur the same costs as part of this internalisation. Unless all consumers change their mindset, it is difficult to imagine a sustainable solution without some form of government intervention (Chopra and Meindl 2013).

Sustainability and the value chain drivers

Opportunities to make meat value chains more sustainable can be grasped from specific analyses of each of the value chain drivers. Chopra and Meindl (2013) considered the impacts on sustainability of the six value chain drivers that they identified. The first driver they considered was facilities, which tend to be significant consumers of energy and water, and emitters of waste and greenhouse gases and consequently offer significant opportunities for profitable environmental improvement. Chopra and Meindl (2013) recommended that firms should start by separating investment opportunities into those that generate positive cash flows and those that generate negative cash flows. Production and processing facilities often have significant opportunity to reuse heat energy generated and reduce water usage during the process.

[10] We regard “sustainability” as a chain good rather than a positive externality because it is a notion for which no market exists.

Second, Chopra and Meindl (2013) observed that inventory sitting in a landfill may not appear in a firm's balance sheet, but it damages sustainability. Materials and energy sitting in a landfill are lost forever and potentially cause harm. The goal of a value chain should be to track its landfill inventory and separate it in terms of harmful additives and unused value. Life cycle assessment can be used to assess the environmental impacts of a product's life from cradle to grave, to remove harmful inventory and unlock the unused value in products when they are discarded. This category could be expanded to consider food wastage.

Third, transportation was identified by Chopra and Meindl (2013) as another value chain driver in which there are potential positive cash flow opportunities through the adoption of sustainable activities. This is especially so for meat products where producers are widespread and frequently located far from the meat consumers. A value chain design innovation that lowers transportation costs also tends to reduce emissions and waste generated from transportation. Product design can also play a substantial role in reducing transportation cost and emissions by reducing packaging and enabling greater density during transportation.

Fourth, for most firms engaging in procurement, energy use, water use, waste and emissions occur in the value chain outside their own enterprise. Chopra and Meindl (2013) recommended that these firms need to link up with other firms from whom they procure goods to improve the sustainability performance of the whole chain. Verifying and tracking supplier performance is a major challenge, especially in global and fragmented chains. This frequently creates a situation where sustainability takes on the characteristics of both a chain good and a public good.

Fifth, good information continues to be one of the biggest challenges to improve value chain sustainability. The absence of measurement and reporting standards has led to claims that are often not verifiable according to Chopra and Meindl (2013) who observed that, in the short term, firm-specific or private standards have emerged and certifications and certifying agencies have proliferated. Firms talk of working towards a common set of standards, but it is unlikely that such standards will emerge unless incentives are aligned across different firms. Even though universal standards may not be possible, Chopra and Meindl (2013) believe that it should be possible to apply the Coase theorem through the use of consistent scorecards within a value chain to align the sustainability efforts of all members of the chain. In this way, a chain good can be largely internalised provided chain participants agree on a procedure and provide the resources for measurement. It is a significant challenge to be taken up in meat value chains in Australia.

Finally, in respect of pricing, Chopra and Meindl (2013) identified consumption visibility and differential pricing by load or time of day as having the potential to make a significant difference in energy usage by consumers. They contended that if this visibility is simultaneously coupled with lower-price off-peak electricity, there is a potential to reduce peak load demand. One of the biggest challenges to improved sustainability of a value chain is changing customers' willingness to pay for a product that is produced and distributed by a value chain in a more sustained manner but which ends up costing more.

4.6 Achieving Economically Efficient Levels of Negative and Positive Externalities in Meat Value Chains

The economically efficient level of a negative externality in a meat value chain is not zero; neither is this usually possible. The optimal decision is to continue an activity to the point where the marginal benefit from reducing the negative externality from that activity is equal to its cost. As the externality is further reduced, the additional benefits become smaller and the additional costs of reducing it become greater. This concept also applies to the provision of a positive externality, which will have its benefits and costs.

The imposition of taxes and subsidies by a value chain governor can bring about an efficient level of throughput in a value chain in the presence of externalities. Taxes are typically used to reduce a negative externality while subsidies are used to internalise a positive externality. A tax that is equal to an external cost can be placed on chain throughput to internalise the negative externality. In principle, at least, it does not matters at which level in the chain the tax is imposed because how much of the tax is borne by participants at each stage is a function of the price elasticities of demand and supply, which dictate the pass-through ratio of the tax from one stage in the chain to the next. However, this incidence may have no bearing on how the benefits from internalisation are distributed across the chain.

A subsidy to producers, consumers or other participants in the chain that is equal to the value of the positive externality can be provided to encourage the provision of goods reflecting that externality. In parallel to a tax, the benefits of a subsidy are distributed across stages in the chain according to the price elasticities of demand and supply. Again, this incidence may have no bearing on how the benefits from internalisation are distributed across the chain.

For a negative externality, setting the marginal cost of reducing it to equal to the marginal benefit from its internalisation is shown in Figure 15(a). For a positive externality, setting the marginal cost of producing it equal to the marginal benefit from its internalisation is shown in Figure 15(b).

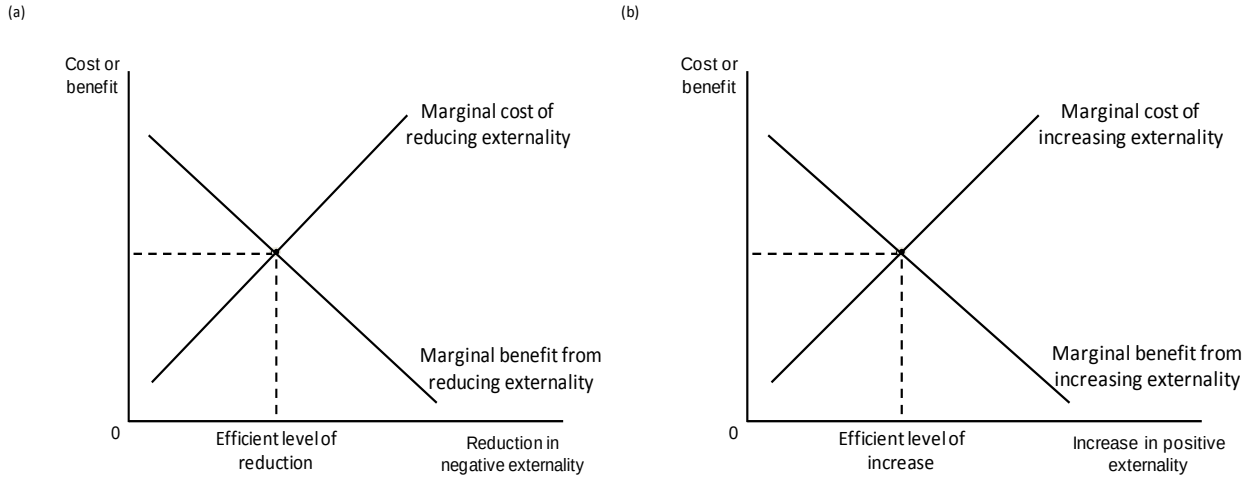


Figure 15. Costs and benefits of internalising chain externalities

Examples of internalising a chain externality are:

- Use of export inspection services to internalise a negative externality caused by an exporter selling low-quality meat products in the world market that damage the reputation of an Australian meat product
- Managing disease problems at a stage in a meat value chain by introducing disease control regulations

- Investing in RD&E processes to internalise a positive externality where quality advances at one stage provide benefits to others in the chain.

The more tightly circumscribed are such externalities, the more likely it is that a solution can be found without the need for government intervention. Applying the Coase theorem, private solutions to the problem of externalities can be found in some circumstances through joint action within the value chain. Solutions obtained from applying the Coase theorem are likely to be more feasible within value chains than in society at large because of the shared interest of members in making the chain work better. There needs to be an economically efficient level of adjustment of an activity causing an externality that members of the value chain can agree to.

Three limitations of applying the Coase theorem in a value chain are:

1. A large number of chain members involved in bargaining makes the process unwieldy and consensus more difficult to achieve.
2. Unreasonable demands may be made by chain members, especially those with market power.
3. All chain members must have full information about the costs and benefits of taking action to internalise the externality.

4.7 Summary

A theoretical framework is proposed where positive and negative chain externalities, generated from both production and consumption, are analysed graphically in the context of a meat market with domestic and export sectors and the possibility of spillovers to the global market. Welfare benefits and losses to chain participants, to market participants outside the value chain and to national welfare are able to be defined. A number of related literatures (the local government literature, the environmental governance literature, the sustainability literature) are then reviewed that provide concepts closely aligned to or compatible with our concepts of chain failure, chain goods and chain externalities. Finally, we discuss whether there is ever any justification for fully removing a negative chain externality or fully implementing a positive chain externality. The answer is no. The optimal decision is to continue an activity to the point where the marginal benefit from reducing the negative externality (or providing the positive externality) from that activity is equal to its cost. The imposition of taxes and subsidies by a value chain governor can bring about an efficient level of throughput in a value chain in the presence of externalities. Taxes are typically used to reduce a negative externality while subsidies are used to internalise a positive externality. The more tightly circumscribed are such externalities, the more likely it is that a solution can be found without the need for government intervention. Applying the Coase theorem, private solutions to the problem of externalities can be found in some circumstances through joint action within the value chain. Solutions obtained from applying the Coase theorem are likely to be more feasible within value chains than in society at large because of the shared interest of members in making the chain work better.

PART II: CASE STUDIES

5. Meat Standards Australia as a Chain Good

5.1 Is MSA a Chain Good?

Meat Standards Australia (MSA) is a voluntary grading system designed to predict beef eating quality that was introduced in the domestic market in Australia in 1999/2000 (Griffith et al. 2010). The MSA grades are based on the taste panel responses of untrained consumers (Griffith and Thompson 2012) while the system itself uses a "total management approach", from animal genetics through to cooking method (Polkinghorne et al. 1998, Thompson 2002).

The rationale for investing in the original RD&E that underpinned the MSA model was that beef consumers in Australia in the early 1990s were turning away from beef because they could not be guaranteed the same eating quality experience they were willing to pay for, each time they purchased beef. Eating quality was subjective and based on vague notions of breed, age and feeding regime, and there was no relationship between consumer preferences, willingness to pay, and the offered quality differentials. Ways of classifying carcases and therefore ways of describing quality varied across suppliers. Brands were little used at the retail level. There was no objective, uniform system to provide the guarantee that consumers wanted.

Is the MSA grading system a chain good? Let us return to some of the discussion in Section 3. Chain failure occurs when a value chain fails to maximise chain surplus because it supplies a suboptimal level of throughput and value (Griffith et al. 2012). An economically efficient value chain, where chain economic surplus is at a maximum, is one in which no one chain participant can be made better off without another participant being made potentially worse off. The degree to which chain economic surplus is not at its maximum shows the extent of chain failure.

As pointed out by Griffith et al. (2009), Doljanin (2012) and Griffith and Thompson (2012), the value of the MSA scheme is derived at the retail level where consumers are willing to pay premiums for beef cuts that are guaranteed tender (MSA-graded beef) in contrast to ungraded beef marketed through the conventional grid system where minimal inducements are offered for eating quality improvements. The feedback on carcass quality received by registered producers combined with adherence to MSA standards facilitates product consistency in both production and consumption.

Here we are taking about the whole fresh beef value system, and we can say that in the early 1990s there was a clear case of system failure. This system failure resulted from both the presence of a chain bad, a poorly functioning beef grading scheme, as well as asymmetric information leading to adverse selection, moral hazard and the principal-agent problem. As well the investment required to undertake the collection of data in the field and in the processing plant of many thousands of animals and the 86,000 consumer taste tests was simply too large to be contemplated by any one firm in the beef value system (that is, the transactions costs were too high).

Thus, a properly designed grading scheme that is based on consumer preferences, and has associated pricing systems that allow consumer willingness to pay for quality to be captured and transmitted to other chain participants, is a perfect example of a chain good.

5.2 Responsiveness in the Australian beef value system: adding value along the chain

We can also apply some of the other discussion about the dimensions of value chains to the generic beef value chain in Australia. For example, factors relating to value chain responsiveness mentioned above are present in the beef value chain in Australia. While the need to meet a high service level occurs in a number of dimensions in the beef value chain, we focus specifically on product quality and the two-way information flow between beef producers and beef consumers.[11]

Point B_1 on PPF_1 in Figure 16(a) represents the optimal throughput under the conventional grid marketing system with negligible recompense for increasing degrees of chain responsiveness.[12] An increased willingness to pay for MSA-graded beef over ungraded beef is depicted as EIC_1, a linear curve reflecting no reduction in demand uncertainty from responsiveness in the conventional system, swivelling to EIC_2, which becomes curved in favour of a responsive approach as beef consumers are willing to pay more for reduced demand uncertainty. Figure 16(a) also illustrates a shift of the frontier from PPF_1 to PPF_2 towards higher levels of responsiveness associated with MSA throughput ($0B_{R1}$ to OB_{R2}) and away from conventional ungraded beef ($0B_{L1}$ to OB_{L2}).

While representing an improvement in the consistency of information and its delivery along the value chain, the MSA system is not by itself an explicit quality enhancement and, at least initially, increased MSA throughput is most likely attributed to increasing MSA compliance rather than greater aggregate domestic consumption of beef. Hence, increased throughput may be due to substitution between MSA-graded beef and non-MSA-graded beef. However, over time the information exchange that MSA provides has the potential to improve beef quality through, for example, changes in on-farm management practices (Griffith and Thompson 2012).

The basic framework of the MSA grading system differs initially only in the eating quality specified between MSA-graded and non-MSA-graded beef. Since its inception, a number of

[11] See Appendix 5 for the microeconomic principles underlying the optimal combination of responsiveness and low cost in determining strategic fit in a value chain.

[12] Quality needs to be incorporated in the exposition of the MSA and "paddock to plate" examples by changing the axes from volume measures to value measures. Using Weaver's (2010, p. 60) definition of production as the "production of value" enables us to represent increases in output through quality improvement as upward shifts of the PPF. Changes in product quality characteristics resulting from new technologies have often been modelled as exogenous demand shifts on the premise that consumers will demand more of the product for a given price if the improved quality characteristics are present in the product. Alston, Norton and Pardy (1995, p. 244) cautioned that limited circumstances apply to this demand shift representation, as a change in product quality is a change in supply conditions, originating from the production process, rather than a change in demand conditions and should be modelled as such. Alston et al. (1995, pp. 243-245) conceded that there are a number of difficulties in establishing an objective measurement of quality in output. We simply note that quality measures do not necessarily equate to the extra amount that consumers are willing to pay for a higher-quality product. It will not always follow that the PPF remains asymmetric with this analytical change. But the fact that higher-quality products are often derived from channels in value chains that are associated with niche markets, which do not share the same opportunities to exploit scale economies as mainstream channels, suggests that at least a slight asymmetry would remain.

commercial value-based models that offer significant price differentials across multiple quality grades have been developed around the MSA grading system. A fundamental problem in conventional beef value chains is the existence of network externalities among participants at different levels in the chain (from producers to consumers), resulting in suboptimal levels of information exchange. For example, the provision of feedback on meat yield and quality is often viewed by processors as an administrative overhead, and so the minimum feedback required is usually delivered (Doljanin 2012).

The change in relative prices from EIC_2 to EIC_3 in Figure 16(b) is indicative of higher premiums for the additional responsiveness attributes of the "paddock to plate" system over single MSA-category graded beef. As noted by Doljanin (2012), additional responsiveness is the outcome of information transfer in the value chain facilitated by traceability throughout the processing stages.

A "paddock to plate" beef value chain described by Polkinghorne et al. (2008) was established around information dissemination and value-based pricing. Chain goods associated with information about the product across the value chain were internalised through a system of full traceability of product from producer to consumer, which was underpinned by a crude payment system whereby remuneration to chain participants is based on a fixed percentage of the retail value.

Because of the traceability and record keeping in the "paddock to plate" beef value chain, a value for each primal[13] could be established. The "live" inventory value, yield and eating quality information created the opportunity to optimise the return of primals by choosing how they would be processed on any given day. This traceability facilitated the flexibility necessary for the business to respond to changing consumer demands requiring alternative inventory use, isolating quality assurance breaches and, most importantly, translating value between each participant of the supply chain.

Point B_2 on PPF_2 in Figure 16(b) represents the initial optimal levels of throughput for "paddock to plate" and MSA-graded beef. Now consider how detailed feedback in adopting a "paddock to plate" approach informs farm-level production decisions. Short-term changes include more accurate assessment and management of fat cover while longer-term responses include changes in breeding and management strategies (Polkinghorne et al. 2008). These long-run production responses are reflected in an upward shift in production value from PPF_2 to PPF_3. If consumers are cognisant of improved eating quality consistency, any additional increases in willingness to pay are represented as a rotation of EIC_2 to EIC_3, resulting in a new optimal point at B_3.

[13] Primals from beef carcasses are combinations of the three primary tissues of muscle, fat and bone according to the boning priorities of individual processing facilities.

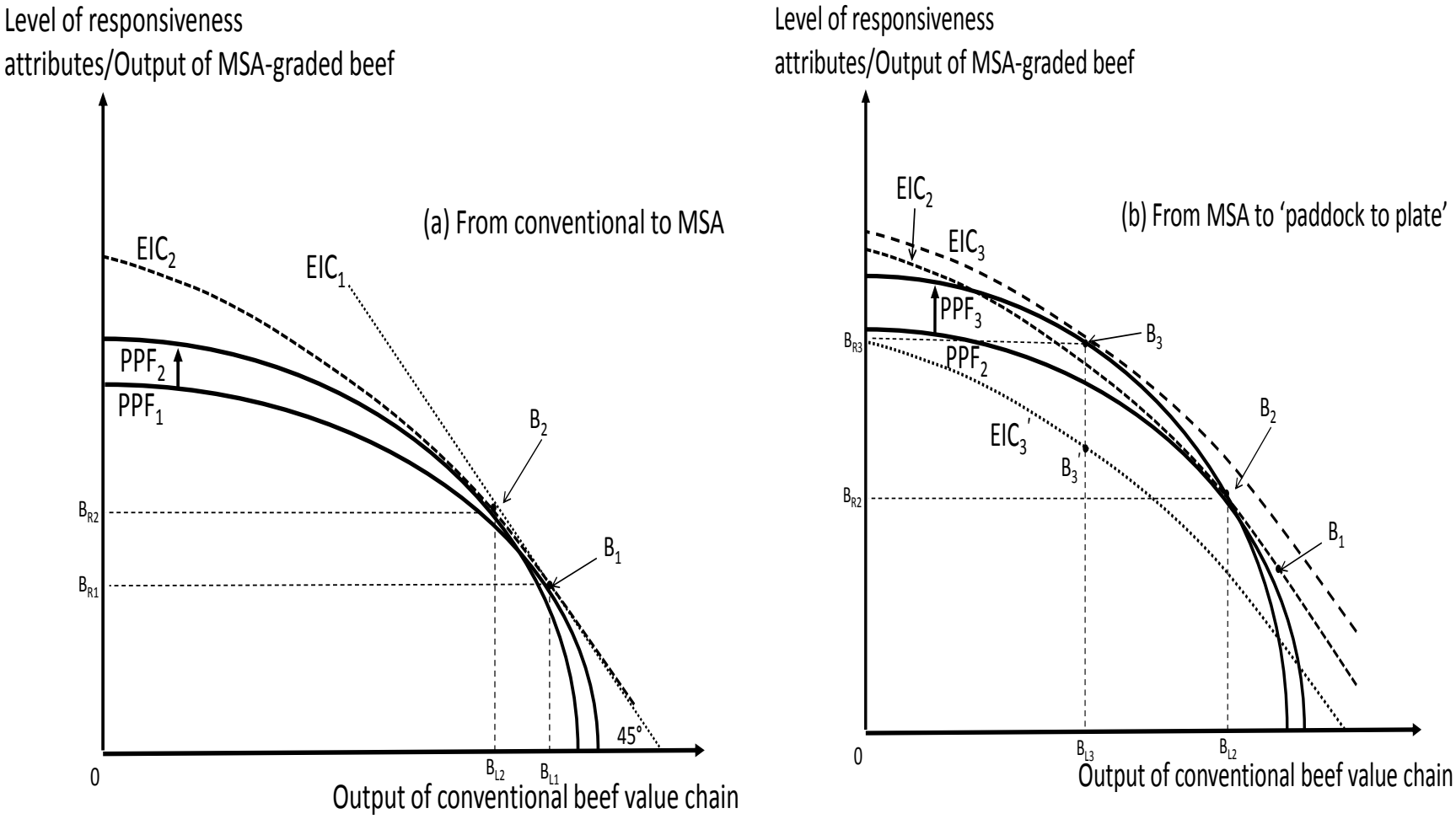


Figure 16. The MSA and "paddock-to-plate" grading systems with differences in eating quality between MSA-graded and non-MSA-graded beef

Beef value chains, like many other food value chains, can experience a high degree of variability in production processes and higher risks in all facets of the chain. A feature of the beef market facing Australian beef value chains is the uncertainty surrounding the quality of beef in the retail market, and the complexity of factors influencing eating quality. Biological factors, processing and value-adding effects all influence eating quality, which varies enormously across carcass musculature and hence cuts of meat (Thompson, Polkinghorne and Griffith 2012). This problem of too much information can result in inefficient outcomes. Figure 24(b) illustrates this point. At point B_3', the value chain is technically inefficient and is operating inside the frontier as chain participants add responsive characteristics to meat of insufficient eating quality to warrant the level of responsiveness. The revenue earned, measured by EIC_3', is less than that earned for the original ungraded beef marketed through the conventional grid system in the non-MSA-graded beef chain operating at point B_1. Efficiency gains are possible with increased revenue by returning to the non-MSA-graded beef chain, thereby reducing responsiveness and expanding output. But it would be preferable to increase efficiency under the "paddock to plate" regime and move to B_3, which is on a higher EIC than B_1, than to retreat to the conventional system. How can this move to B_3 be achieved? A step in the right direction would be to simplify information exchange.

The complexity of information surrounding the factors that influence beef-eating quality is problematic in that no single muscle can be used to describe carcass quality. A simple carcass index (a chain good) would help to alleviate much of the information overload by providing a tool to assess on-farm genetic progress over time and allowing for comparison of the impact of different management strategies (Thompson et al. 2012). Hence, the index would provide producers and processors with a mechanism to enable increased levels of responsiveness over time. Thompson et al. (2012) also noted that the development of such an index that was related to carcass value could potentially assist in the introduction of value-based trading. This dual outcome of increased responsiveness and increased willingness to pay corresponds to a movement towards Point B_3 in Figure 16(b).

5.3 Summary

In considering whether Meat Standards Australia was an example of a chain good, it was concluded that a properly designed grading scheme that is based on consumer preferences, and has associated pricing systems that allow consumer willingness to pay for quality to be captured and transmitted to other chain participants, is a perfect example of a chain good.

6. Horizontal and Vertical Strategic Alliances as a Chain Good

6.1 Strategic Scope: Horizontal and Vertical Alliances in Food Marketing

According to Chopra and Meindl (2013, p. 44), strategic scope (or the scope of strategic fit) "refers to the functions within the firm and stages across the supply chain that devise an integrated strategy with an aligned objective". Fundamental to the accomplishment of the aligned objective is an ability of firms to enter into a strategic alliance.

Varadarajan and Cunningham (1995, p. 282), cited by Jarratt (1998, p. 39), defined a strategic alliance as "the pooling of specific resources and skills by the cooperating organisations in order to achieve common goals, as well as goals specific to the individual partners". Robinson and Clarke-Hill (1994, p. 2), also cited by Jarratt (1998, p. 41), gave a broader definition of a strategic alliance as "a coalition of two or more organisations intended to achieve mutually beneficial goals". Jarratt (1998, p. 39) observed that these alliances "reflect the collective use [of] resources and cross-organisational information flows to assist alliance partners achieve a future desired strategic position". She reproduced a diagram by Robinson and Clarke-Hill (1994, p. 5) showing a hierarchy of alliance types. In order of degree of commitment and infrastructure linkage from "tight" to "loose", these types are: controlling interest or full merger with retained identity of subsidiary; partial acquisition and equity participation; joint ventures; equity participating alliances; international alliances with central secretariats; co-market agreements; national buying clubs; and loose affiliations.

Rolle (2006) observed that horizontal alliances can be particularly useful in the application of new skills and technical expertise by sharing RD&E knowledge and experiences. Links with government departments and research institutes can facilitate learning to help chain participants overcome existing technical and knowledge constraints.

Horizontal and vertical strategic alliances are used as mechanisms within a value system to capture chain goods and internalise chain externalities. They are formed among firms, or groups of firms, at the same level (horizontal alliances – across the network) and across different levels (vertical alliances – up and down the chain) in the value system. They can be used in a manner similar to government intervention to provide chain goods and internalise chain externalities. The strategic alliances may comprise all or only some chain members.

Consider four examples of important chain goods suitable for strategic alliances, including public-private collaboration, in meat value chains with varying degrees of commitment and infrastructure linkage:

- RD&E into meat standards within the beef value chain in Australia (Griffith et al. 2010) (see Section 5 above)
- Inspection services for Australian meat exports (DAFF 2013)
- The provision and dissemination of information in the value chain ("paddock to plate" value chain) (Doljanin 2012)
- Controlling disease in poultry through the Australian Chicken Meat Federation (ACMF 2011).

Sometimes it may be in the interests of a number of food value chains or systems to take joint action to fund applied research. This is especially likely in the case of chains providing experiential products. Consider the example of a "food and wine trail" where wine,

accommodation, restaurant, food retail, tourism and adventure value chains intersect and have a common interest in exploiting scope economies by providing a range of experiential goods[14] to customers and scale economies from joint action.

The relationships needed to create additional net value along a value chain or system can take various forms including partnerships, alliances or joint ventures. Regardless of the nature of the relationship, such collaborations only persist if additional value is created, for example, by reducing the transaction costs associated with obtaining supply or by improving the quality of product supplied. The attributes of agricultural products such as perishability and storeability play a role in the nature of the linkages and relationships which develop.

Red meat is a variable and complex product which creates challenges for marketing. Firms in the Australian meat industry operate with their boundary at one stage in the vertical value chain, and competing with other firms in that stage to buy product to sell, based on prices formed in open markets. Red meat is difficult to standardise, as experiments in grading and descriptive language have shown. Meat production and marketing are risky, which means producers usually diversify their production. Mechanisms exist for dealing with price or supply risk for participants in the value chain, but are used little. In the past two decades, demand for red meat has changed, as has the structure and performance with many leaving the industry, resulting in fewer firms supplying greater shares of total. This is particularly so in meat processing which is more concentrated than the livestock production sector. As well, the supermarket share of red meat sales grown rapidly; over half the red meat is sold through supermarkets. Increasingly, food companies are extending their boundaries, seeking closer relationships with farm suppliers and customers.

Within a value chain relationships and agreements amongst independent firms to co-operate are called strategic alliances. Although a form of integration, a characteristic of strategic alliances is that ownership of assets does not change. Price setting for agreed product characteristics of quality and time is negotiated, replacing the traditional price competition between parties. In the United States, Barry (1995) identified seven key factors as the basis for a trend to greater use of strategic alliances, as follows:

- Consumers' needs have become more specific and the customers more demanding.
- Consumers' preferences have become more specific than traditional price signals in open markets can convey, so retailers use vertical coordination to ensure that product specification meets consumers' demands.
- Some industries such as poultry and pork have developed technologies that provide greater control over product specifications and thus help retailers meet consumers' needs include: reproduction, nutrition, health management, product measurement and biotechnology.
- Information about consumers' needs and product attributes has become more important and more valuable and hence more closely guarded.
- Increased competition and increased capital costs associated with larger firms has provided impetus for further improvements in efficiency and especially for greater utilisation of processing capacity through improved security of supply.

[14] Bassi (2010, p. 52) identified three key characteristics of experiential goods that distinguish them from normal goods: (a) they are primarily intangible, referring to symbols and multi-sensorial perceptions and “are not considered as the simple sum of their attributes, but as the potentials arising from their combination”; (b) they are characterised by “subjective criteria such as personality expression, dream realization, search for pleasure, and fun”; and (c) the focus is on consumption rather than on purchase, which means that they last longer than goods.

- Risk management is becoming one of the key determinants of profitability in the modern business environment where markets are more dynamic, capital investments are greater, margins are smaller than those of the past, and vertical coordination offers a means to reduce these risks for both processors and producers.
- Producers faced with the need for additional capital expenditure find it easier to raise funds if they have more secure marketing arrangements in place in the form of contracts or closer relationships, and some processors may find that provision of finance to suppliers within a strategic alliance is a cost-effective means of securing supply (Barry 1995).

A consequence of marketing alliances and pre-arranged contracts is suppliers give up rights to sell output to any buyer in the market at any price, and buyers cannot buy product from any seller at any price. Strategic alliances shift the boundaries of firms, with buyers and sellers influencing each other. For instance, product has to be described for contracts to be made. Better information in price determination results.

The nature of red meat marketing has implications for the role of strategic alliances. Traditionally the physical functions involved in domestic marketing of red meat have been carried out by separate firms with little vertical integration. Large numbers of small abattoirs killed stock and sold carcasses to numerous wholesalers or to butchers who broke the carcass into cuts and sold direct to their customers. In this system little scope existed for feedback of consumer reaction along this value chain. The emergence of supermarkets with vertically integrated operations has opened new opportunities for improved feedback. Large vertically-integrated firms have advantages over smaller non-integrated firms. Export meat marketing has traditionally been carried out by firms which are vertically integrated, with foreign owned or controlled firms distributing directly in overseas markets. Linkages or alliances are stronger between processors and retailers or exporters than between producers and processors, reflecting that while it is commercially valuable to have closer linkages between processors and retailers and exporters, it is less valuable to have closer linkages with producers. This is in part because of mismatches in size of operation. This mismatch in size can be countered to some extent by development of horizontal alliances of processors and of producers - a development which could offer benefits to processors (e.g. more secure throughput). Benefits to producers forming horizontal alliances can derive from associated vertical alliances being formed.

Closer business relationships facilitate transmission of information. The quality and quantity of information about meat through value chains is constrained because meat is significantly transformed, moving from live animal to carcass to meat cuts that are difficult to follow through the chain. Linkages or closer relationships between firms in a business system are appropriate where they create additional net value that could not be created as efficiently in any other way. In commodity markets, where suppliers are unable to differentiate their product or service, and hence the purchase decision is predominantly price-based, closer relationships can achieve little. In these markets the total amount of value created is fixed. In the meat industry the pressure for closer relationships or supply chain management derives from the needs of supermarkets for quality consistency, reliability of supply and to ensure safety. Marketing activities can be characterised as being largely about obtaining and using information.

Consumer concerns for food safety, which is now reported in consumer surveys as one of their main concerns, continue to provide pressure for closer relationships in the meat industry. Food safety is of value to customers, and it relies on adoption of sound procedures and being able to trace back product through the supply chain. If a retailer can demonstrate that its entire product comes from members of an alliance, and that all members of the alliance follow sound food

safety precautions, this provides the retailer with a competitive advantage over others who cannot trace the origin of their products.

Closer relationships and alliances involve costs. Suppliers lose some control, and mechanisms are needed to share benefits and to keep the relationship functioning efficiently. In successful alliances both parties have to be able to manage the transition from independence to interdependence, without going from independence to dependence. A meat-supplying firm participates in an alliance in the hope of providing increased value for the buyer, and hence can expect more secure outlets and sometimes higher prices for their production. Secondly, they participate because by doing so they can lower their own costs. One example of such cost reduction is the cost of obtaining information about what the customer (or sometimes the ultimate consumer) wants: the suppliers in an alliance can obtain clear and reliable market signals much more cheaply than they would if they were not in an alliance. Strategic alliances offer the opportunity to exploit the complementarities between firms that contribute different component parts to the production and marketing system. Ultimately, the aim of both parties is to manage risks and contain transaction costs.

Horizontal alliances provide the means for producers to collaborate with other producers and offer significant volumes to processors and others along the value chain. Horizontal alliances can improve marketing power and match the power of large, vertically coordinated processors and retailers. Horizontal alliances have usually involved members learning about new technology as well as marketing as a way of increasing profitability of members. Furthermore, some horizontal alliances will choose to be associated with and participate in vertical alliances.

Participation of producers in vertical strategic alliances can help improve their competitiveness by developing a better appreciation of customer needs and improving the efficiency of overall red meat production-more production meeting specifications and hence less downgrading; more product sold per participant; and, in some situations, more product sold at higher value. The feedback provided through such an alliance is unlikely to be available from any other source. This is because although it may be technically possible to provide feedback when product is provided through the existing chain, the cost of tracking the product through the system would almost certainly be greater than the benefit that it could provide to any producer.

Strategic alliances offer the prospect of reducing the cost of dealing with risk for producers, processors and marketers. Risks would not be eliminated but could be reduced in a range of ways as suggested below:

- By providing producers with a more secure and certain forward price for their output they allow the producers to budget more accurately and to embark on other efficiency enhancements.
- By securing a specified level of supply at a certain forward price processors would be more assured of throughput and could invest in other efficiency enhancements in their works, forward contract sales to reduce their own price risks, and schedule throughput more efficiently.
- By securing a specified level of supply at a certain forward price retailers or exporters would be assured of throughput and could invest in other efficiency enhancements in their stores, develop more secure marketing programs, and promote the particular brands or types of meat supplied by the alliance.
- Strategic alliances could reduce price risks to producers and price and supply risks to processors, retailers and exporters. These reduced risks could be expected to generate other efficiency improvements by reducing uncertainty.

Alliances will only develop and remain active where they deliver additional net value to customers and greater long term net profits for all participants. Alliances between producers and processors are much more likely to deliver additional net value to customers, and therefore to be sustainable, if the producers are organised in a horizontal alliance.

The introduction of improved identification of product qualities has proved extremely difficult in the meat industry in part because of the prohibitively high costs of attempting to maintain some level of product identity through the value chain. Strategic alliances can reduce the product identity problem provided that the product handled by the processor or retailer is predominantly obtained from a small number of strategic alliances. Under alliances, producers supplying livestock with higher potential retail value or lower transformation costs have a better chance of being rewarded providing greater customer value.

Strategic alliances may prove to be one of the most effective ways of demonstrating to customers that particular quality assurance procedures have been followed. As consumers' concerns about food quality and safety become more common, quality assurance systems will increasingly become a basis for product differentiation. Strategic alliances will similarly be useful in demonstrating particular attributes of product such as 'animal friendly', 'environment friendly' or 'antibiotic free' production technologies. Strategic alliances could facilitate the introduction of quality assurance systems and ensure that those participating obtained full benefit from their participation.

Price discovery processes for the industry are not adversely affected by greater use of strategic alliances. Further development of alliances is not expected to shift market power to processors and retailers to any greater degree than would apply if the formation of alliances did not happen. To the extent that horizontal alliances are developed, market power which might otherwise be lost could be retained by producers, or some power could shift towards producers.

Alliances will be most likely to form with minimal outside support in situations where there is already a high level of industry concentration in the industry segments of both partners. Alliances between individual producers and processors and/or retailers are be the most difficult to establish and maintain. Alliances between groups of producers in horizontal alliances and processors and/or retailers are more easily formed and constitute the first step towards improved marketing.

6.2 Interpreting the Role of Strategic Alliances as a Response to Chain Failure

There is a vast literature on horizontal and vertical strategic alliances as they are conducted generally in business circles. We briefly review some salient parts of the literature on strategic alliances in marketing as they relate to club goods and chain goods.

Calvet (2005) analysed problems facing the wine industry in France based on the theory of club goods and clusters. He demonstrated how, by acting as clubs, wine regions can achieve competitive advantages. But by focusing on one club good, in particular, *Appellation d'Origine Contrôlée*, he found that it had given rise to two problems: opportunist behaviour by certain members that led to a lowering of wine quality, and a supply process that was too complex, weakening the competitive position of France against New World wine-producing countries.

Morrison and Rabellotti (2009, pp. 985-986) discussed learning "as a collective, social process involving people who share strong social and cultural values" in an Italian wine cluster. They observed how "Informal relations within the milieu, along with other mechanisms (e.g. spin-offs; labour mobility; user–producer interactions), contribute to sustaining the diffusion of knowledge at local level, which is considered a club good within the boundaries of the cluster". They further noted that knowledge is "a club good, whose membership is … not simply regulated by geographical proximity… [but] is unevenly distributed in clusters and that networks (of knowledge, information, business relationships, input exchanges, management ties, etc.) in clusters differ a great deal in terms of their production and diffusion mechanisms" (Morrison and Rabellotti 2009, p. 999).

McVitie, Moran and Thomson (2009, p. 3) recognised club goods as an intermediate stage in the spectrum from public agricultural goods to private agricultural goods, identifying specifically those goods that have private attributes but are rivalrous in use due to congestion. They took a narrow view of the potential for club good characteristics.

How might the conventional argument that there is limited role of government beyond the farm gate and in the meat value chain change once consideration is given to the possibility of there being chain failure and chain goods? Related to the standard considerations about whether government should or should not intervene along the value chain has been whether a situation is one of rivalry or non-rivalry in consumption, and excludability and non-excludability, or whether transaction costs exceed expected benefits, and whether these characteristics create barriers to private solutions being developed to reduce inefficiencies along the value chain. Within the farm gate the case for public intervention to solve the market failure of insufficient investment occurring in agricultural RD&E is well established by the public good/positive externality nature of much agricultural RD&E output (non-rival, non-excludable). The case for public intervention further along the value chain though has generally been considered weak. That is, situations of market failure because of public good, externalities, monopolies and scale and risk, are harder to find. But, what of market failure within a specific value chain in the presence of chain goods? As ever, this is a case by case matter. In the following, the role of strategic alliances in agricultural value chains is explored and the question of chain failure preventing development and use of strategic alliances, and a possible consequent role for government to facilitate strategic alliances is considered.

In principle, the benefits from developing alliances are likely to be largely private. There would be little justification in using industry levies and public funds to develop alliances that could be expected to develop without assistance. Aspects of alliances that may warrant public support would be those designed to:

- enable research into forms of alliances that might provide greatest overall benefit to industry;
- develop better strategies for generating trust between the participants in the alliance;
- enable research into 'tools' that could be used in conjunction with strategic alliances to improve efficiency e.g. tools for value based marketing;
- provide information that would ensure that all parties (particularly producers) were aware of the potential benefits from alliances;
- help demonstrate the practicality of alliances and thus encourage their wider use by providing support for establishment of a range of alliances including horizontal alliances amongst producers and vertical alliances that may not all extend all the way to the final consumer; and

- address any area of market failure or industry failure because of chain goods associated with the further development of alliances.

If potential positive chain externalities exist but are not being realised because non-rival and non-excludable characteristics inhibit firms from acting collectively via relationships, then the case for collective action by chain participants, possibly facilitated by the public or even public-private joint activity, depends on the total expected benefits versus expected costs of such forms of intervention. In some cases, the chain goods may be realisable by collective action by participants in the chain, without public intervention to make it happen. In other cases, role of government considerations may amount to an enabling role: public intervention to facilitate collective action by chain participants to achieve chain benefits and additional net value to society, some of which will be shared by people external to the participants in the value chain.

6.3 Summary

In considering whether horizontal and vertical strategic alliances could be considered as chain goods, it was concluded that such alliances are often used as mechanisms within a value system to capture chain goods and internalise chain externalities. They are formed among firms, or groups of firms, at the same level (horizontal alliances – across the network) and across different levels (vertical alliances – up and down the chain) in the value system. They can be used in a manner similar to government intervention to provide chain goods and internalise chain externalities. The strategic alliances may comprise all or only some chain members.

7. Livestock Genetic Improvement in the Context of Chain Failure and Chain Goods

7.1 Traditional Approaches to Genetic Improvement

Identifying, selecting and breeding from farm animals which show signs of probably being genetically superior to other potential breeding stock in the same industry has long been done for reasons of private passion and profit. Achieving genetic improvement of livestock requires identifying superior animals and selecting them to breed from. The more animals whose characteristics are known about and from which the best are selected, the more rapid the genetic gain. The need for large populations of animals, and information about these populations, meant that in their pursuit of genetic improvement, aficionados of particular breeds of farm animals saw early in the piece the benefits of joining with others of like mind to form specialised breed clubs and societies, working together to achieve aims which, unattainable or unprofitable individually, become possible and profitable collectively.

Breed clubs or societies pool information about populations of herds and flocks with the genetic make-up for superior performance. They establish and enforce standards and criteria for animals that are thought to provide production gains and are necessary to warrant the description of being of a particular breed which will have probable, defined performance characteristics. Breeders work collectively to supply and maintain the information needed about the “brand” of their product that is needed to supply and maintain the credence attributes of their product. Improving the genetic potential, and credibility of that potential, of a breed of farm animal to contribute to farm production and profit, aims to facilitate growth in both demand for and supply of such improved animals, potentially benefiting individual breeders in that particular breed club or breed society. Recognition that by acting together breeders of particular types of farm animals could benefit individually was a private solution to the otherwise “public good” type of market failure, at an industry level, where insufficient resources would be devoted to seeking animal improvement because individual breeders could not capture sufficient of the benefits to justify the investment.

The coincidental advent in the 1970s of recording the performance of progeny of breeding animals and ready computer capacity to analyse masses of data about the performance of bred progeny and their relatives made, for the first time, the pursuit of genetic gain in animals a scientific process based on relevant empirical evidence. Performance recording can be termed the first revolution in modern animal breeding. The second revolution, genomic science applied to identifying animals carrying desired traits, emerged thirty years later and is developing rapidly. The benefits of these two approaches to identifying the probable genetic potential of animals to perform in desired ways remain subject of course to lifting environmental limits to expressing this potential.

Performance recording involves collecting data about the pedigrees of individual animal and their performances on farm, and analysing this information using Best Linear Unbiased Prediction (BLUP) to obtain Estimated Breeding Values (EBVs). An EBV is a number ranking an animal with its peers for a trait, such as growth rate, muscle yield, maternal ability. EBV figures are predictions of probable genetic merit of an animal for these traits; predictions whose accuracy depends on the number of relatives of the animal about which data is also available. Depending on the breeding/selection objectives of farmers, EBVs on individual traits are

weighted and combined to develop a selection index which farmers who understand EBVs are able to use to inform their selection and genetic investment decisions to a far greater extent than the traditional, non-EBV methods of attempting to identify superior animals.

7.2 Is There Any Chain Failure in Livestock Genetic Improvement?

The question arises: if livestock breed societies have formed and survived over many generations of breeders and animals, out of which modern scientific principles and applications of animal genetic improvement such as EBVs have developed, is there any relevant chain failure involved requiring public attention and even intervention?

A case that there exists information failure which is inhibiting adoption of EBVs by breeders and by their customers would be able to be made more convincingly if over the past several decades there had *not* been considerable industry investment and concerted efforts made in making information about EBVs available to industry participants, and if there had *not* been considerable adoption. Virtually all Angus bull breeders use BREEDPLAN, and for other British and European beef breeds, approximately 50 per cent of animals are evaluated through BREEDPLAN. With the northern beef breeds, approximately 25-30 per cent of animals are evaluated, and this is growing, and another 25 per cent are sons of animals with BREEDPLAN EBVs. In sheep breeding, over 70 per cent of buyers of meat breed rams (terminal sires), 50 per cent of buyers of meat breed rams (maternal breeds), and 35 per cent buyers of Merinos are buying rams with ASBVs. Over 67 per cent of the Merino semen market is rams with ASBVs.

While in general potential market failure resulting from ignorance is sufficient to justify public investment in basic education for the general population, at an industry level, where there are no barriers to access to information about the role and use and productivity gains from using the benefits of modern quantitative breeding methods, and where considerable collective industry action has been taken already, the presence of value chain participants choosing not to use these methods for whatever reasons would not justify public intervention to facilitate further collective action by participants in the genetic improvement value chain.

Nor is there a case that some form of chain failure prevents investors in genetic improvement from reaping benefits from their activities. Economic theory has some things to say about how the net benefits of innovations in a value chain (e.g. superior genetics) are shared between the supply side of the market, the producers, and the demand side, summarised as processors and consumers.

The theory about how the net benefits of a change in costs or benefits in a value chain are shared is straight-forward: the side of the market that is least able to respond to the change bears the largest share of an additional cost burden and, conversely, gets the largest share of an additional benefit along the chain. A single supplier of a product with a set of new and unique characteristics for which there is competitively responsive additional demand can capture all the added benefits of the new product. In the case of a supplier of uniquely superior genetic material, competition among buyers would bid up the value of the uniquely superior genetic resources such that the supplier would receive all the benefit. In practice, there is no single supplier of superior genetic material so the benefits are shared between all the suppliers of superior genetic material. Is there chain failure that somehow interferes with this piece of economic theory working in practice? Is there some failure in the value chain markets that mean there is a lack of incentive for breeders to use modern breeding methods such as EBVs?

For the “right” amount of investment of economic resources to be made in achieving genetic improvement – the investment that maximises contribution to social welfare – markets in the value chain need to perform efficiently. Efficient markets refer to both operational and pricing efficiency. Operational efficiency refers to the marketing functions such as distribution and transformation and financing functions being performed at least cost. Pricing efficiency refers to the information role of market prices. The central tenet of neoclassical economic theory is that private participants in markets act with ‘full information’; in practice this means that consumers are supplied with much detailed information about the characteristics of product that are important to them and which they are considering purchasing, and, producers along the value chain are well informed about the requirements of their customers (the next buyer).

In economics a lack of information can be seen as a deviation from the theory that explains how markets can achieve efficient outcomes; a constraint that limits the extent to which potential levels of efficient resource uses are achievable in practice. There are a couple of ways that information deficiencies can amount to market failure. First, there is asymmetric information, where one party to a transaction is in a position to know much more about the characteristics of items in the transaction than the other party. In such cases, sub-optimal decisions are inevitable, resulting in lesser social welfare than would be the case if both parties were similarly informed about the elements of the transaction. Another dimension to information in the context of market failure derives from when information has non-rival and non-excludable characteristics. This situation justified the historical practice of the public provision of information about market supply, demand and prices of livestock. However, with technological advances, information has been made available cheaply, and excludable, and private supply of market information now abounds, often alongside industry or public funded sources of information.

Information has a particular set of challenges in the red meat industry. The conceptual framework for thinking about the role of information in marketing is the additional benefit of extra information versus the additional cost of acquiring it. A long standing concern of participants in red meat value chains has been the attenuation of information from consumers to chain participants about what consumers of red meat want and are willing to pay. The assumed consequence is that there is potential net value available if only chain participants were better informed about what their buyers want. And, for such information to be known, the product the consumers buy has to be able to be described and classified. The thinking is that if producers along the value chain know more about consumer requirements they will to some extent be able to control their production environment and attempt to meet these requirements more precisely and a new consumer demand will emerge paying more for a product whose precise characteristics add to consumer utility. This explains public investment in Meat Standards Australia: the benefits of more information were expected to exceed the costs.

In the context of animal breeding the question is the relationship between the characteristics of animals bred and raised on farms and feedlots, the characteristics of animal carcasses and cuts through the chain, and the characteristics of the parts of those animals that are ultimately purchased by consumers. There are two aspects here: information known by participants in the value chain about desired characteristics of animals and meat, and the extent to which the characteristics of animals and meat are under the control of the participants in the value chain.

An interesting case is that of genetic improvement of livestock. Animals can be identified by EBVs for a dozen or more traits to do with production, with implications for farm efficiency and profit, and to do with specific consumer preferences for eating quality, with implications for consumer demand, market price and net value through the chain. Investigations of market

prices for sires with different EBVs for various traits indicates that animal breeders receive higher prices for supply bulls with only a small number of the total number of traits which describe the sires they sell. Breeders get paid extra for supplying more of only some traits of their animals. This is because only some traits are recognisable at the level of consumer demand and the relationship between the characteristics which a young sire in a paddock has a good probability of passing on to generations of offspring and the eventual eating quality experience of the consumer that is valued as being sufficiently superior to entice the consumer to pay higher prices, is a long and winding road. Unless the value of traits at the end of the chain are reflected through the chain, a livestock producer fitting particular production traits into their farm system and making possible the expression of genetic potential in their systems, may be rewarded more by traits that contribute to achieving high production efficiencies of animals, albeit with reasonable end of chain traits. Increased transmission through the value chain of information relevant to all traits holds the potential to add net value through the chain, provided the benefits of the extra information exceed the costs. The two questions, for chain goods, is whether perceived inadequacies of information flows through the value chain have the characteristics of being a chain good and if so would the benefits of fixing this failure exceed the costs?

7.3 Summary

In considering whether the provision of services about livestock genetic improvement is a chain good, it was concluded that while in general potential market failure resulting from ignorance is sufficient to justify public investment in basic education for the general population, at an industry level, where there are no barriers to access to information about the role and use and productivity gains from using the benefits of modern quantitative breeding methods, and where considerable collective industry action has been taken already, the presence of value chain participants choosing not to use these methods for whatever reasons would not justify public intervention to facilitate further collective action by participants in the genetic improvement value chain.

PART III: IMPLICATIONS FOR MLA

8. Discussion and Conclusion

8.1 Is there a role of government in these new private closed information food chain and experience systems?

We have shown that the traditional justification for government intervention in markets based on public good arguments no longer holds because modern agriculture and food markets no longer possess the characteristics that warrant it. Is there another justification? A relevant question is how do we align all the partners in these value chains to deliver the food experience demanded by consumers, and also be efficient in the sense of maximising chain surplus?

In our view there is a justifiable role for local, regional and national governments, and occasionally supranational organisations, to play in the new world of private, consumer-driven value chains. The justification is based on the notion of chain failure, so the objective of the intervention must be to provide or facilitate the provision of new or better public and chain goods, or to internalise global, national and chain externalities.

8.2 What is the role of government in these new private closed information food chain and experience systems?

If the justification for government intervention is based on the notion of correcting chain failure, then the type of intervention must be in the promotion of positive chain externalities and the mitigation of negative chain externalities, through the provision of chain goods and the removal of chain bads. This leads to a set of broad areas for intervention:

- Regulations to provide efficient and effective legal, taxation and competition environments
- Governance and relationships
- Consumer, technology and channel knowledge (local, regional, national, international, environmental knowledge, cultural knowledge)
- Business models and skills, including new ways of sourcing capital/investment
- Education and training in value chain analysis
- RD&E and innovation.

Governments may focus on a wide range of issues within particular value chains, or preferably on common issues across a range of value chains, in providing public and chain goods or internalising externalities.

Some specific examples are:

- Establishing chain-wide standards and certification
- Establishing uniform grading schemes
- Agricultural RD&E
- Process innovation: new or better tools and technologies for use in the value chain
- Product innovation: new product development
- Systems/logistics innovation
- Enhancing consumer and channel knowledge
- Disease control: inspection services to control for pests and diseases and to regulate food safety
- Coordination – contracts and design collaboration
- Collaboration in the use of information and communication technologies
- Inventory aggregation
- Transportation policy
- Exploiting scale economies in capital investment through joint action
- Exploiting scope economies through joint action
- Risk sharing
- Governance, relationships and competition issues
- Application of business models and skills
- Operation of auction and other market facilities
- Ensuring sustainability in the value chain.

In all of these specific examples, as well as a focus on chain externalities, attention should be on reducing or eliminating asymmetric information, moral hazard, adverse selection and the principal-agent problem.

Asymmetric information occurs in a situation in which one party to an economic transaction within a value chain has less information than the other party. Adverse selection is a situation in which one party to a transaction takes advantage of knowing more than the other party to the transaction. For instance, every firm in a value chain knows more about its own financial situation and ethics than does any other participant in the chain. Other participants are reluctant to do business with a firm unless information is available about its methods of operation and financial status.

Procurement in the value chain is an area particularly susceptible to adverse selection. Both buyers of goods within the chain and consumers of products from the chain may fall victim. Examples are purchasing meat of inferior quality derived from animals slaughtered using inhumane methods and the substitution of one meat for another that is advertised to be an ingredient. The recent horse meat scandal in Europe (France24 2013) is an example of the substitution of one meat for another and the treatment of Australian live sheep exports to the Middle East (Oakes and Lewis 2013) is an example of animals slaughtered using inhumane methods.

Examples of ways to address the problem of adverse selection in the value chain are:

- Regulations requiring minimum warranties (free repairs on equipment used in the chain or replacement of a product for a specified time period after purchase)
- Use of penalty clauses in contracts
- Implementation of grading systems
- Better access to information and traceability throughout the value chain.
- Governance of marketing channels.

Moral hazard refers to the risk of actions taken by people, after they have entered into a transaction, that make the other party to the transaction worse off. An example in a value chain is where a risk-sharing arrangement is in place across a number of chain members. Certain members may act in a risky manner knowing that adverse outcomes will be shared with other chain participants.

Two examples of ways to reduce moral hazard in the value chain are:

- Set specific requirements or performance standards.
- Use penalties in contracts between suppliers of a good and the procuring firm.

The principal-agent problem is a problem caused by an agent, being one firm in a value chain, pursuing its own interest rather than the interests of the principal, another firm in the chain. An area particularly prone to the principal-agent problem is where one firm outsources to another firm. Potentially adverse outcomes include the leaking of sensitive data and information, ineffective contracts, loss of value chain visibility and potential for a negative impact on the firm's reputation. Consider again the horse meat scandal in Europe where the reputation of a major frozen food processor, Findus, was tarnished by unknowingly selling lasagne containing horse meat instead of beef (France24 2013).

Economists generally favour the use of market-based policies to deal with negative national and global externalities caused within a value chain, as for example pollution. An example of such a policy is an emissions trading scheme, or a carbon tax if policy intervention is to be undertaken, to reduce carbon dioxide emissions in the chain.

8.3 Summary

Chain failure arises in meat industries in a wide variety of forms. Where the expected net benefits are positive, industry intervention/investment is justified, although the nature and extent of this intervention/investment will vary according to the nature of the failure. Where possible, market-based policy interventions are preferred.

9. Financing Meat RD&E

In light of the primacy accorded to innovation in the framework for the economic study of meat value chains, we need to give special attention to the issue of financing meat RD&E. We begin by explaining how to determine the demand for a chain or public good such as RD&E in a meat value chain. We then consider the crucial question of who should fund it by comparing the relative merits of public finance and sourcing funds from members of the meat value chain.

9.1 Determining the Demand for a Chain or Public Good

A common argument for public funding of RD&E focuses on positive externalities, given the extensive spillover benefits from its outcomes to people who do not contribute to the funding: there is a risk that socially desirable projects will not be funded by private firms or chains unless the government intervenes to internalise the externality. But a feature of RD&E in food value chains is the lack of a market, which makes the analytical framework for positive externalities difficult to implement. To determine the demand curve for a chain or public good such as RD&E, it is usual to add the price each user is willing to pay for each quantity of a good. This approach differs from how the demand curve for a private good is determined, where the quantity of the good demanded at each price by each consumer is summed.

In evaluating the worth of RD&E, the standard approach is to identify those RD&E projects for which the present value of benefits exceeds the present value of costs. This task is difficult and the government and chain governors also find it difficult to know what quantity of a public or chain good to supply because:

- Consumer preferences for chain and public goods are not revealed in the market.
- A price cannot be charged, so there is not a price mechanism on which to base any analysis.

RD&E has long been considered as a public good: public funding aims to supply RD&E outputs by filling the RD&E funding gap. But public funding is just one manifestation of collective or joint funding possibilities. Of particular interest here is that RD&E may also be a chain good in circumstances where the identification and adoption of improved tools and technologies by chain members results in benefits, some of which can be captured by other chain members. The “chain goods solution”, a subset of the broader “club goods solution” (see Romer (1993, pp. 348-351) on joint action in the “widget” value chain), is thus an alternative “collective approach” to public funding, entailing selective excludability.

9.2 Who Should Fund Meat RD&E?

Agricultural researchers have become increasingly concerned about improving the value chain for agricultural products as opposed to a narrow focus on improving agricultural production. This issue was a major focus of a report by the Productivity Commission (2011) on funding rural RD&E, which made a series of recommendations. A finding of the report was: “ … the case for public funding contribution does not centre on the public-private balance in research benefits as such. What is important is whether or not there are sufficient potential returns for a private party to invest in a project. If there are, then the case for public funding is weak, even if there are

subsequently wider benefits for the rest of the industry as the innovation concerned takes hold." (Productivity Commission 2011, p. 273)

Despite the conclusion drawn by the Productivity Commission, we suggest that there is still a justifiable role for national and regional governments to play in consumer-driven food chain and experience systems by funding RD&E that results in new or better chain goods, as outlined above in Section 8.

Challenges exist in deciding who should fund RD&E in a meat value chain. By substituting "value chains" for "clubs" and "chain goods" for "club goods" to reflect the fact that research in a value chain is an important chain good (a good in the value chain with club attributes), we use Swann's (2003) idea of a "club goods solution" to research funding, reflecting the view that a "chain goods solution" has a role in funding applied research activity, in particular.

Swann (2003) compared the relative merits of public funding of RD&E with what he termed a "club goods solution" to funding. He observed that a common "club goods" response to the externality/public good[15] argument is to ask why the diverse beneficiaries from a research project cannot fund it. Or in the current context: Why can't members of the meat value chain form a "club" to fund RD&E within it? If a sufficient number of members join forces such that the joint present value of their benefits exceeds the joint present value of their costs, the socially desirable project will be funded even if the "club" that is formed does not capture all the benefits. In this way the chain goods solution complements the private and public finance solutions.[16] Where the boundary lies between public funding, private funding and a chain goods solution depends in large part on the ease with which the RD&E benefits can be captured within a value chain but also on a variety of other factors. Public funding is required where socially valuable projects do not appear to be profitable to members of the chain as a whole or to private members within the chain. The chain goods solution is to internalise (at least some of) the research externalities/public goods as they affect chain members. In this way, it complements the public finance solution in society in general and private funding complements the chain goods solution within a value chain. A collective funding solution can be disaggregated into solutions involving various levels of joint action according to stake holdings in RD&E outcomes.

On the assumption that private firms in a value chain will undertake RD&E where they can capture sufficient benefits, we focus on two levels:

- public funding of meat RD&E at the national level
- a chain goods solution at the value chain level (which is currently in place using a crude funding model – see below).

The chain goods solution is divided into two parts to reflect different incentives to invest in meat RD&E projects: a "whole club solution" and a "Coasian solution".

[15] Swann (2003) refers often to research externalities where we think it would be better to refer to research chain goods given the lack of a market for RD&E that is necessary to analyse externalities.

[16] Romer (1993, pp. 346-347) recalled that Vannevar Bush "identified an important opportunity for collective action and then constructed an institutional arrangement to exploit this opportunity at minimal political cost". It is in this spirit that we consider the appropriate levels of collective action in funding RD&E in the meat value chains in Australia.

9.3 Comparing Public Finance and Chain Goods Solutions to Funding Meat RD&E

Chain goods and public finance solutions can be compared on two criteria: profit and funding, both of which can be applied in a manner that is consistent with the guiding principle of equi-marginal returns discussed in section 2.1. A 2x2 matrix prepared by Swann (2003) and featuring outcomes for funding decisions based on Type 1 and Type 2 errors is our starting point. A Type 1 error occurs with the rejection of a null hypothesis: a socially (collectively) profitable research project is not funded. A Type 2 error occurs with failing to reject a false null hypothesis: a socially (collectively) unprofitable research project is funded (see Table 3).

Table 3. Two types of error in RD&E

	Socially profitable	Socially unprofitable
Funded	Correct decision	Type 2 error: public finance solutions prone to fall here
Not funded	Type 1 error: club goods solutions prone to fall here	Correct decision

Source: Swann (2003, p. 338).

A Type 2 error (failure to reject a false null hypothesis, or acceptance of a bad research idea) occurs if a socially undesirable research project is funded. It is tempting, but simplistic according to Swann (2003), to believe that the (imperfect) chain goods solution is more prone to Type 1 errors while the public finance solution is more prone to Type 2 errors, but it is a useful thesis to begin with. We outline Swann's (2003) reasoning to show below that the chain goods solution can indeed incur Type 2 errors.

At best, Swann (2003) believes, the errors of the club goods solution are skewed towards the bottom left corner of the Table 3 while errors of the public finance solution are skewed towards the top right corner. He argued that the problem with the club (chain) goods solution is that high transaction costs and free riding can mean that not all benefits are realised: some socially valuable projects may not be undertaken. Also, there is a natural bias towards projects within the value chain that bring the highest benefits to chain members – regardless of externalities.

Swann (2003) identified four problems with the public funding of research projects:

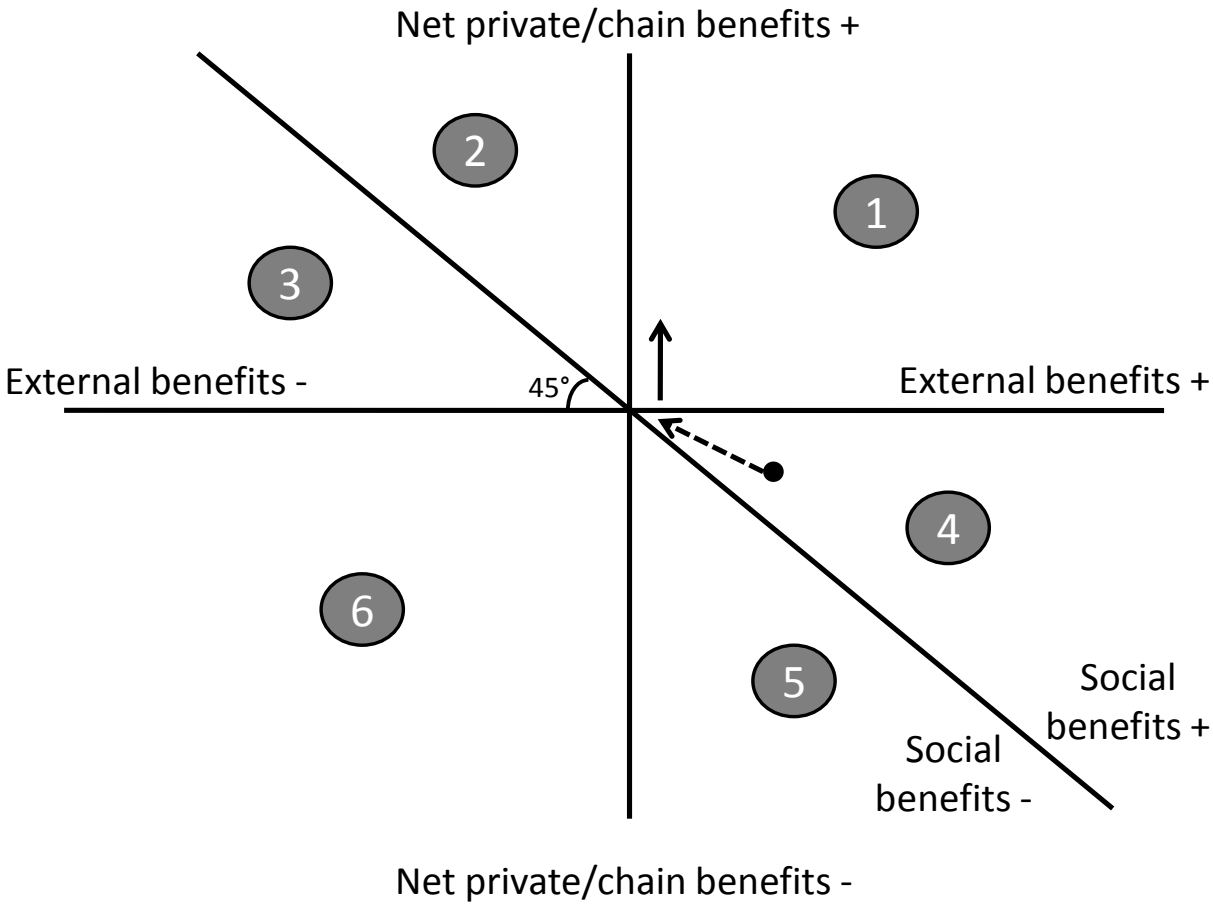
1. Some projects that pay (e.g. because of lobbying) do not benefit society.
2. Contributions are unrelated to the project benefits.
3. Selection mechanisms in public funding are often dubious.
4. Publicly funded research can often be too slow in anticipating market changes.

According to Swann (2003), it has been a popular conception that the public finance solution incurs too much Type 2 error in fear of incurring a Type 1 error. It is debatable whether this view prevails these days as public evaluation of research has become more sophisticated but certainly doubts remain about the efficacy of selection methods (see below). On the other hand, one might expect that the chain goods solution is less likely to incur Type 2 errors because it is more concerned about their occurrence and hence more vigilant in preventing them. From the perspective of this simplistic hypothesis, Swann (2003) avers, the choice between public and chain funding can be cast in terms of relative concern about Type 1 and Type 2 errors. But Swann (2003, pp. 339-340) also observed that this perspective confounds a number of factors. He therefore argued that it is important to compare public finance and club goods solutions on three more criteria: efficient composition; equity; and the relative importance of transaction costs (Swann 2003). These criteria are considered in detail below in respect of moderating influences on Type 1 and Type 2 errors.

Figure 17 summarises the net internal benefits of a research project and the externalities. Any particular research project can be located as a point on this map. The decision whether or not to fund it is outlined in Table 4. The research project marked by a dot in area 4 of Figure 17, for example, is socially desirable but unprofitable to the chain as a whole or to individual members within the chain. Projects in area 1 (fund) and area 6 (do not fund) are clear-cut.

Areas 2 and 5 are slightly more complicated. Projects in area 2 should be funded, and will be unless external parties have especially strong lobbying power or they are able to extract compensation. Projects in area 5 should not be funded, and will not be unless external parties have strong lobbying powers. Areas 3 and 4 are problematic. Projects in area 4 should be funded but will not be privately funded by the chain or members of the chain. Those in area 3 should not be funded but will appear privately profitable – a Type 2 error for a chain goods solution.

The position of an RD&E project depends on where the boundary is drawn between the internal and external environments. If the funding “club” were enlarged beyond the value chain by internalising some externalities, our project in area 4 in Figure 17 would move in a north-westerly direction. But there are two complications that are demonstrated in Figure 17 and discussed below. First, transaction costs will accrue, and the realised internalisation converges towards the 45° line, and, second, an increased ability to extract rents shifts the position of the project into area 1.



Source: Adapted from Swann (2003, p. 344).

Figure 17. Net internal benefits of a research project and the externalities

Table 4. Analytical framework: Summary of regions

	1	2	3	4	5	6
Internal	+	+	+	–	–	–
External	+	–	–	+	+	–
Social	+	+	–	+	–	–
Chain goods solution	Fund	Fund	Fund	Do not fund	Do not fund	Do not fund
Public finance	Fund	Fund*	Do not fund	Do not fund	Do not fund	Do not fund

* May require compensation to external parties

Source: Adapted from Swann (2003, p. 342).

Imperfections exist in both public finance and chain goods solutions and, in the spirit of Wolf (1993), the relative merits of public finance and club goods solutions to RD&E are judged as a "choice between imperfect alternatives". Comparing their relative merits beyond the Type 1 and Type 2 errors entails a subjective assessment of various moderating influences. These various moderating influences, shown in Figure 18, are now described.

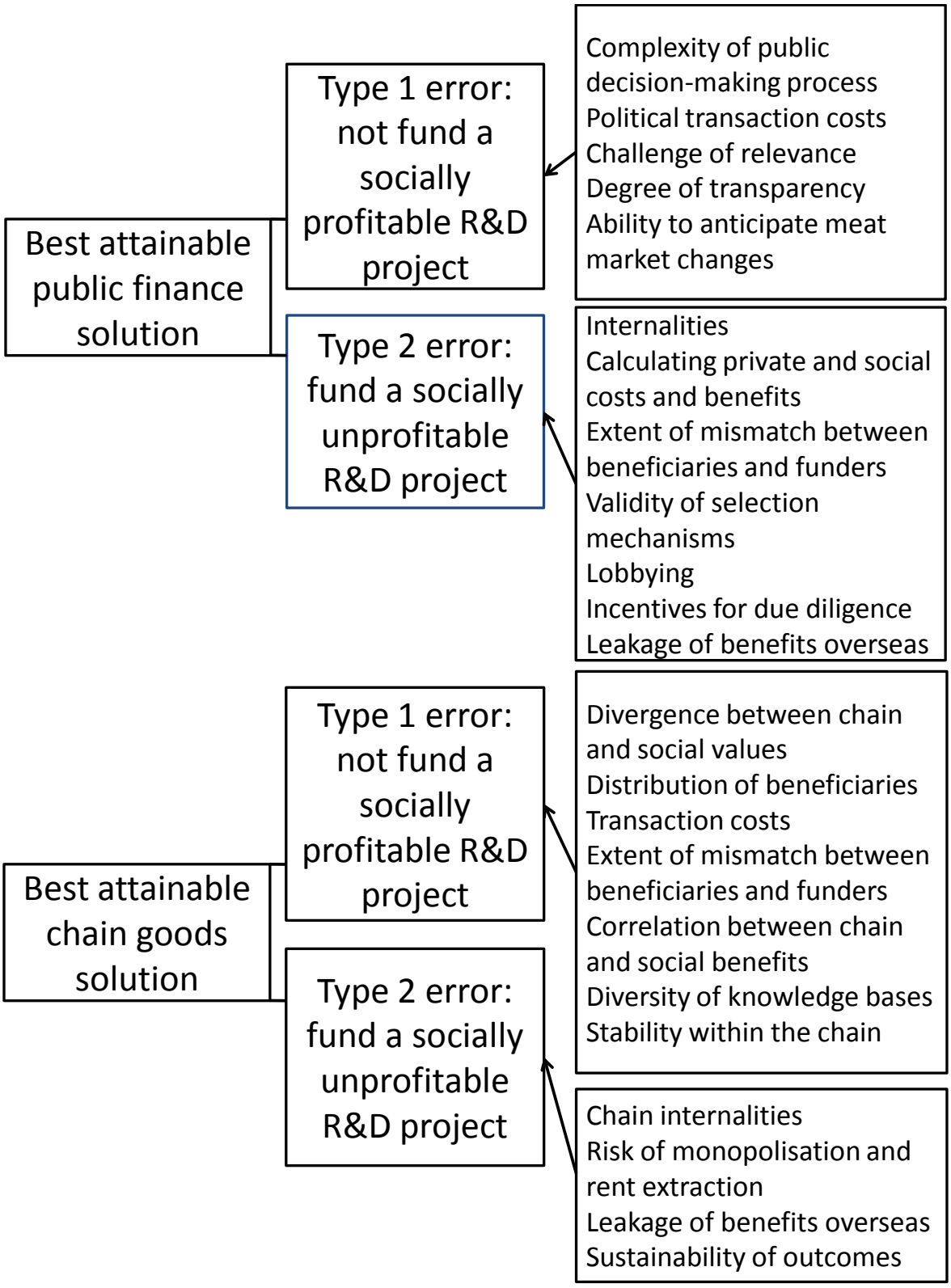


Figure 18. Assessing potential solutions for best attainable public finance and chain goods solutions

9.4 Influences Moderating Type 1 Errors

Complexity of the public decision-making process

Swann (2003, p. 340) observed that public decision making is more complex and prone to lobbying. The complexity of the public decision-making process has a confounding influence on both public finance and chain goods solutions. But this effect is more prominent in the public finance solution where there is a greater variety of competing demands for public finance and greater scope for lobbying by interest groups, while club (and hence chain) decision making is more straightforward.

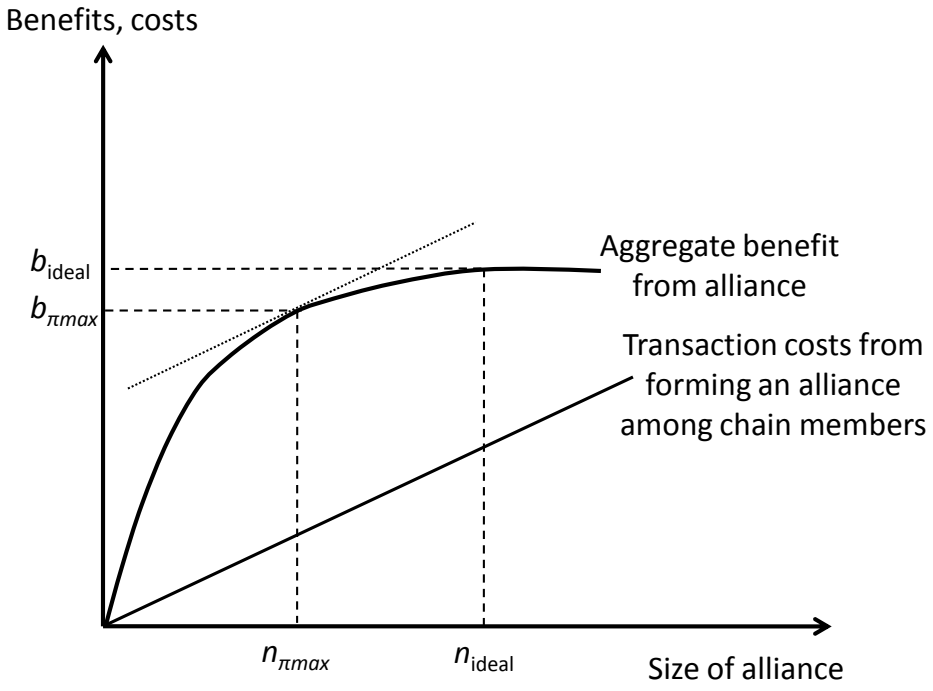
While lobbying is most likely to lead to a Type 2 error of funding socially unprofitable projects (see below), it can also lead indirectly to a Type 1 error among public finance solutions with some socially profitable projects consequently not being funded.

Transaction costs

Transaction costs affect Type 1 errors for both solutions (see the dotted line with an arrow in Figure 17). For a chain goods solution, they discourage the expansion of membership for a research project as it can be costly tracking down all beneficiaries from spillovers, especially given that knowledge of these spillovers *ex ante* is incomplete (Swann 2003, p. 340), and charging them for the benefits they receive. Political transaction costs can be substantial in a public finance solution even if the logistical costs associated with raising revenue through taxation are relatively small (Swann 2003, p. 341).

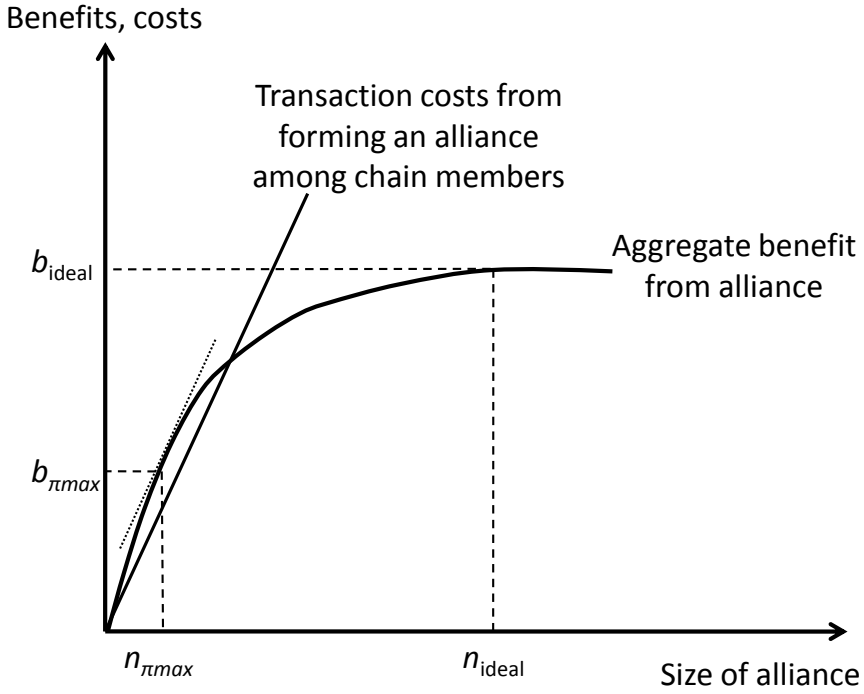
Governments will sometimes intervene to help a value chain lower its transaction costs. An example is where a government provides an incentive for chain members to participate by contributing part of the research costs, such as the cooperative research centres in Australia that are a strategic alliance of private industry, research institutes and government agencies (CRC 2012). The value chain also benefits from the exploitation of scale economies in research effort when alliance membership is increased.

The economics of funding RD&E in a chain is summarised in Figures 19 and 20 in respect of low and high transaction costs. A value chain seeks to maximise profits by setting marginal benefit equal to marginal cost, but we need not assume that all members will participate in an alliance to undertake a research project. In Figure 19, transaction costs – and hence the marginal cost of increasing the number of chain members in the alliance – are relatively low, consistent with an epidemic diffusion process (Swann 2003). The profit-maximising alliance ($n_{\pi max}$) is therefore quite large relative to the ideal (n_{ideal}). In Figure 20, transaction costs are relatively high. The profit-maximising club ($n_{\pi max}$) is small relative to the ideal (n_{ideal}). This situation corresponds to a probit diffusion process (Swann 2003).



Source: Adapted from Swann (2003, p. 347).

Figure 19. Funding RD&E in a chain with low transaction costs



Source: Adapted from Swann (2003, p. 347).

Figure 20. Funding RD&E in a chain with high transaction costs

Figures 19 and 20 illustrate two key points made by Swann (2003). First, the extent to which spillovers can be internalised depends on the "spatial" distribution of the beneficiaries, where "spatial" is used in a socioeconomic as well as geographical sense. Second, the achievable rate

of internalisation of spillovers depends on the precise character of the diffusion process. In sum, transaction costs are likely to be larger for the chain goods solution, but there may be large political transaction costs associated with the public finance solution.

Challenge of relevance

The challenge of proving their relevance faces administrators of both the public and chain funding of RD&E, and can cause Type 1 errors. As Swann (2003, p. 337) put it in terms of an "economic efficiency" or "value for money" issue, "how can researchers demonstrate to their funders the value of what they do?". He observed that "Such a challenge can become much harder in the public context because the constituency is the entire tax-paying public, rather than the select members of a club". If the persuasive powers of researchers in the public domain are insufficient, some socially desirable RD&E projects from society's viewpoint may not be funded, causing a Type 1 error.

Degree of transparency

The degree of transparency influences Type 1 errors where opacity leads to the non-selection of socially profitable RD&E projects. This problem is more common in the public finance solution, especially when combined with the complexity of the public decision making but, according to Swann (2003, p. 340), public organisations are more open to the scrutiny of the general public in principle (but not always in practice) than are clubs. Decision making in clubs tends to be more transparent to those within the club, but not to the general public.

Ability to anticipate meat market changes

RD&E is a stochastic process, made more uncertain by the need to forecast future outcomes in the meat value chain where demand and supply uncertainties are prevalent. Public sector administrators are expected to be less able to anticipate future changes in a meat value chain and therefore more prone to committing Type 1 errors in not recognising projects with high future payoffs than their counterparts within the value chain. For an example in meat markets, see Fearne (2009, p. 27).

Divergence between chain and social values

Swann (2003, p. 340) observed that private and social values diverge, a phenomenon that can be extended from private to the values of chain participants as a group. To the extent that value chain participants have a particular focus on maximising chain surplus, they are likely to be less aware of social issues when making RD&E decisions and therefore more likely to commit a Type 1 error by not funding socially desirable projects.

Distribution of benefits

Swann (2003) drew attention to the varied ways in which the benefits from RD&E outcomes are distributed to beneficiaries. The rate of internalisation of chain goods depends in large part on whether the diffusion of benefits from RD&E follows an epidemic or probit diffusion process. Swann (2003) noted that the use of processes is clustered in contiguous or coherent blocks in an epidemic process and the characteristics of actors are similar. In a probit process, the use of processes is not clustered but is spread in patchwork fashion across the population. The distribution of benefits from RD&E in value chains is likely to correspond more closely to an epidemic than to a probit diffusion process. Also, it is possible to map the stakeholders in a

chain and the flow of products between them, and to track changes in value added at each stage. Appropriation of funds from chain beneficiaries can be made by levying members according to their changes in value added, but this process may not be easy in all circumstances. Consider a meat value chain where the raw material is produced by numerous smallholders and collected, processed and wholesaled by numerous marketing intermediaries. It is difficult to locate the beneficiaries let alone survey them. Internalisation will be a challenge while trying to keep transaction costs low. However, this situation is more typical of livestock industries in developing countries than in developed countries such as Australia where, as mentioned below, there are means by which levies can be collected effectively from producers.

Extent of mismatch between beneficiaries and funders

An endemic problem that afflicts both solutions is where RD&E outcomes lead to a mismatch between the beneficiaries and funders. But it is especially prevalent for Type 1 errors for a chain goods solution because of a narrower set of funding sources than public funding solutions, where it may lead to a Type 1 error.

In terms of efficiency and equity, there are the risks of free riding, whereby a large number of externalities evade research levies, and forced riding, where chain members with market power impose research activities on less powerful members for whom they are unsuitable. Swann (2003, p. 340) referred to the matching of beneficiaries and funders as the "efficient composition" of RD&E. He demonstrated this criterion with the aid again of Type 1 and Type 2 errors. Table 5 illustrates efficient composition where the funding approach includes whom it should and excludes none who would benefit. Arguably, the Type 2 error is trivial for basic research, meaning that the public finance solution is preferred on this criterion. A key question then becomes: Are we more concerned about funding basic or applied research in value chains?

Table 5. Matching beneficiaries and funders as the efficient composition of RD&E

	Private benefit	**No private benefit**
Include	Correct decision	Type 2 error: public finance solutions prone to fall here
Exclude	Type 1 error: non-optimal chain goods solutions prone to fall here	Correct decision

Source: Adapted from Swann (2003, p. 340)

On the equity criterion, the free-riding problem characteristic of some (sub-optimal) solutions is shown in Table 6. The Type 2 error of charging those who do not benefit seems an inevitable attribute of public finance. It is much less likely for a chain goods solution but could occur if "forced riding" takes place whereby some chain members are coerced into partly funding RD&E against their private interests.

Table 6. The free-riding problem in RD&E

	Private benefit	**No private benefit**
Charge	Correct decision	Type 2 error: public finance solutions prone to fall here
Do not charge	Type 1 error: chain goods solutions may fall here if weakly excludable or non-excludable, and hence prone to free-riding	Correct decision

Source: Adapted from Swann (2003, p. 341).

The distribution of benefits from meat RD&E is deeply influenced by the structure of the meat value chain, particularly the large number of suppliers of raw materials – cattle properties producing beef, for example – and the concentrated processing stage, dominated by major brands, and highly concentrated retail stage, dominated in Australia by the two major supermarket firms. The issue of forced riding imposed on producers is an especially sensitive issue. Griliches (1958, 1971) argued that producers might not benefit greatly from research outcomes if the products they supply are demand-inelastic: rightward shifts of the supply function from RD&E would result in a fall in total revenue when the price-depressing effect outweighs the positive effect of increased supply. Duncan and Tisdell (1971), Jarrett and Lindner (1977) and Sarhangi et al. (1977) criticised and built on the original thesis posited by Griliches (1958, 1971) and generalised for econometric estimation by Peterson (1967). They pointed out that who gains and looses from agricultural research depends on the nature of both the demand and supply curves and the type of shifts in these curves induced by research outcomes. It is true that one possibility is that if the demand for the meat raw material entering a value chain from farms is price-inelastic, technical change within the chain could decrease the rents to the scarce resources in meat production as Griliches (1958, 1971) argued, but Duncan and Tisdell (1971), Jarrett and Lindner (1977) and Sarhangi et al. (1977) showed that this need not be the outcome in all circumstances.

Another potential for forced riding is if the levies paid for by producers, along with other chain participants, are used for RD&E that results in the introduction of new technologies along the

chain that in turn leads to the consumer demand for meats becoming more income-elastic relative to the raw material off farms. In this instance, producers would not receive much of the benefit from increased demand as consumers' incomes increase in the future. Value chain research might therefore be counterproductive from a private producer's viewpoint even though it is beneficial from a whole-chain perspective, and the internalisation of RD&E externalities will be a challenge while trying to keep transaction costs low.

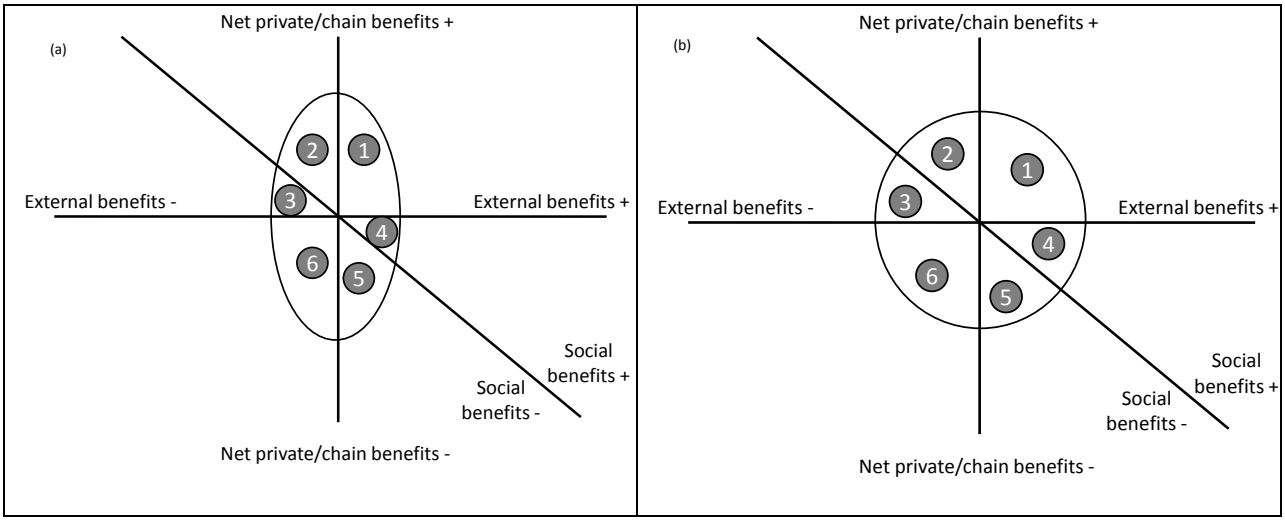
The degree of appropriability of knowledge generated by RD&E[17] also significantly affects the extent of mismatch between beneficiaries and funders. It varies markedly across a value chain being low in agricultural production and high in the supply of many farm inputs (through the use of patents) (Pray and Umali-Deininger 1998), and variable across the value chain beyond the farm.

Correlation between chain and social benefits

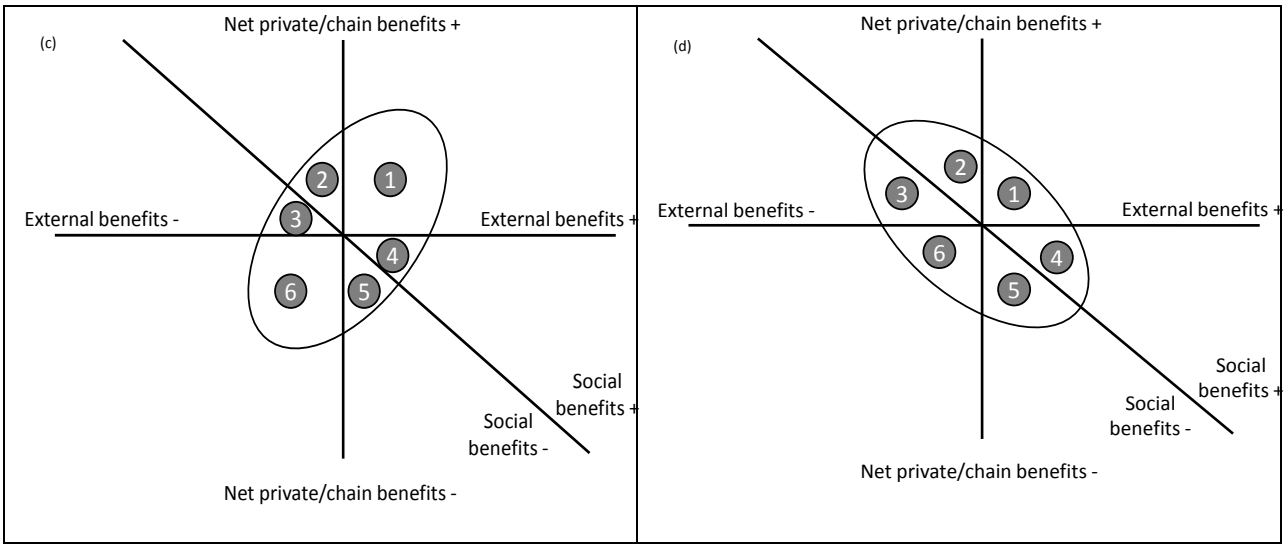
The seriousness of the difference between chain good solutions and public finance solutions depends on the joint distribution of private and chain benefits, and externalities and chain and public goods. Figure 21 summarises four different sorts of distribution that might be relevant (Swann 2003):

1. A high rate of internalisation
2. Variable returns and variable internalisation
3. Positive correlation between internal and external
4. Negative correlation between internal and external.

In Figure 21(a), a high rate of internalisation results in small problem areas 3 and 4. Returns and the rate of internalisation are variable in Figure 21(b), with problem areas 3 and 4 more substantial. In Figure 21(c), the ratio of externalities to chain benefits is constant, and problem areas 3 and 4 are small. In Figure 21(d), on the other hand, there is a highly variable rate of internalisation, with large problem areas 3 and 4. If the funding "club" were enlarged beyond the value chain by internalising some externalities, our project in area 4 would move in a north-westerly direction.



[17] Appropriability of technological advances affects the attribute of excludability in distinguishing between private and chain goods, on one hand, and public goods, on the other hand.



Source: Swann (2003, p. 346).

Figure 21. Four different sorts of distribution of RD&E benefits

These four distributions are compared in Table 7. Where the problem areas are substantial, failures in chain goods solutions will also be substantial. In practice, Swann (2003) noted, the rate of internalisation tends to be highly variable across basic research projects and there is no clear positive correlation between internal and external benefits. A key issue is the extent to which the rate of internalisation varies across applied research projects in meat value chains. There is a need to explore the factors influencing internalisation.

Table 7. Assessing different distributions of RD&E benefits

	Variability of social return	Rate of internalisation	Correlation between internal and external	Size of problem areas 3 and 4
Figure (a)	High	High	Nil	Small
Figure (b)	High	Variable	Nil	Substantial
Figure (c)	Very high	Variable	Positive	Small
Figure (d)	Low	Very variable	Negative	Substantial

Source: Adapted from Swann (2003, p. 347).

Stability within the chain

Stability within a meat value chain is a two-edged sword. The emergence of RD&E chain goods is probably of least concern in stable value chain environments, where the most likely beneficiaries are spatially contiguous and when there are few beneficiaries outside the value chain. On the other hand, the value of chain goods is likely to be greater where beneficiaries are not a tight-knit socioeconomic group in the value chain, where new and recent entry into the chain is important and where beneficiaries are widely dispersed (Swann 2003).

Diversity of knowledge bases

Internalisation of research externalities may be made more difficult in two specific sets of circumstances described by Swann (2003). First, innovators in value chains who accumulate insights from diverse knowledge bases will be spatially dispersed and the rate of internalisation will consequently tend to be low. Research funders will have more work to do, and chain goods solutions will become harder to implement. Because chain goods solutions presume stability and familiarity (see above), they are therefore likely to exhibit conservatism and be susceptible to capture by incumbents who resist new developments that threaten their competitive position. This situation is likely to discourage internalisation. In contrast, Swann (2003) asserts that publicly funded research projects encourage disruption of stability and familiarity. Much will depend on the attributes of agencies in the value chain. Pilon and De Bresson (2003, pp. 27-28) discussed how shared history and values, and tolerance for diversity to allow for new entrants and ideas can stimulate innovation.

Internalities

Internalities refer to non-market or government failure (Fleming, Heinecke and Dollery 2007) and are a seemingly inevitable outcome of the process of internalisation of externalities and the production of public goods. They are the non-market equivalent of externalities where individuals working in the non-market sector such as employees in government agencies divert the use of resources to satisfy their own goals, which diverge from social goals. The impetus for this divergence is the presence of incentives that differ from those that lead to socially optimal behaviour. It arises from a decoupling of beneficiaries from those who pay the costs of interventions aimed at meeting the need of those beneficiaries.

The term, internalities, was first coined by Wolf (1993) who posited that government intervention in market operations creates costs to society as a result of this. Fleming et al. (2007) developed a conceptual framework to examine internalities that scrutinises and values them within a benefit-cost analytical framework in the same manner that such a framework is used to identify and value externalities.

Public financing is particularly prone to internalities leading to Type 2 errors where socially unprofitable projects are funded at the expense of more deserving cases. Resources are used up in capturing funds for these projects (rent-seeking is one of the most egregious costs of non-market failure).

Calculating private and social costs and benefits

The calculation of private and social costs and benefits can lead to a Type 2 error in public funding. Many costs and benefits are difficult to quantify and their estimation is prone to error,

especially valuing some social benefits. Asymmetric information creates uncertainty surrounding policy interventions, increasing the difficulty in measuring all their social benefits and costs. But the measurement of private costs within meat value chains can also be difficult where the commercial-in-confidence defence is offered by firms that do not want to publicise their revenues and costs, raising the spectre also of Type 2 errors in chain goods solutions.

Validity of selection mechanisms

Invalid selection mechanisms that distort the choice of RD&E projects are a Type 2 error to which the public finance solution is especially prone. The risk of political interference in selection of RD&E projects is always present.

Lobbying

Lobbying can distort the RD&E project selection processes in both solutions, causing a Type 2 error of funding socially unprofitable projects. It is likely to be especially strong where government agencies are involved in selecting RD&E projects.

Incentives for due diligence

Swann (2003, p. 340) asserted that “incentives for due diligence are greatest in the private/club setting”. If this is true, it suggests that there is greater scope from this source for Type 2 errors with the public finance solution.

Leakage of benefits overseas

It was assumed above when examining the impacts of externalities on economic surplus that export-oriented industries face a perfectly price-elastic demand function. Where this is so, as shown in Figure 10, and research benefits are captured within the value chain, a positive production externality results in no leakage of surplus overseas. However, if this function were to be less than perfectly price-elastic, there will be some leakage depending on the elasticity value. Even if demand is price-elastic, research benefits are likely to be competed away and not greatly benefit the original investors in research activity if the research benefits are public (Griliches 1993, p. 391).

Risk of monopolisation and rent extraction

The risk of monopolisation occurs when chain members conduct RD&E to prevent the entry of new firms into the meat industry by using the market power of the chain and extracting rents from exclusive control of their intellectual property. A value chain is more able to extract rents from exclusive control of its intellectual property as internalisation increases its market power. This is demonstrated in Figure 17 by the vertical continuous line moving northwards into area 1 (positive net chain benefits). On one hand, this prospect encourages value chain participants to engage in RD&E projects that might otherwise not be worthwhile. But if the research activities and benefits are not freely available to current and future chain participants, total research effort and value chain competition may be eroded (Swann 2003). This outcome would lead to a Type 2 error.

Sustainability of outcomes

In an earlier section, the scope was described for creating negative externalities associated with practices in a value chain that threaten its sustainability. Lack of sustainability of processes and outcomes in the value chain resulting from RD&E projects based on a chain goods solution would lead to a Type 2 error characterised by negative externalities.

9.5 Public Finance and Chain Goods Solutions Compared

Swann (2003) concluded that there are two broad sets of circumstances in which public finance is preferable to attainable club (chain) goods solutions:

1. The ideal club (chain) goods solution converges to the public finance solution but is costlier to implement.
2. Transaction costs are high and the only viable club (chain) goods produce undesirable solutions.

These circumstances are more common in respect of basic research but could still apply in some situations involving the sorts of applied research projects in meat value chains.

We focus on convergence now and turn to the second set of circumstances below. One circumstance of convergence is where spillovers from research are widely dispersed, most commonly in projects conducting basic research. In this case, it is hard (and expensive) to assemble a suitable "club", or to rely on chain members, because to do so presumes some *ex ante* knowledge of where these beneficiaries are located and the scale of the benefits to each of them (Swann 2003). This sort of "chain failure" arises when benefits are uncorrelated with obvious firm characteristics (such as chain membership) or when it is hard to see how anyone would wish to make use of the products of the research project (Swann 2003).

Another circumstance of convergence, according to Swann (2003), is in a very complex economy – the Australian economy would be in this category. Many firms and individuals may benefit indirectly from a research project through multiplier effects, even if they are not direct beneficiaries. In a simple economy, on the other hand, the beneficiaries of an RD&E project are easier to identify and transaction costs of including them in the membership of the RD&E process and getting them to contribute to its funding are likely to be lower.

A third circumstance of convergence, according to Swann (2003), is when all taxpayers benefit, and benefits are positive and in proportion to tax paid. Leakages of benefits from the value chain are obviously going to be very high. A variant is where internal benefits are perfectly (or at least close to perfectly) correlated with external benefits. Areas 3 and 4 in Figure 25 are very small in this circumstance, and the chain goods solution is at odds with public finance.

Following Swann (2003, pp. 353-355), public finance is preferable to any attainable chain goods solution under the following three broad scenarios:

1. Transaction costs are high and the only viable chain groups are small, excluding many beneficiaries of research.
2. Attainable club (chain) good solutions are too exclusive.
3. Excessive closure associated with a value chain reduces technological variety.

There is another area of concern with clubs in general and, one suspects, value chains in particular. Consider the example of research into setting meat standards. There is strong pressure in the standards community to restrict membership to leading players in the interests

of securing rapid convergence on an accepted standard. Such leading players often reject the involvement of smaller players and customers, on the grounds that their involvement slows down the leading players and is anyway redundant. Swann (2003) warns that we should be sceptical of arguments that larger firms' interests encompass those of smaller firms and consumers. A recent Australian example is in the wine industry where major wine producers attempt to dominate the wine policy and research agenda (Mounter et al. 2011).

The current pragmatic solution in Australia

A pragmatic solution adopted to fund meat RD&E has elements of best attainable public finance and chain goods solutions, but lacks a vehicle to facilitate a Coasian solution. Meat & Livestock Australia Limited (MLA), as an Australian statutory authority, is well placed to offer a chain goods solution through its functions of providing marketing and RD&E services for Australia's cattle, sheep and goat producers. Most of its funding is derived from transaction levies placed on the sale of livestock, with the Australian Government providing matched funding for levy investment in most RD&E (MLA 2013). The decision in weighing up social and meat value chain benefits from RD&E is thus a 50:50 split in funding. While unlikely to be accurate, this solution avoids a lot of complicated calculations and arguments. If it is very inaccurate, the social and chain net benefits from meat RD&E are substantially suboptimal.

It also neglects the optimal two-part tariff pricing of club goods (membership fee plus payment for services). Treating the meat value chain as a "club" should enable a chain-facilitating agency such as MLA to use pricing mechanisms that maximise chain surplus by applying a two-part tariff ("entry fee" and payment for specific shared RD&E services that the corporation provides to chain members). The advantage of such a tariff is that it enables members of the "club" to convert latent demand for RD&E services into effective demand by internalising a chain good. By collectively paying for those services that suit their goals, chain members are able to enjoy the consumption of RD&E outputs that otherwise would not have been satisfied.

A quasi-Coasian solution

While a Coasian solution to funding RD&E in meat value chains is lacking, an example of a quasi-Coasian solution to funding RD&E is found in the wine industry where RD&E is facilitated by the actions of the Australian Wine Research Institute (AWRI). About 30 per cent of AWRI's activities are financed by the Grape and Wine Research Development Corporation (GWRDC) on a competitive basis, with a proportion of income being generated by AWRI's analytical service and contract services. AWRI is "industry driven", implying a role for the institute throughout the value chain. It plays a pivotal role in collaborative wine research by bringing stakeholders together to innovate, consistent with a Coasian solution to RD&E. It values collaboration highly: "Collaboration is an essential part of the research community and forms part of everything we do at the AWRI." This collaboration is largely achieved through the Wine Innovation Cluster (WIC) in which "partners have complementary assets and talents and the AWRI will continue to foster linkages with them and other national and international collaborators to the benefit of partners, stakeholders and the whole Australian wine sector".

9.6 Appraising RD&E in Meat Value Chains: Applying Benefit-Cost Analysis

Methods to appraise RD&E investments and identify the distribution of their rewards among chain members and between the chain and the general economy are important analytical tools.

Two alternative approaches could be adopted to appraise RD&E projects in meat value chains. The first approach, discussed in this section, is a standard application of benefit-cost analysis. This approach is consistent with the guiding principle of equi-marginal returns, discussed in section 2.1, and is practical where reasonable estimates can be made of the expected benefits from each project. The second approach is heuristic, using demand-pull techniques to ascertain where the greatest value can be added to the chain.

Benefit-cost analysis is sometimes used to determine what quantity of public goods to supply. Similar procedures could be used to determine the optimal level of chain goods.[18] A political process is frequently used to determine the supply of a public good, making it a governance issue. For chain goods, this process is usually in terms of strategic alliances (discussed above) including public-private collaboration.

An analytical framework is needed to detect the presence of chain goods, and to assess whether governing agency intervention through a strategic alliance is warranted to improve its overall performance and progress towards the optimal value chain. To do this, we adapt the framework developed by Pannell (2008) to the context of a value chain.

The starting point to consider is that participants in a meat value chain benefit from being members of strategic alliances, while the private firms and other groups that are non-members of the alliance cannot procure such benefits. In order to attain the benefits of strategic alliances, there is a need for a governing agency in the chain to play a role in establishing a policy framework and a set of policy mechanisms. Pannell's (2008) policy framework is adapted to develop a map of recommended policy mechanisms, as presented in Table 8.

Table 8. Alternative policy mechanisms to generate changes in the management of a meat value chain.

Category	Specific policy mechanisms
Positive incentives	Use of financial or regulatory instruments to encourage change in the meat value chain
Negative incentives	Financial or regulatory instruments to inhibit change in the meat value chain
Facilitation	Extension, technology transfer, education, training, communication and demonstrations to support the meat value chain network through strategic alliances
Technology change (TC)	Mechanisms that alter the benefits of meat value chain management options.
No action	Informed inaction

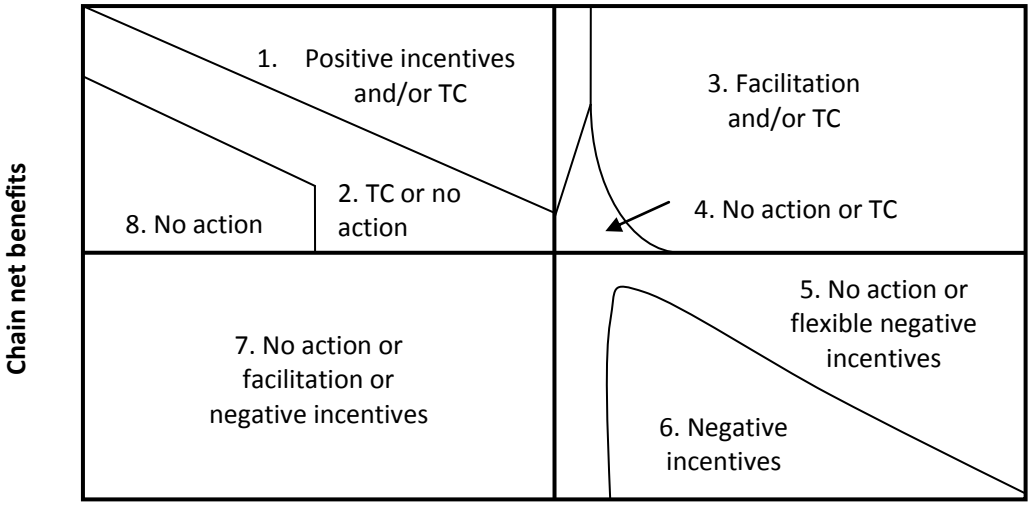
Source: Adapted from Pannell (2008, p. 4).

Table 8 shows the areas for possible actions within the meat value chain with different levels of chain and private net benefits that they may generate. The horizontal axis is defined as the private net benefit (in present value) derived by individual participants in the value chain for meat. The vertical axis is defined as the chain net benefit (in present value) derived by all participants in the value chain for meat. We change Pannell's (2008) use of social net benefit to chain net benefit to reflect the narrower focus of our policy analysis. Chain net benefit is defined as the net benefits derived by all firms and individuals who participate in the value chain for

[18] This framework could be expanded to include spillovers into the wider economy.

meat. Within this framework, we identify alternative policy mechanisms to generate changes in the management of this value chain.

The best choice of policy mechanism to encourage technical change (TC) depends on the levels of private net benefits and chain net benefits. Pannell (2008) calculates benefit-cost ratios (BCRs) to compare participants' behaviour with and without the intervention. Policy mechanisms are selected from the five categories in Table 8. Figure 22 shows the allocation of policy tools to interventions depending on the resulting levels of chain net benefit and private net benefit. The boundary of areas 8 and 2 is raised slightly to account for learning cost. For projects with positive but low private net benefits, positive incentives are used rather than facilitation because of the time lag to adoption; it is assumed that positive incentives can eliminate the lag. For projects with positive but low chain net benefits and private net benefits, facilitation is not suitable because the transaction costs are higher than the resulting benefits. The boundary for area 6 is moved to the right because, when learning costs are considered, private firms would not adopt changes with low private net benefits.



Source: Adapted from Pannell (2008, p. 12).

Figure 22. Recommended policy options for different levels of chain net benefits and private net benefits.

Figure 22 can also be used to consider TC. According to Pannell (2008), TC refers to any intervention that improves the net benefit (in our case, in the value chain for meat) such as strategic RD&E, participatory RD&E with chain participants, provision of infrastructure to support a new management option and training to enhance the performance of existing technologies. TC through RD&E is generated by new potential projects that are to the right of (more attractive to private participants in the chain) or above (more attractive to the chain as a whole) existing options. In addition, TC through training may move an existing value chain change to the right and/or upwards.

The comparison between the benefits of a TC intervention and the benefits of other changes in a meat value chain needs to be made according to the location of BCR lines. Pannell (2008)

observed that there are several factors influencing the ability to generate TC: the predicted improvement in public or private benefits of new technology compared with the best previous technology; the chance of RD&E delivering those predicted benefits; the time lag for improving technology; the discount rate; and the cost of RD&E management. He posited that the lag between intervention and benefits is expected to be shorter for training than for RD&E, whereas the potential for improvements in private net benefit may be higher for RD&E. While his concern was with the natural environment, the same principles apply in value chains.

Policy interventions that fall in areas 1, 3, 4 and 5 would generate positive net benefits. On the other hand, a policy intervention that falls in areas 2, 6, 7, and 8 may have any combination of positive or negative private or chain benefits. Positive and negative incentives are provided in different situations. Consider actions in areas 3, 4, 5 and 6 that all yield positive net benefits for private firms. If learning costs for private firms are taken into account, the following appropriate regulatory policies or pricing mechanisms to influence the attractiveness of each project to the participants in the value chain for meat are proposed.

Governing agency policy makers can use pricing mechanisms within the value chain to generate positive incentives in area 1, where they would generate chain net benefits that outweigh private net costs. They would also use positive incentives that yield small private net benefits for situations where there is a time lag to adoption. Otherwise, positive incentives are either not necessary (significant private incentives to change already exist), would result in negative public net benefits, or TC would be a preferred option.

In area 2, the option of RD&E to generate TC is preferred to positive incentives to value chain participants, with the boundary between areas 1 and 2 depending on the BCR of the RD&E. If the BCR is insufficient, no action should be taken by policy makers in this area.

Intervention is not necessary in area 3 because private firms would adopt changes (such as entering into strategic alliances) without the need for any incentives provided by the governing agency. But projects facilitating decision making by chain participants and/or TC are suited here. Paraphrasing Pannell (2008, p. 13), all benefits from changes in the value chain are captured by private firms in the top-right quadrant. It means that TC that only improves private net benefits might not be an attractive option to a governing agency trying to improve chain net benefits. However, TC that enhances the chain benefits from changes in management of value chain would be a more attractive option.

Area 4 shares a similar approach of policy inaction to area 3. As in area 3, TC is well suited to projects that result in both low positive chain net benefits and low positive private net benefits. On the other hand, facilitation is less well suited and not advised for situations of low benefits because of lags and learning costs.

In area 5, no action is required by the governing agency because private net benefits are sufficient to outweigh chain net costs. Alternatively, a relatively flexible negative incentive instrument may be used to persuade chain members to make decisions consistent with the overall welfare of participants in the value chain if there is uncertainty about whether private net benefits are sufficient to outweigh chain net costs. However, inflexible negative incentives, for example command and control, should not be used in this case (Pannell 2008) and are especially unsuitable for use in meat value chains.

In area 6, on the other hand, chain net costs are higher than private net benefits. Only negative incentives should be used by a governing agency to inhibit private action that is to the detriment of the whole value chain.

Chain net benefits and private net benefits are both negative in area 7. If it is recognised by value chain participants that private net benefits are negative, no action is needed by the governing agency. But negative incentives or advice might be needed to curb the actions of private firms if they misperceive the situation and expect to achieve private net benefits. It is unlikely that TC would result in an outcome situated in this quadrant as the BCR would not be greater than 1, and so it is not included as an option for governing agency action. In all cases in area 7, any intervention by the governing agency needs to be compared with a strategy of no action.

Governing agency policy does not have any role in area 8 because chain net benefits are larger than private net benefits. Regardless of the positive chain net benefits, private firms cannot achieve net benefits from TC or incentives provided by the governing agency sufficient to make it profitable for them to participate in projects.

9.7 Summary

There is not an emphatic case for either a best attainable public finance solution or best attainable chain goods solution to meat RD&E in Australia. The pragmatic 50:50 funding solution has its merits, but may well be an inaccurate measure of the distribution of benefits from internalisation by RD&E. Coasian solutions to RD&E within a value chain can help, but sometimes require a degree of nudging. This appears to be the case with wine, where these solutions are facilitated by the collaborative actions of AWRI.

10. Recommendations

Priorities for the governing agency of the meat value chain

We expect the governing agency in a meat value chain to have a potential role to play in counteracting many different types of chain failure. The following checklist of areas prone to chain failure provides a useful means to assess where intervention and/or investment is needed to correct for this failure:

- Meat RD&E
- Regulation of markets within the meat value chain
- Enhancing consumer and channel knowledge
- Chain sustainability
- Education and training
- Inventory aggregation
- Transportation policy
- Exploiting scale and scope economies in capital investment through joint action
- Risk sharing.

The first five of these forms of intervention/investment should be accorded highest priority as they offer the greatest scope to increase chain surplus and net social benefits. The other potential roles are important but tend to be less prone to chain failure. In addition, a sixth key role of the chain governing agency is governance and managing relationships.

Evaluating RD&E activity

Meat RD&E leads to process and product innovation (new or better tools and technologies for use in the value chain), new product development and systems/logistics innovation. It has traditionally been strong in livestock production, but has been less strong in other parts of the value chain and in integrating livestock genetics and production research with other activities in the chain.

Evaluating RD&E activity using formal methods such as benefit-cost analysis is fraught with difficulty because often the expected net benefit is unknowable and/or the probabilities of different outcomes is unknowable. In these situations, a consumer-oriented heuristic approach can be more effective, using demand-pull techniques to ascertain where the greatest value can be added to the chain, especially as product differentiation is an area of increasing importance in markets for meat products.

Financing RD&E activity

We suggest the following four approaches to determine who funds RD&E activities in meat value chains:

1. Where there is a reasonable expectation that private net benefits from a research activity will be positive – whether for an individual firm or group of firms acting collaboratively – a private goods solution should be selected regardless of spillovers.
2. A public finance solution is recommended where an RD&E activity is expected to result in a net social benefit but net chain loss, and (a) the ideal chain goods solution

converges to the public finance solution but is costlier to implement and (b) transaction costs are high and the only viable chain goods produce undesirable solutions.

3. A pure chain goods solution is recommended where a net chain benefit is expected from a research activity and spillovers to society as a whole are expected to be outweighed by the transaction costs of the chain governing agency engaging with governments.
4. A hybrid public finance/chain goods solution should be adopted to fund RD&E activity within a value chain where a net chain benefit is expected and spillovers to society as a whole are expected to be significantly greater than the transaction costs of the chain governing agency engaging with governments. A decision on the relative contributions of public and chain funding in these circumstances can be approximated using a four-step Delphi process to establish a scoring system. In the first step, the probabilities of Type 1 and 2 errors would be elicited for both solutions. Second, criteria would be identified that may moderate Type 1 and Type 2 errors in chain goods and public funding solutions. In the third step, the criteria would be weighted according to their potential to influence Type 1 and Type 2 errors. Finally, score the research activity and match to a funding process based on deciles (10:90 funding contribution, 20:80 funding contribution and so on).

Where it is considered impossible or too costly to judge the distribution of benefits of an RD&E activity, the current system of a 50:50 split between the national government and the meat value chain should be maintained.

Regulation of markets within the meat value chain

Regulation of markets within the meat value chain involves: establishing chain-wide standards and certification and uniform grading schemes; regulations to provide efficient and effective legal, taxation and competition environments; disease control: inspection services to control for pests and diseases and to regulate food safety; and operation of auction and other market facilities.

Facilitating the flow of information and knowledge in the chain

Enhancing consumer and channel knowledge entails facilitating the two-way flow of information and knowledge throughout the chain; coordination of roles taken by chain members in terms of contracts and design collaboration; and collaboration in the use of information and communication technologies. It helps build up channel knowledge at the local, regional, national and international levels. A consumer-oriented heuristic approach to RD&E will rely heavily on the dissemination of information and knowledge through the value chain, which generates chain goods and provides a compelling case for intervention to facilitate the flow.

Market power is usually considered to be the main reason to explain imperfect price transmission through meat value chains, but it is not the only reason. Other factors are transport and transaction costs, government interventions or policies, product differentiation, publicity, perishability of the product, and vertical coordination, which includes risk management contracts offered by some chain members[19].

Information is the lubricant of properly functioning meat value chains, and hence poor pricing efficiency imposes a cost. There is a clear need to harmonise the regulations to do with product description and food quality assurance. Markets are becoming increasingly differentiated and

[19] Some of these arguments are canvassed in more detail in UNE Business School (2014).

value added, but there is little evidence that chain partners, on average, have a sophisticated view of long-run optimal practice.

Information flow is critical at all levels of the meat value chain. The infrastructure needs of a meat value chain transitioning to higher value-added production will be greater and more diverse. One area that will need particular attention is communications infrastructure. Telecommunications infrastructure is becoming increasingly important to all chain members and producers in particular. Improved telecommunication infrastructure, including the availability and reliability of high-speed Internet, will improve producers' access to markets and other services, enable the use of remote technologies that save labour and fuel and improve management efficiency.

Chain sustainability

Making meat value chains sustainable is an emerging role for a chain governing agency that is likely to become increasingly important. The agency can act to internalise the negative chain and national externalities from environmental damage that are caused by chain activities.

Education and training

The chain governing agency has a key role to play in the education and training of the workforce in meat value chains. Examples are in developing management skills, including the formulation of business models and sourcing investment funds, aiding the accumulation within the chain of environmental knowledge, and education and training in value chain analysis.

Governance and managing relationships: 'oiling the wheels' for collective action within the meat value chain

Governance and managing relationships within a meat value chain involves both intra-chain management and liaison and negotiation with various government agencies at the national, state and local levels. In both cases, the aim is to minimise the transaction costs of collective action. Another vital role for the chain governing agency is likely to be enhancing competition within the chain, especially where there is heavy market concentration in retail and processing.
Involvement of the governing agency in the chain may be particularly desirable where there is friction obstructing potentially remunerative collaboration among private firms at different levels in the chain.

Pricing services offered by the governing chain agency

By treating the meat value chain as a club, a two-part tariff pricing mechanism can be applied to maximise both chain surplus and social welfare for shared services that the governing chain agency provides to chain members.

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Bibliography

Alston, J.M., Norton, G.W. and Pardy, P.G. (1995), *Science under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting*, Cornell University Press, Ithaca and London.

Anon. (2011), 'Yarra Valley to Victoria's High Country: A culinary adventure', *Spirit*, Winter 2011, 6-17.

Antonelli, C. (2010), "From population thinking to organization thinking: Coalitions for innovation": A review article of *Complexity Perspectives in Innovation and Social Change*, by Lane, D.A., van der Leeuw, S.E., Pumain, D., West, G. (eds.), Springer, Berlin, 2009, Working paper No. 2/2010, Università di Torino, Torino. Downloaded 15 November 2013 from: http://www.unito.it/unitoWAR/ShowBinary/FSRepo/D031/Allegati/WP2010Dip_L&B/2_WP_Momigliano.pdf

Australian Chicken Meat Federation (ACMF) (2011), The Australian chicken meat industry: An industry in profile, Australian Chicken Meat Federation. Downloaded 28 October 2013 from: http://www.chicken.org.au/industryprofile/downloads/The_Australian_Chicken_Meat_Industry_An_Industry_in_Profile.pdf

Australian Food and Grocery Council (2010), *State of the Industry 2010 — Essential information: facts and figures*, report prepared by KPMG, Canberra.

Baker, D., Hamza, K., Parker, W., Scrimgeour, F. and Griffith, G. (2014), "Primary industry chains and networks: public and private interests", paper presented to the 12th ANZAM Operations, Supply Chain and Services Management Symposium, University of Auckland, Auckland, New Zealand, 3-4 July.

Bannock, G., Baxter, R.F. and Davis, E. (1984), *Dictionary of Economics*, 3rd edn, Hutchinson, London.

Barling, D. (2007), "Food supply chain governance and public health externalities: upstream policy interventions and the UK state", *Journal of Agricultural and Environmental Ethics*, 20(2), 285-300.

Barry, P.J. (1995), "Industrialization of US Agriculture: Policy, Research and Education Needs", *Agricultural and Resource Economics Review*, Vol. 24:1.

Bassi, F. (2010), "Experiential goods and customer satisfaction: an application to films", *Qualitative Technology and Quantitative Management* 7(1), 51-67.

Bathelt, H., Malmberg, A. and Maskell, P. (2004), "Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation", *Progress in Human Geography* 28, 31-56.

Bonney, L., Clark, R., Collins, R., Dent, B. and Fearne, A. (2012), *Sustainable Value Chain Analysis: An Agri-Food chain Diagnostic*. Available at: http://www.pir.sa.gov.au/__data/assets/pdf_file/0017/120455/Final_version__SVCA_Methodology_guidePIMC_IDC_approved.pdf

Burch, D., Dixon, J. and Lawrence, G**.** (eds) (2013), "From Seedlings to Supermarket: Agrifood Supply Chains in Transition", *Special Edition of Agriculture and Human Values* 30, 2, 215-309.

Burch, D. and Lawrence, G**.** (eds) (2007), *Supermarkets and Agri-food Supply Chains: Transformations in the production and consumption of foods*, Edward Elgar, Cheltenham.

Burns, C. (2004), A review of the literature describing the link between poverty, food insecurity and obesity with specific reference to Australia, Food Insecurity Program, Victorian Health Promotion Foundation, Melbourne. Downloaded 30 October 2013 from: http://secondbite.org/sites/default/files/A_review_of_the_literature_describing_the_link_between_poverty_food_insecurity_and_obesity_w.pdf

Cahill, C. and Legg, W. (1989), "Estimation of agricultural assistance using producer and consumer subsidy equivalents: theory and practice", *OECD Economic Studies*, no.13, winter.

Calvet, J. (2005), "Les clusters vitivinicoles français à AOC: Une analyse en termes de biens clubs", *Revue d'Économie Régionale et Urbaine* 2005(4), 481-506.

Campbell, K.O. and Fisher, B.S. (1982), *Agricultural Marketing and Prices*, 2nd Edition, Longman Cheshire Pty Ltd, Sydney.

Capello, R. and Faggian, A. (2005), "Collective learning and relational capital in local innovation processes", *Regional Studies* 39(1), 75-87.

Caputo, V., Nayga, R.M. and Scarpa, R. (2013), "Food miles or carbon emissions? Exploring labelling preference for food transport footprint with a stated choice study", *Australian Journal of Agricultural and Resource Economics* 57(4), 465-482.

Carter, C. and Easton, P. L. (2011), "Sustainable supply chain management: evolution and future directions", *International Journal of Physical Distribution & Logistics Management*, 46-62.

Chopra, S. and Meindl, P. (2013), *Supply Chain Management: Strategy, Planning, and Operation*, Pearson, Harlow.

Cooperative Research Centre (CRC) Program (2012), *Cooperative research centres: an Australian Government initiative*. Available at: https://www.crc.gov.au/Information/default.aspx

Connell, P. (2004), “Durum wheat: Australia’s role in world markets”, *Australian Commodities* 11(2), 319-324.

Costanza, R. (2008), “Ecosystem services: Multiple classification systems are needed”, *Biological Conservation* 141, 350-352.

Department of Agriculture Forestry and Fisheries (DAFF) (2013), Australian export meat inspection system (AEMIS) information package. Downloaded 28 October 2013 from:
http://www.daff.gov.au/biosecurity/export/meat/elmer-3/meat-inspection-aemis-package

Dexter, J.E. and Marchylo, B.A. (2000), “Recent trends in durum wheat milling and pasta processing: Impact on durum wheat quality requirements”, in P. Feillet (ed.), *Proceedings of an International Workshop on Durum Wheat, Semolina and Pasta Quality: Recent Achievements and New Trends*, 27 November, Institute National de la Recherche, Montpellier, France, pp. 77-101.

Doljanin, A. (2012), Aligning price signals throughout the beef value chain to reflect consumer preferences by assigning economic weights to the Meat Standards Australia (MSA) model inputs, Master of Economics thesis, University of New England, Armidale.

Dollery, B.E., Grant, B. and Kortt, M. (2012), *Councils in Cooperation: Shared Services and Australian Local Government,* Federation Press, Sydney.

Duffy, R. and Fearne, A. (2004), “The impact of supply chain partnerships on supplier performance: an empirical study of the UK fresh produce industry”, *International Journal of Logistics Management* 15(1), 57-71.

Duncan, R. and Tisdell, C. (1971), “Research and technical progress: The returns to producers”, *Economic Record* 47, 124-129.

Fearne, A. (2009), Sustainable food and wine value chains, Government of South Australia. Downloaded 5 November 2012 from:
http://www.pir.sa.gov.au/__data/assets/pdf_file/0017/120419/Fearne_Final_Report.pdf

Fearne, A. et al. (2009), Sustainable value chain analysis: A case study of South Australian wine. Downloaded 5 November 2012 from:
http://www.pir.sa.gov.au/__data/assets/pdf_file/0003/93225/V2D_Final_Report.pdf

Feller, A., Shunk, D. and Callarman, T. (2006), “Value chains versus supply chains”, *BPTrends*, March.

Fleming, E., Heinecke, D. and Dollery, B. (2007), “An analytical framework for assessing the impact of internalities on policy and projects using examples from Papua New Guinea”, *Impact Assessment and Project Appraisal* 25(3), 199-207.

Foodwise (2013), Fast facts on food waste. Downloaded 30 October 2013 from:
http://foodwise.com.au/foodwaste/food-waste-fast-facts/

France24 (2013), Horsemeat scandal highlights lack of traceability. Downloaded 28 October 2013 from:
http://www.france24.com/en/20130212-france-findus-beef-horse-meat-lasagna

Gans, J., King, S. and Mankiw, N.G. (2012), *Principles of Microeconomics*, 5th Edition, Cengage Learning, South Melbourne.

Gereffi, G., Humphrey, J. and Sturgeon, T. (2005), "The governance of global value chains", *Review of International Political Economy 12:1*, 78–104.

Giuliani, E. (2007), "The selective nature of knowledge networks in clusters: evidence from the wine industry", *Journal of Economic Geography* 7, 139-168.

Giuliani, E., Morrison, A. and Rabellotti, R. (2011), "What have we learned from the wine industry? Some concluding remarks", in E. Giuliani, A. Morrison and R. Rabellotti (eds), *Innovation and Technological Catch-Up: The Changing Geography of Wine Production*, Edward Elgar, Cheltenham, pp. 199-210.

Giuliani, E., Pietrobelli, C. and Rabellotti, R. (2005), "Upgrading in global value chains: Lessons from Latin American clusters", *World Development* 33(4), 549-573.

Glaeser, Edward L. (1995), "The incentive effects of property taxes on local governments," NBER Working Papers 4987, National Bureau of Economic Research, Inc., Cambridge, MA.

Glaeser, Edward L., Laibson, David and Sacerdote, Bruce (2000), "The economic approach to social capital," NBER Working Papers 7728, National Bureau of Economic Research, Inc., Cambridge, MA.

Grant, B., Fleming, E., Mounter, S., McFarlane, J. and Griffith, G. (2013), "Collective action in the value chain: A conceptual framework for analysis and policy for the Australian wine Industry", *Enometrica* 6(1), March.

Griffith, G.R., Rodgers, H.J., Thompson, J.M. and Dart, C. (2009), "The aggregate economic benefits from the adoption of Meat Standards Australia", *Australasian Agribusiness Review* Volume 17, Paper 5, pp. 94-114.
Available at: http://www.agrifood.info/review/2009/Griffith_Rodgers_Thompson_Dart.pdf

Griffith, G. and Thompson, J. (2012), "The aggregate economic benefits to the Australian beef industry from the adoption of Meat Standards Australia: updated to 2010/11", *Australasian Agribusiness Review* 20(2), 11-38.

Griffith, G., Thompson, J., Polkinghorne, R. and Gunner, R. (2010), "Meat Standards Australia as an innovation in the Australian beef production and marketing system", Paper presented at the 4th International European Forum on System Dynamics and Innovation in Food Networks, Innsbruck, Austria, 8-12 February.

Griffith, G., Umberger, W., Gow, H. and Fleming, E. (2012), "What is the role of local governments in new global food markets?", Paper presented at the 6th International European Forum on System Dynamics and Innovation in Food Networks, Innsbruck, Austria, 14-18 February.

Griliches, Z. (1958), "Research costs and social returns: Hybrid corn and related innovations", *Journal of Political Economy* 66(5), 419-431.

Griliches, Z. (1971), “Research costs and social returns: Hybrid corn and related innovations”, in N. Rosenberg (ed.), *The Economics of Technological Change*, Penguin, Harmondsworth.

Griliches, Z. (1993), “Implementing a national technology strategy with self-organising industry investment boards – Comments and discussion”, in M.N. Baily, P.C. Reiss and C. Winston (eds), *Brookings Papers on Economic Activity: Microeconomics*, Vol. 2, pp. 391-399.

Harden, G. (1968), “The tragedy of the commons”, *Science* 162, 1243-1248.

Heller, M.C. and Keoleian, G.A. (2000), *Life Cycle-Based Sustainability Indicators for Assessment of the U.S. Food System*, Centre for Sustainable Systems. Downloaded 12 March 2013 from:
http://css.snre.umich.edu/css_doc/CSS00-04.pdf

Hicks, J.R. (1939), “The foundation of welfare economics”, *Economic Journal* 49, 696-712.

Hochman, O. (2011), “Efficient agglomeration of spatial clubs”, *Journal of Urban Economics* 69, 118-135.

Hubbard, R.G., Garnett, A.M., Lewis, P. and O’Brien, A.P. (2012), *Microeconomics*, 2nd edition, Pearson, Sydney.

Humphrey, J. and Schmitz, H. (2000), Governance and upgrading: Linking industrial cluster and global value chain research, IDS Working Paper No. 120, Institute of Development Studies, University of Sussex, Brighton.

Institute for Strategy and Competitiveness (2013), Clusters and cluster development, Downloaded 15 November 2013 from: http://www.isc.hbs.edu/economicdevelopment.htm

Jarratt, D.G. (1998), “A strategic classification of business alliances: A qualitative perspective built from a study of small and medium-sized enterprises”, *Qualitative Market Research: An International Journal* 1(1), 39-49.

Jarrett, F.G. and Lindner, R.K. (1977), “Research benefits revisited”, *Review of Marketing and Agricultural Economics* 45(4), 147-178.

Johansson, B. and Quigley, J.M. (2004), “Agglomeration and networks in spatial economies”, *Papers in Regional Science* 83, 1-13.

Kneipp, J. (2008), Durum wheat production, NSW Department of Primary Industries, Orange.

Kohls, R. and Uhl, J.N. (1980), *Marketing of Agricultural Products*, 5th Edition, Macmillan Publishing Co., New York.

Krugman, P. (1995), *Development, Geography and Economic Theory*, MIT Press, Cambridge, MA.

Lane, D.A. (2002), “Complexity and local interactions: Towards a theory of industrial districts”, in A. Quadrio Curzio and M. Fortis (eds), *Complexity and Industrial Clusters: Dynamics and Models in Theory and Practice*, Physica-Verlag, New York.

Lazzarini, S.G., Chaddad, F.R. and Cook, M.L. (2001), "Integrating supply chain and network analyses: the study of netchains", *Chain and Network Science* 1(1), 7-22.

Liebowitz, S.J. and Margolis, S.E. (1995), "Are network externalities a new source of market failure?", *Research In Law And Economics* 17: 1-22.

Mann, S. (2003), "Why organic food in Germany is a merit good", *Food Policy* 28, 459-469.

Manzini, P. and Mariotti, M. (2002). "A tragedy of the clubs: excess entry in exclusive coalitions", *Journal of Public Economic Theory* 4(1), 115-136.

Marshall, A. (1920), *Principles of Economics*, 8th edition, Macmillan, London.

Marshall, G. (2001), Crafting cooperation in the commons: an economic analysis of prospects for collaborative environmental governance, PhD thesis, University of New England, Armidale.

McNutt, P. (1999), "Public goods and club goods", in B. Bouckaert and G. de Geest, (eds), *Encyclopedia of Law and Economics*. Cheltenham, Edward Elgar. Downloaded on 30 May 2011 from: http://www.scribd.com/doc/239217/0750-Public-Goods-and-Club-Goods

McVitie, A., Moran, D. and Thomson, S. (2009), A review of the literature on the value of public goods from agriculture and the production impacts of the single farm payment scheme, Research report, Rural Policy Centre, Scottish Agricultural College, Edinburgh. Downloaded 1 October 2013 from:
http://www.scotland.gov.uk/Resource/Doc/278281/0093368.pdf

Meat and Livestock Australia (MLA) (2013), About MLA. Downloaded 28 October 2013 from: (http://www.mla.com.au/About-MLA)

Mishan, E.J. (1971), "The post-war literature on externalities: An interpretative essay", *Journal of Economic Literature* 9(1), 1-28.

Morrison, A. and Rabellotti, R. (2009), "Knowledge and information networks in an Italian wine cluster", *European Planning Studies* 17(7), 983-1006.

Mounter, S., Grant, B, Fleming, E. and Griffith, G. (2011), "Latecomers: Charting a course for the New England Australia wine region", *Australasian Journal of Regional Studies* 17(3), 298-327.

Mueller, R.A., Buergelt, D. and Seidel-Lass, L. (2007), "Supply Chains And Social Network Analysis", paper presented at the 1st International European Forum on Innovation and System Dynamics in Food Networks, Innsbruck-Igls, Austria, February.

Mullen, J.D. (2010), 'Trends in investment in agricultural RD&E in Australia and its potential contribution to productivity', *Australasian Agribusiness Review*, vol. 18, pp. 18–29.

Oakerson, R. (1999), *Governing Local Public Economies*. ICS Press, Oakland.

Oakes, D. and Lewis, P. (2013), Barnaby Joyce urges against overreaction to footage of cruelty to Australian sheep in Middle East. Downloaded 31 October 2013 from: http://www.abc.net.au/news/2013-10-30/new-footage-puts-live-export-industry-back-in-the-spotlight/5059060

O'Donnell, C.J. (2010), "Measuring and decomposing agricultural productivity and profitability change", *Australian Journal of Agricultural and Resource Economics* 54, 527-560.

Omta, S.W.F., Trienekens, J. and Beers, G. (2001a), "Chain and network science: a research framework", *Chain and Network Science* 1(1), 1-6.

Omta, S.W.F., Trienekens, J. and Beers, G. (2001b), "The knowledge domain of chain and network science", *Chain and Network Science* 1(2), 77-85.

Omta, S.W.F., Trienekens, J. and Beers, G. (2002), "A research and management agenda for chain and network science", *Chain and Network Science* 2(1), 1-5.

Organisation for Economic Cooperation and Development (OECD) (2007), *Moving Up the Value Chain: Staying Competitive in the Global Economy. A Synthesis Report on Global Value Chains*, OECD, Paris,

Organisation for Economic Cooperation and Development (OECD) (2009), *Agricultural Policies in OECD Countries – Monitoring and Evaluation*, OECD, Paris.

Pannell, D.J. (2008), "Public benefits, private benefits, and policy intervention for land use change for environmental benefits", *Land Economics* 84(2), 225-240.

Parr, J. (2002), "Missing elements in the analysis of agglomeration economies", *International Regional Science Review* 25(2), 151-168.

Penny, S. (2000), Crop updates – durum wheat obtains a premium over bread wheat, Agriculture Western Australia. Downloaded 1 November 2012 from: http://www.agric.wa.gov.au/PC_91067.html

Perkins, C. (2013), Canada invests millions behind beef industry. Downloaded 11 November 2013 from: http://www.globalmeatnews.com/Industry-Markets/Canada-invests-millions-behind-beef-industry

Peterson, W.L. (1967), "Returns to poultry research in the United States", *Journal of Farm Economics* 49, 656-669.

Pilon, S. and De Bresson, C. (2003), "Local culture and regional innovation networks: Some propositions", in D. Fornahl and T. Brenner (eds), *Cooperation, Networks and Institutions in Regional Innovation Systems*, Ashgate, Burlington, VT, pp. 15-37.

Pindyck, R.S. and Rubinfeld, D.L. (2012), *Microeconomics: International Edition*, Pearson Australia Group Pty Ltd. Sydney.

Polkinghorne, R., Philpott, J., Gee, A., Doljanin, A. and Innes, J. (2008), "Development of a commercial system to apply the Meat Standards Australia grading model to optimise the return

on eating quality in a beef supply chain", *Australian Journal of Experimental Agriculture* 48, 1451-1458.

Polkinghorne, R., Watson, R., Porter, M., Gee, A., Scott, A. and Thompson, J.M. (1998), "Meat Standards Australia, a 'PACCP' based beef grading scheme for consumers: 1. The use of consumer scores to set grade standards", *Proceedings of the International Congress of Meat Science and Technology* 45, 14-15.

Porter, M. (1985), *Competitive Advantage, Creating and Sustaining Superior Performance,* The Free Press, New York.

Porter, M.E. (1998), "Clusters and the new economics of competition", *Harvard Business Review*, November–December, 77-90.

Porter, M.E. (2000), "Location, competition and economic development: local clusters in a global economy", *Economic Development Quarterly*, 14(1), 15-34.

Powell, W.W. (1990), "Neither market nor hierarchy: network forms of organisation", *Research in Organisational Behaviour* 12, 295-336.

Pray, C.E. and Umali-Deininger, D. (1998), "The private sector in agricultural research systems: Will it fill the gap", *World Development* 26(6), 1127-1148.

Preissl, B. and Solimene, L. (2003), *The Dynamics of Clusters and Innovation: Beyond Systems and Networks*, Springer-Verlag, Heidelberg.

Productivity Commission (2011), *Rural Research and Development Corporations*, Report No. 52, Final Inquiry Report, Canberra.

Robinson. T.M., and C.M. Clarke-Hill (1994), "Competitive advantage through strategic retailing alliances: An European perspective", Paper presented at the Recent Advances in Retailing and Services Science Conference, Banff, Alberta.

Rolle, R.S. (2006), "Processing of fruit and vegetables for reducing postharvest losses and adding value", in R.S. Rolle (ed.). *Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region*, Asian Productivity Organisation, Tokyo, pp. 32-42.

Romer, P. (1993), "Implementing a national technology strategy with self-organizing industry investment boards", in M.N. Baily, P.C. Reiss and C. Winston (eds), *Brookings Papers on Economic Activity: Microeconomics*, Vol. 2, pp. 345-390.

Roper, S., Vahter, P. and Love, J.H. (2013), "Externalities of openness in innovation", *Research Policy* 42, 1544-1554.

Sarhangi, R.F., Logan, J., Duncan, R.C. and Hagan, P. (1977), "Who benefits from agricultural research: Comment", *Review of Marketing and Agricultural Economics* 45(4), 179-185.

Saunders, C., Barber, A. and Sorenson, L.-C. (2009), Food miles, carbon printing and their potential impact on trade, Paper presented to the 53rd AARES Annual Conference, 13-15 February. Downloaded 28 October 2013 from: http://ageconsearch.umn.edu/handle/48051

Schmitz, H. (1999), "Collective efficiency and increasing returns", *Cambridge Journal of Economics* 23, 465-483.

Simmons, D., Francis, M., Bourlakis, M. and Fearne, A. (2003), "Identifying the determinants of value in the U.K. red meat industry: A value chain analysis approach", *Chain and Network Science* 3(2), 109-121.

Smith, T.G., Chouinard, H.H. and Wandschneider, P.R. (2011), "Waiting for the invisible hand: novel products and the role of information in the modern market for food", *Food Policy* 36, 239-249.

Soosay, C., Fearne, A. and Dent, B. (2012), "Sustainable value chain analysis – a case study of Oxford Landing from "vine to dine"", *Supply Chain Management: An International Journal*, 68–77.

Stimson, R.J., Stough, R.R and Roberts, B.H. (2006), *Regional Economic Analysis and Planning Strategy*, 2nd edition, Springer, Heidelberg.

Swann, G.S.P. (2003), "Funding basic research: when is public finance preferable to attainable 'club goods' solutions?", in A. Geuna, A.J. Salter and W.E. Steinmuller (eds), *Science and Innovation: Rethinking the Rationales for Funding and Governance*, Edward Elgar, Cheltenham.

Taylor, M. (2005),"Embedded local growth: A theory taken too far?", in R.A. Boschma and R. Kloosterman (eds), *Learning from Clusters: A Critical Assessment from an Economic Geographical Perspective*, Springer, Dordrecht.

Thompson, J.M. (2002), "Managing meat tenderness", *Meat Science* 62, 295-308.

Thompson, J., Polkinghorne, R. and Griffith, G. (2012), A carcass index for MSA, Paper presented to BeefEx 2012, 9-11 October, Ashmore, QLD.

Tomek, W.G. and Robinson, K.L. (1972), *Agricultural Product Prices*, First Edition, Cornell University Press, Ithaca.

Tourism Victoria (2012), Marketing your tourism business. Downloaded on 5 February 2012 from: http://www.tourism.vic.gov.au/industry-resources/industry-resources/marketing-your-tourism-business/

Troccoli, A., Borrelli, G.M., de Vita, P., Fares, C. and di Fonzo, N. (2000), "Mini review: Durum wheat quality: A multidisciplinary concept", *Journal of Cereal Science* 32(2), 98-113.

UNE Business School (2014), Submission to the White Paper on the Competitiveness of the Agriculture Sector, University of New England, Armidale.

Varadarajan, P.R. and Cunningham, M. (1995), "Strategic alliances: a synthesis of conceptual foundations", *Journal of the Academy of Marketing Science* 23(4), 282-296

Weaver, R.D. (2009), "Microeconomics of collaboration and network configurations", *British Food Journal* 111(8), 746-761.

Weaver, R.D. (2010), “Supply chain and network performance: metrics for profitability, productivity and efficiency”, *International Journal of Food System Dynamics* 1, 56-68.

Wolf, C. (1993), *Markets or Governments: Choosing between Imperfect Alternatives*, 2nd edition, MIT Press, Cambridge, MA.

APPENDICES

Appendix 1. Terminology

The terminology we use for the concepts we have developed is potentially confusing and potentially controversial. Here we provide definitions of the terms we use and a rationale for why we have chosen them.

One of the original terms created was that of the "supply chain". There are numerous definitions: Wikipedia says "A supply chain is a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. Supply chain activities transform natural resources, raw materials, and components into a finished product that is delivered to the end customer." Lazzarini et al. (2001, 7) say "Supply chains are defined as a set of sequential, vertically organised transactions representing successive stages of value creation." While this latter definition mentions value, when the term "supply chain management" was coined in the early 1980s it was very much about the flows of product and information. However, no matter which definition is chosen, the primary focus of supply chains is on a particular product or service, from the point of view of a particular firm.

Another original concept was that of a "network" of firms, that is, the horizontal relationships between firms belonging to a particular industry or group (Powell 1990). Firms belong to networks primarily to promote knowledge exchange.

In the European literature, the terminology "chains and networks" is common. There is now a *Journal on Chain and Network Science*, and the editors have published various papers outlining their view of the content and scope of chain and network theory and a broad research agenda covering the field (Omta et al. 2001a,b, 2002). The term "netchain" has been promoted as a formal way to integrate supply chain analysis and network analysis (Lazzarini et al. 2001).

In the US literature, the concept of a "value chain" was developed and popularised by Porter (1985) as part of a competitive strategy to improve business performance. Porter defined value as the amount buyers are willing to pay for what a firm provides. He conceived the value chain as comprising nine generic value-adding activities operating within a firm that, when combined, provide value to customers. The aim of value chain participants is to maximise this value. Thus, a value chain includes a supply chain, but in addition, includes processes that create, capture and transmit value. The primary focus in value chains is on the benefits that accrue to customers, the interdependent processes that generate value, and the resulting demand and flow of funds that are created. Value is added at each stage in the chain. Summing these values added yields total chain value. Effective value chains generate profits (Feller, Shunk and Callarman 2006), which are a measure of the surplus of the value chain.

Porter (1985) linked the value chains between firms to form what he called a "value system". An industry value system is therefore a representation of the various physical, financial and informational processes involved in producing and marketing goods and services, starting with raw materials and ending with the delivered product, and covering all firms in that industry.

In trying to rationalise the two sets of literature, our preference would be to use the chain and network terminology. However, when we came to test that against the concepts we were considering, we found that the term “network externality” already had a precise (and different) meaning. “Network externality has been defined as a change in the benefit, or surplus, that an agent derives from a good when the number of other agents consuming the same kind of good changes” (Leibowitz and Margolis 1995).

Thus at least in this version of our writing, we have decided to go back to the original Porter concepts of value chains (from the point of view of an individual firm) and value systems (from the point of view of an industry).

Value chain: the value-producing activities of one organisation

Value system: the network of organisations and value-producing activities involved in the production and delivery of an offering to the end customer.

Appendix 2. Local Collective Failure as a Guide for Analysing Chain Failure

Some common themes exist in the literature on clusters[20] and value chains. In order to develop a full set of analytical tools on market failure at different levels of aggregation, it is worth defining failure at a local as well as chain level to provide a clear separation between its sources and remedy in different domains. Locality is defined in space by the boundary around some disaggregated level of the national economy such as region, district, city, town or village. To simplify matters, we focus on local government areas (LGAs) in Australia where the form of government is typically a council. The local economy at this level is subject to two main forms of failure in the guise of "local public goods" and "local club goods". The former affect all the population of an LGA whereas the latter affect a specific group of the local population.

"Joint action", to use the terminology of Schmitz (1999), is used to produce and provide these goods, notably from the exploitation of agglomeration economies[21] associated with proximity. For local public goods, the main agency is the local government authority, or council. Dollery, Grant and Kortt (2012, p. 55) used Oakerson's (1999, p. 15) description of local public goods as having distinctive characteristics and a reliance on "the availability of specific time-and-place information, such as neighbourhood conditions, to support effective production choices". Grant et al. (2013) argued that the distinctiveness of local public goods and the advantages that can be derived from their production and provision have echoes of Porter's (1998) cluster model.

To capture the economies of proximity, Johansson and Quigley (2004) emphasised the need to identify the source and nature of the benefits. They categorised agglomeration economies into three (often interconnected) basic cases: "In the first place, an entire industry may benefit from agglomeration, since the size of the agglomeration provides sufficient demand to allow individual firms with internal scale economies to develop differentiated products. Second, an individual firm may benefit from the option to buy more specialised inputs at lower transactions costs from differentiated input suppliers within the region. Third, an individual firm may benefit from information spillovers outside the market that arise from proximity within an agglomeration". (Johansson and Quigley 2004, p. 4)

Along similar lines, Parr (2002, p. 159) identified three forms of external economies derived from agglomeration (he also defined three types of internal economies): (1) external economies of localisation (the co-location of several independent firms in the same industry); external economies of urbanisation (the co-location of firms in different, unrelated industries that exploit scope economies); and (3) external activity-complex economies achieved by a specific set of firms that have linkages, such as those in a value chain) that derive from productivity gains

[20] The term, cluster, is often used in a general or non-spatial sense, which differs from what we regard as a cluster. For example, Perkins (2013) referred to government funding of RD&E in the beef industry in Canada, called the "beef cattle industry science cluster", that resembles an Australian CRC rather than a spatially defined cluster. We follow the definition of clusters used by the Institute for Strategy and Competitiveness (2013) as "*geographic concentrations* of interconnected companies, specialised suppliers, service providers, and associated institutions in a particular field that are present in a nation or region" [emphasis added].

[21] We define agglomeration economies as increases in the total factor productivity of a firm that are brought about by the concentration of economic activity in a specific location or a defined geographical region. Agglomeration economies may be internal or external to a firm, with the implication that internal agglomeration economies can be fully captured by the firm and require no joint action.

induced by their co-location. Henceforth, we shall refer to external economies that reflect Parr's taxonomy and include only the external types of his agglomeration economies.

Increasing returns to scale from the capture of external economies (Schmitz 1999) are frequently associated with scope economies. The nature of this relationship is consistent with the first basic case of Johansson and Quigley (2004) of the development of differentiated products by firms in an industry, and with the second type of agglomeration outlined by Parr (2002) of the co-location of firms that exploit scope economies.

The distinction between local public goods and local club goods is often an empirical one. Johansson and Quigley (2004) observed that their third basic case can affect the productivity of an individual firm (or, by extension, a group of firms) or the productivity of an entire region. The latter case in an LGA warrants an intervention by the local government authority while the former may induce a group from the locality to form a club to capture the external benefits.

Hochman (2011) argued that the literature on agglomeration had focused too narrowly on primary agglomeration caused by direct attraction effects. He widened the focus to include secondary and tertiary agglomerations that arose because of the presence of the primary agglomeration. His paper is of particular interest because of the way the primary agglomeration attracts clubs once the secondary agglomeration has occurred, and these clubs provide facilities. The same process may occur where there is secondary and tertiary agglomeration of value chains where follower value chains are attracted by an original one.

Schmitz (1999, p. 469), like many before and after him, stretches the concept of cluster beyond its usefulness by including vertical forms of joint action, namely "producer and user improving components" and "alliance across value added chain". We concur with Taylor (2005, p. 69) about the theoretical and empirical shortcomings of the cluster literature, which are well summed up by his following statement:

Currently, economic geography, along with many other areas of the social sciences, is firmly linked to a theoretical approach that seeks to explain local economic growth in terms of the embeddedness of business enterprises in small-firm social networks. These networks are conjectured to mobilise knowledge, stimulate innovation and create competitive advantage through enhanced productivity. Variants of the approach are labelled as 'regional innovation systems', 'innovative milieu', 'learning regions' and, of course, 'clusters (Porter, 1998, 2000). These increasingly self-referential, institutionalist literatures emphasise the social construction of economies, the importance of social capital and the fundamental role of institutional structures in shaping and driving those economies. The layers of reasoning in these approaches amount essentially to a 'soft' version of the endogenous growth theory that economists have built around the stylised facts of 'local human capital', specialisation, 'competition' and agglomeration' (Glaeser 1995, Glaeser et al. 2000). The 'embeddedness' approaches, however, use a different but equally stylised set of facts as explanators; 'institutional thickness', 'trust', 'learning' and 'social capital', for example. It can be suggested that what has been created is an institutionalised theoretical straightjacket, a complex edifice that is weakly and selectively grounded in reality.

Ingenious efforts have been made to overcome the problem of confinement to proximity by adding non-spatial concepts to the analytical framework. For example, Capello and Faggian (2005, p. 78) introduced the concept of "relational space", which they defined as "relationships – market relationships, power relationships and cooperation – established between firms,

institutions and people that stem from a strong sense of belonging and a highly developed capacity of cooperation typical of culturally similar people and institutions".

Stimson, Stough and Roberts (2006) weighed in on the shortcomings of cluster policy and research, and Grant et al. (2013) declared that cluster analyses lack conceptual and theoretical rigour. Our point of departure from the literature on cluster theory and its application in empirical analysis is that we feel the concept of chain failure has a stronger theoretical framework and basis for making policy recommendations and appropriate collective action involving chain members. Hence, as indicated above, we prefer to treat failure in the value chain as a focus for analysis that is distinct from local collective failure.

What can be learned from the embedded local growth or cluster literature?

Despite the shortcomings of cluster theory and its application in empirical analysis, mentioned above, there is nevertheless much in the cluster literature that assists in an understanding of, and is consistent with, the concepts of chain failure, chain externalities and chain goods. Four potential areas for enhancing the analysis of value chains by accessing this literature are:

9 Defining the boundary between chain failure and local collective failure
10 Improving joint action among parties interested in overcoming chain failure
11 Augmenting the processes of knowledge creation and application in value chains
12 Improving the governance of value chains.

In the fourth area, we distinguish between the literature on clusters and the literature in another spatially defined area of study: Australian agri-environmental governance.

Defining the boundary between chain failure and local collective failure

First, and foremost, the literature on clusters has a wealth of material on identifying and exploiting any economies associated with proximity, notably external economies. Schmitz (1999) summarised the history of clustering dating back to Marshall (1920) and popularised more recently by Krugman (1995), referring to Krugman's (1995) three main reasons for industrial clustering as labour market pooling, access to intermediate inputs and technological spillovers. He averred that they still remain valid but are nevertheless insufficient to explain "the strength of clustering firms" (Schmitz 1999, p. 468). The reason for their insufficiency, according to Schmitz (1999) quoting Mishan (1971, p. 2), is that the "effect produced is not a deliberate creation but an unintended or incidental by-product of some otherwise legitimate activity". What is needed in the mindset of Schmitz (1999, p. 469) is a "deliberate force at work, namely consciously pursued joint action". The literature on joint action is discussed below.

An Australian example of the secondary and tertiary agglomeration of value chains in the manner that Hochman (2011) described for clusters is the capture of spillover benefits among chain members in experience markets and concerns the inter-industry promotion of the region designated as the Victorian wine trail. The presence of wineries has attracted other tourist industries. Experiences associated with visiting a region are translated to potential customers through cross-promotion and exploiting scale and scope economies in offering promotional services. In addition to wine tourism services, the experience market spans hospitality (accommodation, restaurants and cafes and outlets for purchasing food), travel, scenic visit and adventure services that are bundled together for the purpose of promotion. While most benefits from promotion are likely to be captured by the industries in the value chain, there are nevertheless likely to be substantial leakages of benefits to the general economy that induce the government to subsidise promotional campaigns. The Victorian state government (Tourism

Victoria 2012) invests heavily in the promotion of the services, attractions, facilities and events to be found along the wine trail. More generally, it promotes a wide range of services associated with the wine tourism sector in Victoria online through the Tourism Victoria (2011) website using taxpayers' funds. An example of a recent promotion pertinent to this study is Anon. (2011), an article on the pleasures of the wine trail that is based on the Tourism Victoria (2011) material and is accompanied by numerous advertisements paid for by the various service providers in the region.

The development of programs such as those under the banner of Victorian tourism is financed by the typical funding model used for club goods: a two-part tariff. It comprises, first, membership of a 'club', usually called an association, which covers the costs of administration and activities such as generic promotion and representation at relevant policy forums. These organisations usually operate at the supra-chain level (so-called 'peak bodies'), in the way that Tourism Alliance Victoria operates for all value chains associated with tourism in Victoria. The second part comprises fees for specific services such as workshops, business advice, networking, the provision of information and advertising (such as the above example) that are pertinent to tourism and which tend to be specific to a value chain. They are usually offered on a full cost recovery basis because the benefits can be captured by the firms buying the services.

Joint action

Schmitz 1999, (pp. 475-477) discussed the impetus to joint action, contrasting government intervention and "private self-help" in response to market failure.

"It is ironic that in an age where neo-liberalism triumphed, the sequence of external economies → market failure → government intervention remained unquestioned. Perhaps the main reason is that *mainstream economics does not know how to handle joint action"*. [emphasis added] (Schmitz 1999, p. 476)

It is precisely this problem with "mainstream economics" that we believe can be resolved by identifying chain failure. The resolution, referred to in general terms by Schmitz as "private self-help", can be instigated by involving members of the value chain just as market failure is resolved through government intervention on behalf of all individuals in the general economy. Schmitz (1999, p. 477) asserts that "It is hard to build economic theory with joint actors", but we disagree if the nature and causes of chain failure are properly diagnosed. But we do agree with his statement that game theory can aid understanding of the conditions under which joint action would be worthwhile. The literature and empirical examples that Schmitz cites have the hallmark of the sorts of intervention within the value chain that we have in mind.

One area of interest in respect of joint action to produce chain goods and internalise positive chain externalities is in the development of the concept of "collective efficiency". Schmitz (1999, p. 466) defined this concept in the context of clusters as "the competitive advantage derived from local external economies and joint action". He made two useful observations about it, namely "(a) that economic viability can neither be understood (nor fostered) by focusing on individual enterprises and (b) incidental external effects are not sufficient explanation and that the effects of purposeful joint action are an essential second component" (Schmitz 1999, p. 470). Schmitz distinguished between static and dynamic external economies and static and dynamic cooperation effects, and in this respect it is useful to resort to basic microeconomics and revisit the definition of "dynamic efficiency", which Hubbard et al. (2012, p. 9) note occurs within firms "when new technologies and innovation are adopted over time". The definition of

Hubbard et al. (2012) can be extended to describe the dynamic efficiency of an interdependent group of firms or industries.

Augmenting the processes of knowledge creation and application in value chains

There is a degree of confluence of ideas about knowledge networks, knowledge creation and upgrading[22] from the literature on embedded local growth and clusters and the literature on value chains. An example is the study by Bathelt, Malmberg and Maskell (2004) on the different layers of knowledge among firms in related industries that are transferred through a value chain (or what they term a "pipeline"). Humphrey and Schmitz (2000) formulated a useful typology of upgrading in value chains: process upgrading (transforming inputs into outputs more efficiently); product upgrading (moving into more valuable product lines); functional upgrading (obtaining new superior functions); and intersectoral upgrading (applying existing competence in a new sector). Giuliani, Pietrobelli and Rabellotti (2005) emphasised the role played by leaders in the global value chain in transferring knowledge along the chain. Schmitz (1999, p. 478) observed that clustering "draws out the less exceptional, and more common 'ordinary' entrepreneurs [because] it makes it possible to advance by taking smaller and calculable risks". He might have added that value chains perform the same service. Preissl and Solimene (2003, pp. 206-207) discussed how large firms in clusters provide collective goods such as RD&E, although Taylor (2005, p. 73) cautioned about the propensity for large firms sometimes to act in a predatory manner.

A recurring theme in the cluster literature is that innovation is not just about formal RD&E and that innovation systems are learning systems:

"To account for knowledge generation in this industry, it is necessary to pay attention to different types of activities and indicators other than formal RD&E and patents. RD&E and patent statistics are ill suited to this industry, where experimentation, learning, trial and error and other means for generating new knowledge are mostly informally undertaken and measured." (Giuliani, Morrison and Rabellotti 2011, p. 203)

Improving the governance of value chains

A major way in which the resolution of chain failure differs from market failure is the lack of an established set of institutions to remedy the situation. Having identified opportunities to add value in the value chain by remedying chain failure, there remains the question how this value-adding intervention is to be generated: who are the agents of change? Here, the theory of industrial districts promulgated by Lane (2002, p. 65) is handy, where he takes what he calls a "complexity perspective" to argue in respect of a spatial unit, a district, that:

"… a district may be defined in terms of two kinds of structures: networks and scaffolds. At the nodes of the networks are individual entrepreneurs/artisans and firms. The links between the nodes consist of processes of recurring interactions. The networks carry the competences through which the district gathers and interprets information about products, production technologies and markets; produces and sells artefacts; and develops concepts for new artefact functionality, new markets, and new artefact types. The network structure undergoes constant transformation as the district generates new products and explores new markets. The transformation processes rely on various scaffolding structures, which may be regarded as the

[22] Following Giuliani et al. (2005, p. 552), upgrading in a value chain is defined broadly as "innovation to increase value added".

institutions that provide both a meta-stable identity *and* the possibilities for renewal and change to the district."

Substitute "chain" for "district" and it requires only a little imagination and creativity to apply this perspective to value chains. Lane (2002) then explains two important types of scaffolding structure – interaction loci and emergent rules and roles" – and discusses how districts innovate by outlining two perspectives on innovation from the literature on complexity: "recombination" of learning agents and "generative processes" that enable social systems such as firms and value chains to overcome the limits placed on their growth. Generative relations and processes "enable the participation … and the convergence of the incentives of a variety of actors [read value chain members from our perspective] able to put in place complementary actions converging towards the realization of a common, innovative goal" (Antonelli 2010, p. 3).

Giuliani et al. (2005) attributed a central focus to the concept of governance in value chains in their discussion of the links between the concepts of clusters and value chains. They distinguished three types of governance that are important: "(a) network implying cooperation between firms with more or less equal power which share their competencies within the chain; (b) quasi-hierarchy involving relationships between legally independent firms in which the rest of the actors have to comply; and (c) hierarchy when a firm is owned by an external firm" (Giuliani et al. 2005, p. 551).

The nature of cooperation within the value chain is important to implement remedies to chain failure. Antonelli (2010, p. 5) observed that "the generative potential of a relationship depends upon the 'aligned directedness' of the agents – whether they are all interested in operating in the same region (or in neighboring regions) of agent-artifact space [or, in our case, cooperating in a value chain]; and their 'mutual directedness' – whether the agents are interested in interacting with each other". In this respect, Schmitz's (1999) point about the relevance of game theory and the meaning of cooperation in this context is worth revisiting. Manzini and Mariotti (2002) coined the expression, "tragedy of the clubs", to illustrate how the potential for creating a negative externality arises when members of a value chain undertake joint action that results in what they termed a collective inefficiency. The process parallels the tragedy of the commons – hence the title of their article. They show how equilibrium can be reached in which there is excessive entry in the joint production and exploitation of an excludable good. But the result depends on the operation of a non-cooperative game by forming a coalition and dividing the surplus generated from the output produced. The key to avoiding this form of "tragedy" is in the nature and intent of the joint action by club members: will they cooperate or not and, if they do cooperate, how and to what extent will they do so. This issue goes to the heart of governance within the chain.

Appendix 3. Collaborative Environmental Governance

Another field of research that provides useful hints as to how to govern a value chain is collaborative environmental governance. Concern about managing local ecosystem services in value chains has arisen relatively recently. Here again, there is a need to govern the interdependent activities of an otherwise legally independent set of actors. Costanza (2008, p. 351) used a classification system of five groups of ecosystem services, one of which he called "local proximal" services that depend on proximity. Examples include the regulation of disturbance, storm protection, habitat protection, pollination, biological control and waste treatment. Some of these services assume considerable importance in meat value chains.

Marshall (2001, pp. v-vi) is a good source of much of the material on this form of collaboration:

"A collaborative vision for agri-environmental governance whereby collaboration among stakeholders in addressing problems supposedly leads them to cooperate more in implementing solutions emerged in the 1980s. This vision was prompted by mounting dissatisfaction with the progressive vision upon which such governance had been founded, a vision that had resulted in compartmentalised, paternalistic governance. It was based on a modern worldview regarding social behaviour as mechanistic and concerns about scientific progress as irrational. …There is an emerging consensus in Australia that the complexity of environmental governance requires learning through adaptive management wherein policies are regarded as experiments to be learned from rather than through the rational-comprehensive approach typically associated with the progressive vision. However, as yet the literature in respect of the collaborative vision is silent on how adaptive management's experimentation might proceed according to science's hypothetico-deductive method rather than in an ad hoc manner. In particular, no coherent theory of how collaboration increases cooperativeness in this setting from which hypotheses motivating experimental design could initially be deduced has been presented."

Marshall (2001) set out to test and elaborate a framework of rational-choice theory on which "hypothetico-deductive pursuit of the collaborative vision for environmental governance might fruitfully be instigated" in the context of Australian agri-environmental governance. He set three objectives, the first of which was to review experience with agri-environmental governance in Australia. His second objective was to propose a theoretical framework synthesised from developments in the rational-choice theory of collective action. According to Marshall (2001), this framework "highlights the role that increasing-return, or positive-feedback, dynamics play in the emergence of spontaneous large-group cooperation, and thus the importance of the feedback upon which these dynamics depend". His third objective was to examine the application of his proposed theoretical framework to collaborative agri-environmental governance in Australia. While he reported favourable results from this application, he observed that:

> … the increasing-return dynamics that make large-group spontaneous cooperation possible also make it difficult to achieve. These dynamics can lead past patterns of uncooperative behaviour to 'lock-in'. (Marshall 2001, p. vi)

Appendix 4. Negative Externalities and Sustainability in Food Value Chains

Sustaining value in a meat value chain

Chopra and Meindl (2013) acknowledged that the health and survival of each value chain ultimately depends on the health of the surrounding world, highlighting the importance to expand the goals of a value chain beyond the interests of its participants to others who may be affected by their decisions. According to Chopra and Meindl (2013), three factors have forced a sustainability focus on managing value chains: (a) reducing risk and improving financial performance; (b) attracting customers who value sustainability; and (c) making the world more sustainable.

Sustainability has presented a greater challenge when it requires efforts that do not provide obvious returns on investments because customers of value chains have not always backed up words about the importance of sustainability with a willingness to pay more for sustainable products (Chopra and Meindl 2013). One of the biggest challenges in building sustainable value chains is that benefits may be shared but costs may be local to a firm, creating sustainability as a chain good[23]. Alternatively, the status quo might provide benefits from the sale of goods that are local to firms in the value chain but costs that are national or global, creating a negative externality.

Common resources and sustainability

The "tragedy of the commons" (Harden 1968) is the tendency for common resources to be overused, creating a negative externality. Chopra and Meindl (2013) asserted that every firm in a value chain faces the challenge of the tragedy of the commons because it operates in a global environment. As a negative externality, the social cost of an activity in the value chain over-using a common resource is greater than the private cost, leading to an inefficient level of the activity. The source of the tragedy of the commons is the lack of clearly defined and enforced property rights.

Hubbard et al. (2012) identified four potential ways out of the tragedy of the commons:
- Legal restrictions on access to the common resource
- Taxes
- Tradable permits
- Quotas.

Internalising a national negative externality in the value chain

Regulations differ among countries in attempts to internalise negative externalities. Firms in value chains in Australia face the challenge of competing against other firms and chains that may not incur the same costs as part of this internalisation. Unless all consumers change their mindset, it is difficult to imagine a sustainable solution without some form of government intervention (Chopra and Meindl 2013).

[23] We regard "sustainability" as a chain good rather than a positive externality because it is a notion for which no market exists.

All firms report some social and environmental metrics, but a large variation exists. From an environmental perspective, Chopra and Meindl (2013) suggested that all firms in a value chain should measure and report the following four items:

1. Energy consumption
2. Water consumption
3. Greenhouse gas emissions
4. Waste generation.

Two fundamental challenges exist in a value chain in measuring and reporting the above four categories according to Chopra and Meindl (2013):

1. The scope over which a category is measured
2. The use of absolute or relative measures of performance.

The focus of the first challenge, according to Chopra and Meindl (2013), is to ensure all categories are measured over the entire value chain, which is the best way to capture the full impact of activities in the value chain on the environment. In respect of the second challenge, Chopra and Meindl (2013) pointed out that an absolute measure reports the total amount of consumption whereas a relative measure may report the consumption per unit of output. They advised that the advantage of an absolute measure is that it captures the full effect of the value chain on the category being measured. The main drawback is that a change in the level of activity in the value chain will appear as an environmental improvement or deterioration in its impact when no such variation has occurred.

Chopra and Meindl (2013) considered a relative measure to be more effective at capturing an improvement or deterioration, but noted that the challenge with using such a measure is the choice of unit because each category can be measured relative to the size of the activity, measured in dollars of sales, kilograms of output or a variety of other units. In general, they felt that it is better for firms to measure and report both absolute and relative measures to get a true picture of their environmental performance.

Bonney et al. (2012) discussed how to evaluate environmental sustainability by focusing on the economic, social and environmental impact of a product over its life cycle. “It involves systematic evaluation and management of resource use and environmental releases to air, water and soil from products, processes and services” (Bonney et al. 2012, p. 14). Six types of commercial benefits identified by Bonney et al. are:

1. Reduced operational expenditure
2. Product/service differentiation
3. Protecting asset value and deferring capital investment
4. Regulatory compliance and accessing/protecting markets
5. Reduced exposure to risk and future cost increases (notably, energy)
6. Strengthening business-to-business (B2B) relationships within the chain, and influencing internal and external stakeholders.

Bonney et al. (2012) observed that the activities to be included should reflect the chain boundary and detail used for mapping the material flow. They identified some activities that could be excluded either because they fall outside the material flow being assessed or because their impacts are not substantial. Ecological consequences to measure include: emissions affecting climate change; energy use; water use; biodiversity and land use; use/release of toxic chemical; water and air pollution; waste management; ozone layer depletion; depletion of oceans and fisheries; and deforestation.

Using a slightly different perspective from Chopra and Meindl (2013), Bonney et al. (2012) identified two main ways to assess the environmental impact of a value chain:

- The relative impact of each activity in the material flow, which is different in perspective from the relative measure of Chopra and Meindl (2013) in that it is concerned with whether the activity has a small or large environmental impact
- The comparative impact of each activity and product with others in the same industry.

It has proved difficult to make meaningful comparisons using the comparative approach, according to Bonney et al. (2012), who argued that relative assessment within the chain is more appropriate in terms of informing strategic decisions. They recommended that the scope for adding consumer value is mapped against the relative environmental impact of that activity, shown in Table A1 for high and low levels of value and impact. The opportunity to create value and a sustainable environment simultaneously will be greater the more consumers value the environmental sustainability of the product. In those circumstances, all activities, but especially those in the top right quadrant, offer scope for differentiating the product on environmental attributes.

Table A1. Scope for adding consumer value mapped against relative environmental impact

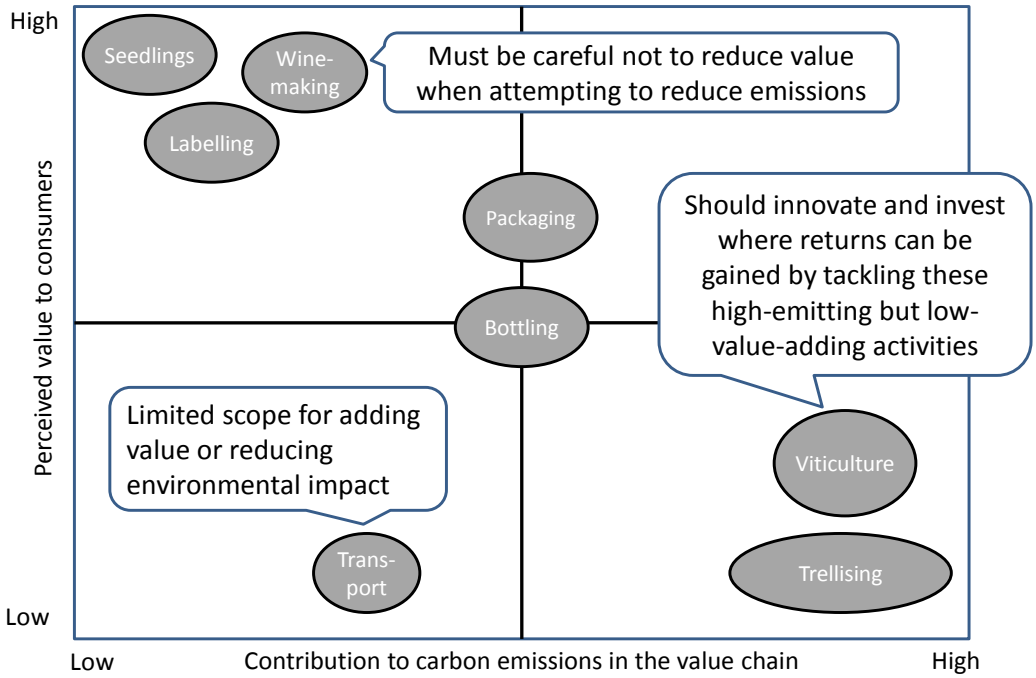
Scope for adding consumer value	Low relative environmental impact	High relative environmental impact
High	Innovate to create value Avoid increasing environmental impact	Focus for innovation to add value Simultaneously reduce environmental impact
Low	Limited scope for adding value or reducing environmental impact	Chain only invests to reduce cost May require government intervention to ensure environmental improvement

Source: Bonney et al. (2012, p. 15).

An example of the management conclusions that can be drawn on the issue of sustainability is provided in the case study conducted by Fearne et al. (2009) (see also Fearne 2009) for the Oxford Landing wine value chain from Yalumba winery in South Australia to Tesco supermarket consumers in UK (Figure A1). Most consumers did not place much significance on its environmentally sustainable attributes, providing limited opportunity to create value through improved environmental management.

Three examples of conclusions drawn from this analysis are shown in Figure A1. First, given the contribution of their activity to carbon emissions in the value chain is low and the perceived value to consumers of their product is high, winemakers must be careful not to reduce value

when attempting to reduce emissions. Second, there is limited scope for adding value or reducing environmental impact through transport where both the contribution to carbon emissions in the value chain and the perceived value to consumers are low. Third, in respect of viticulture and trellising where the contribution to carbon emissions in the value chain is high and the perceived value to consumers is low, the relevant actors should innovate and invest where returns can be gained by tackling these high-emitting but low-value-adding activities.



Source: Fearne et al. (2009, p. 30).

Figure A1. Significance to UK consumers of Oxford Landing wine of its environmentally sustainable attributes

Heller and Keoleian (2000) developed a set of sustainability indicators based on a food product's life cycle through the value chain. The indicators in Table A2 contain details on economic, social and environmental factors at five life cycle stages:

1 Origin of resource
2 Agricultural growing and production
3 Food processing, packaging and distribution
4 Preparation and consumption
5 End of life.

Table A2. Sustainability indicators based on a food product's life cycle through the value chain in USA

Stakeholders	Life cycle stage	Indicators		
	1	Economic	Social	Environmental
Farmers Breeders Seed companies	Origin of (genetic) resource – seed production, animal breeding	Degree of farmer or operator control of seed production and breeding	Diversity in seed purchasing and seed collection options Degree of cross-species manipulation	Ratio of naturally pollinated plants to genetically modified and hybrid plants per hectare Reproductive ability of plant or animal Proportion of disease-resistant organisms
	2	Economic	Social	Environmental
Farm operators Farm workers Agricultural industry Agricultural schools Government Animals	Agricultural growing and production	Rates of agricultural land conversion Return on investment Cost of entry to business Farmer saving and insurance plans Flexibility in bank loan requirements to foster environmentally sustainable practices Level of government support	Age of farmers Diversity and structure of industry, size of farms Labour productivity Average farm wages vs other professions Ratio of migrant to local farm workers % workers with health benefits Number of active agrarian community organisations Education programs on sustainable practices Animal welfare	Rate of soil loss to regeneration Soil microbial activity and nutrient balance Chemical inputs per unit of output Air pollutants per unit of output Species per hectare Water withdrawal vs recharge rates Contaminated or eutrophic water Waste utilisation Veterinary costs Energy input per unit of output Renewable to non-renewable energy Harvest lost to pests and diseases
	3	Economic	Social	Environmental
Food processors Packaging providers Wholesalers Retailers	Food processing, packaging and distribution	Distribution of profits between farmers, processors and retailers Geographic proximity of grower, processor, packager and retailer	Quality of life and worker satisfaction in the food processing industry Nutritional value of food products Food safety	Energy requirement for processing, packaging and transportation Waste produced per unit of food Waste and by-products used in the food processing industry Food lost due to spoilage and mishandling

Stakeholders	Life cycle stage	Indicators		
	4	Economic	Social	Environmental
Consumers Food service Nutritionists and health professionals	Preparation and consumption	Portion of consumer disposable income spent on food Proportion of the food dollar spent outside the home	Malnutrition rate Obesity rate Health costs from diet-related disease and conditions Balance of average diet Proportion of products with consumer labels Consumer literacy on food system consequences, product quality vs appearance Time for food preparation	Energy use in preparation, storage and refrigeration Packaging waste and calories consumed Ratio of local to non-local food and seasonal vs non-seasonal consumption
	5	Economic	Social	Environmental
Consumers Waste managers Food recovery and gleaning organisations	End of life	Ratio of food wasted to food consumed Dollars spent on food disposal	Ratio of (edible) food wasted vs donated to food gatherers	Amount of food waste composed vs food sent to landfill, incinerator or waste water treatment

Source: Heller and Keoleian (2000).

Heller and Keoleian (2000) used their set of sustainability indicators to analyse trends in the food value chain in USA. Their conclusion was that it is not economically, socially or environmentally sustainable. The key indicators leading to this conclusion in respect of production, consumption and the whole food system are presented in Table A3.

Table A3. Economic, social and environmental trends in the food value chain in USA

	Economic	Social	Environmental
Production	Rapid conversion of prime farmland 84% of farm household income earned off-farm Increasing number of farms reporting a net loss	52% of farm workers are illegal Age of farm operators increasing Declining entry of young farmers	Depletion of topsoil exceeds regeneration Rate of groundwater withdrawal exceeding recharge in major agricultural regions Losses to pests increasing Reduction in genetic diversity
Consumption	Costs of diet-related diseases increasing	Obesity rates rising Diet deviates from nutritional recommendations	26% of edible food wasted
Total system	Marketing is 80% of the food bill Industry consolidation in the food system threatens market competition	Relation with food and its origin has been lost	Heavy reliance on fossil energy 7.3 units of energy consumed to produce one unit of food energy

Source: Heller and Keoleian (2000).

Evaluating environmental sustainability for value chains

Food miles is a summary concept that is often used to measure the distance a food product travels from point of production to point of consumption. It is commonly applied as a proxy to measure the environmental impact of a food value chain. Environmentalists have used measures of food miles to argue that more energy is used when the food travels further. On the basis of this measure, they have concluded that the carbon emissions are greater for food that is imported from far-away countries.

Saunders, Barber and Sorenson (2009) compared some agricultural products grown in New Zealand that are shipped to UK with a UK source. They found that, due to the different production systems, NZ dairy products used one-half the energy of their UK counterpart even when shipping was taken into account. The New Zealand lamb exporters used around one-quarter of the energy of their UK counterparts in getting their lamb into the UK market. In the case of apples, the New Zealand source was 10 per cent more energy-efficient, but there are seasonal differences in energy use in UK between on-season and off-season apples. This seasonal variation suggests that the more energy-efficient source varies with the time of the year. While New Zealand used slightly more energy to produce onions, the energy cost of shipping was found to be less than the cost of storage in UK making NZ onions more energy-efficient overall.

Saunders et al. (2009) concluded that food miles is an erroneous concept to use despite its popularity among the popular media and some consumers. It has lost credibility with supermarkets and government agencies, which have turned their attention to carbon footprinting and take account of energy used throughout the product life cycle. Some comparisons of

estimated CO2 emissions are provided in Table A4. Caputo, Nayga and Scarpa (2013) found that consumers now tend to value the CO2 label at least as much and sometimes more than the food miles label.

Table A4. CO2 emissions for selected agricultural products

How the CO2 emissions compare:	
Lamb	
UK	New Zealand
2,849kg CO2 per tonne of carcass	688kg CO2 per tonne of carcass
Lettuce (winter)	
UK	Spain
3,720kg CO2 per tonne of lettuce (indoor production)	3,560kg CO2 per tonne of lettuce
Apples (in May when off season in UK)	
UK	New Zealand
271kg CO2 per tonne of apples	185kg CO2 per tonne of apples
Roses	
Netherlands	Kenya
35,000kg CO2 per 12,000 stems	6,000kg CO2 per 12,000 stems

Source: http://www.telegraph.co.uk/news/uknews/1553456/Greener-by-miles.html.

Appendix 5. Achieving Strategic Fit in a Meat Value Chain

The decision framework for strategic fit in a meat value chain is to determine how much responsiveness to include, given that it is rare that a value chain possesses all possible responsiveness attributes or is completely devoid of these attributes. We provide an outline of how we think the optimal level of responsiveness should be determined for a food value chain in general, which should be useful in meat value chains in Australia. We present and discuss examples of the Australian wheat industry and the UK fresh potato industry in demonstrating some of the responsive attributes that currently exist in the value chain or which could be added if the expected additional revenues exceed the additional resource costs of providing them (a third example of the Australian beef industry is presented above in section 5).

An analytical framework is needed to identify and assess remedies for the presence of inefficiency in a food value chain.[24] It is preferable to represent the two different attributes of a chain – responsiveness and low cost – in terms of the food product or products emanating from them. To keep our exposition simple, the curve of the production possibilities frontier (PPF) can be used to determine the extent of scope economies between responsiveness and low cost for two value chains in the same value system, or two channels within a value chain, or for a single value chain with different levels of value-adding activities. We initially concentrate on one product whose throughput flows along two separate channels within a value chain, one being a responsive channel and the other being a low-cost channel. This situation is representative of the UK fresh potato value chain discussed below. Then, we provide two examples of wheat products, with channels of the wheat value chain that overlap with other channels.

For now, assume one product can be produced and marketed through two parallel chains or through two separate channels within the same chain.[25] The trade-off between responsiveness and low cost in Figure A2 is represented in the traditional microeconomic framework using the PPF to reflect the different levels of output of products for two channels in a value chain exhibiting different degrees of responsiveness.

Because there are usually economies to be gained from combining attributes of responsiveness with low-cost production, the PPF between the two strategic fits bows outwards. But because increasingly greater volumes of inputs are used to produce each unit of output in the responsive channel in the value chain, the PPF would also typically take an asymmetric shape such as the frontier in Figure A2. An inefficient value chain would lie inside the frontier, such as at point A in Figure A2. Efficiency gains may be made, for example, by expanding output in the low-cost channel without sacrificing output in the responsive channel when moving from point A to point B. It is also possible to increase output in the responsive channel without reducing output in the low-cost channel when moving from point A to point C. Output could be increased in both channels by moving from point A towards any point on the section of the frontier between points B and C.

[24] See Chopra and Meindl (2013) for an alternative approach to achieving a strategic fit in a supply chain.

[25] Various terms are used to describe segments within a value chain or, for more complex configurations, value chains within a value network or a value system. Weaver (2010), for example, specified six different configurations: single chains, parallel chains, peer sourcing with heterogeneous layers, cross-layer sourcing, peer sourcing and shared sources. For simplicity, we shall confine ourselves to discussing channels within a value chain where the term, value chain, is used to encompass networks or systems.

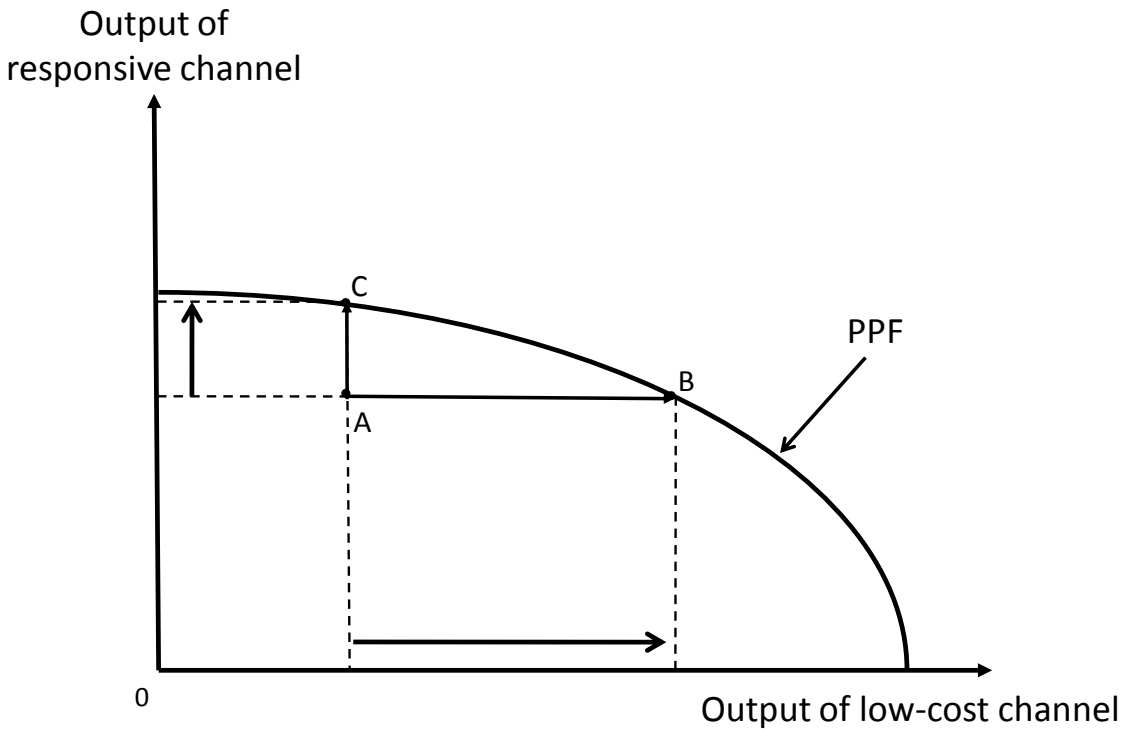


Figure A2. Technical inefficiency in a food value chain

The representation of technical inefficiency in Figure A2 is highly simplified, as can be seen when comparing it with Weaver (2010) who provides a framework for analysing efficiency[26] in the context of a value chain. Technological progress, reduction in transaction costs, greater flexibility of product composition and enhanced responsiveness to external change have altered the view of the decision-making unit (DMU) when measuring inefficiency. Boundaries have been widened and performance has become "conditional on the decisions of other DMUs and management of these interdependencies through relational rather than asset-based command-control mechanisms" (Weaver 2010, p. 57). Weaver (2010) establishes a conceptual framework for measuring the performance of networks of interdependent and collaborating DMUs that coordinate decisions across various sub-DMUs and are subsidiary to more centralised decision making in a value chain. We discuss causes of technical inefficiency in a value chain below.

The analytical usefulness of the method outlined above is that it enables the decision maker to determine the optimal mix of products from responsive and low-cost channels within a value chain or the optimal level of responsiveness attributes in a particular value chain. The main practical advantage of the approach we recommend is that an isorevenue curve can be fitted to determine the optimal level of responsiveness attributes in a chain or to determine the optimal mix between separate responsive and low-cost channels within chains or between chains. The slope of the isorevenue curve needs to reflect the fact that a value chain is likely to achieve higher prices for its product when it is more responsive. We call it an expected isorevenue curve (EIC), which is demonstrated in Figure A3 to reflect the important issue of demand uncertainty

[26] Weaver (2010) focuses on inefficiency, and apparently only technical inefficiency, in the application of data envelopment analysis (DEA) and observes that productivity and profitability indices can be obtained within his framework. Both scale inefficiency and mix inefficiency are also likely to be present in value chains. A good reference on their derivation in a DEA framework is O"Donnell (2010).

that was raised by Chopra and Meindl (2013) as a major factor influencing decisions on strategic fit for a value chain. There is likely to be a strong correlation between implied demand uncertainty and the need for responsiveness in the chain. We treat the isorevenue curve as an EIC, based on the probabilities of achieving a range of product prices with varying levels of responsiveness.[27]

Consider again the decision on the optimal mix of two channels in a value chain. Because the probability of achieving a high price would be greater in a responsive channel in the value chain, an EIC would favour producing the product from such a channel (EIC in Figure A3). The optimal mix of channels in the value chain moves from point B to point C as responsiveness is rewarded by the greater likelihood that consumers would be willing to pay for the attributes delivered by the more responsive channel.

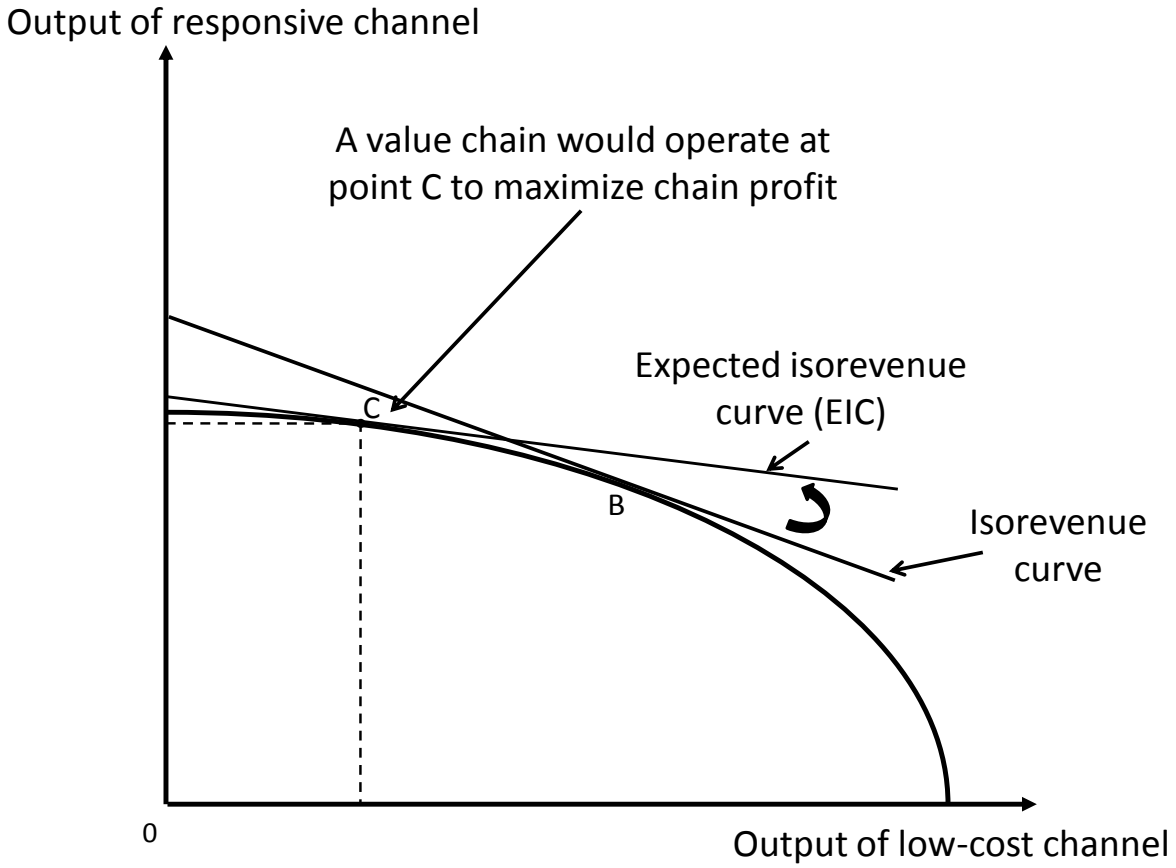


Figure A3. A value chain with high consumer willingness to pay for responsiveness

Where there is no extra pay-off from being responsive, the EIC is a straight line at an angle of 45° to the vertical and horizontal axes in the region of the optimal combination of low-cost and responsive output. In these circumstances, it pays to produce more output with few attributes of responsiveness, at point D in Figure A4. The more skewed the PPF, the fewer responsiveness attributes it is worth incorporating in the chain for a given EIC and the closer the optimal solution will be to the horizontal axis. This situation is similar to the example used by Chopra and Meindl (2013) of Barilla pasta with low supply and demand uncertainty where designing "a highly responsive supply chain in which pasta is custom made in small batches in response to

[27] For food products, implied demand uncertainty is felt predominantly in terms of fluctuations in the price received for final products rather than the risk of being unable to dispose of a product at the retail level.

customer orders and shipped via a rapid transportation mode … would obviously make the pasta prohibitively expensive, resulting in loss of customers" (Chopra and Meindl 2013, p. 39).

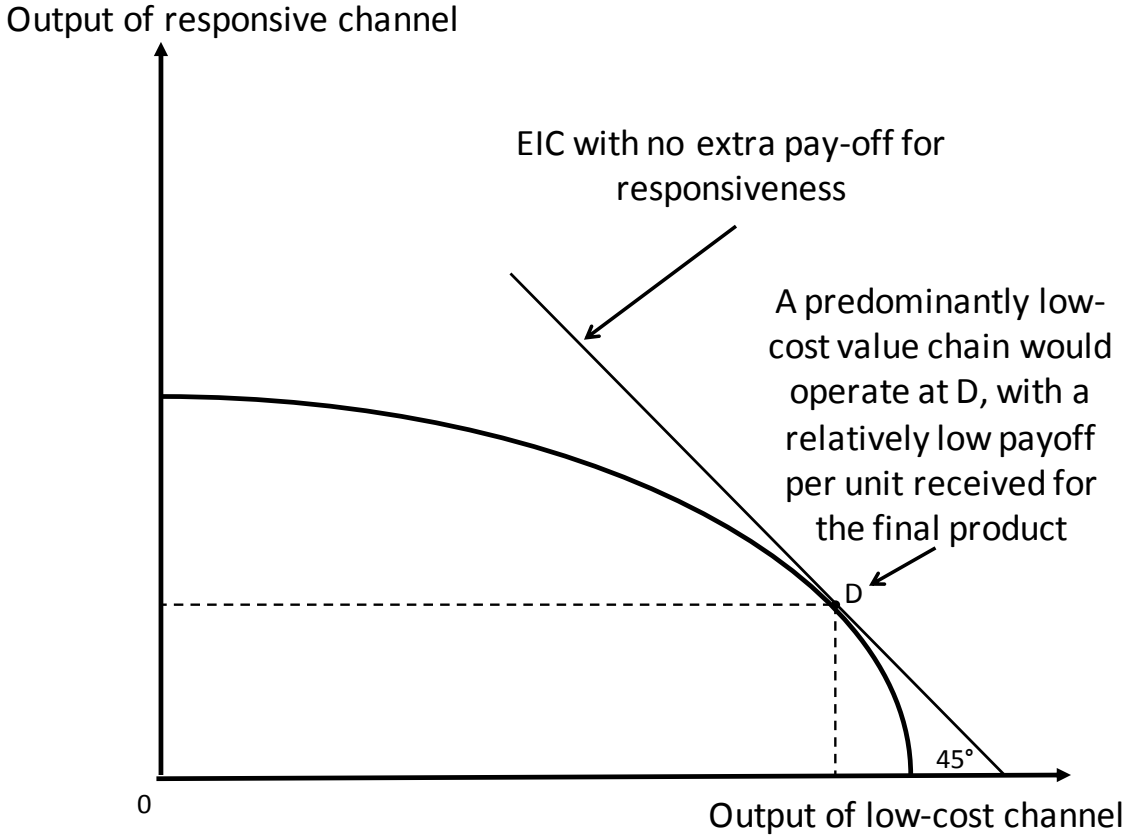


Figure A4. A value chain with low consumer willingness to pay for responsiveness

We now assume that a trade-off exists between responsiveness and throughput in a single value chain, as represented in Figure A5 to reflect the different levels of output of the product for varying degrees of responsiveness. It is assumed that the PPF is formed by successively adding the responsiveness attributes that contribute most value to the output of the final product of the chain for a given level of resources (volume is being traded off for greater responsiveness). The isorevenue curves are concave, reflecting increases in expected revenue with higher levels of responsiveness.

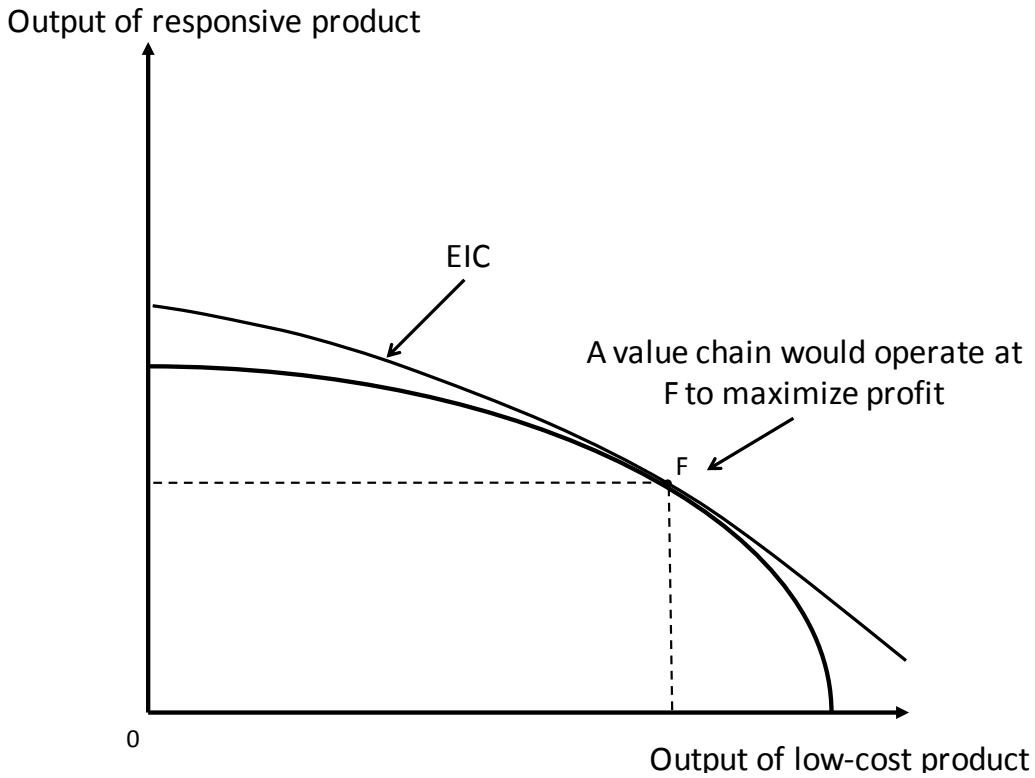


Figure A5. A value chain with varying levels of responsiveness

We now return to the matter of technical inefficiency and consider a channel within a value chain that attempts to become more responsive but its members do not have the capability or skills to accomplish the necessary responsive activities in a technically efficiently manner. Chopra and Meindl (2013) point out that value chains need to understand their capabilities when establishing the zone of strategic fit. They stated that effective response means an ability to respond to a wide range of quantities demanded, meet short lead times, handle a variety of products, build innovative products, meet a high service level and handle supply uncertainty (Chopra and Meindl 2013, p. 37). There is potential for at least some members of the chain to fail to meet these challenges, resulting in technical inefficiency. Assume this happens in a value chain that is operating at point A in Figure A6. This chain would face the same relative prices as an efficient chain operating on the frontier such as the chain at C or the chain at E. The revenue that the chain at point A earns is much less than that earned by the chain at point C and equivalent only to the revenue earned by a chain situated at point E even though the latter chain is operating with fewer responsiveness attributes than the EIC dictates to maximise profit.

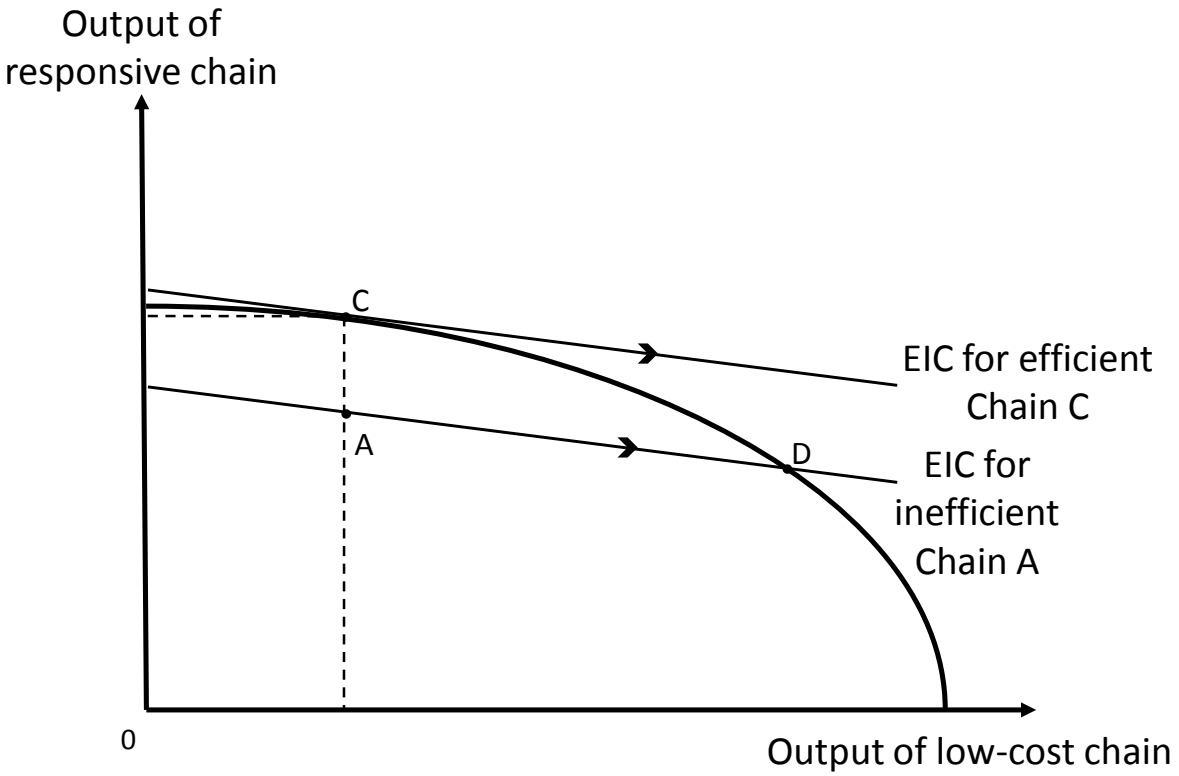


Figure A6. Revenue implications for an inefficient value chain

We need to incorporate the potential for chain failure In determining the appropriate extent of strategic scope. Chopra and Meindl (2013) present a typology of different levels of strategic scope for a value chain, the widest of which is the intercompany scope for maximising chain profit (Chopra and Meindl 2013, p. 45). situation where all firms in the value chain work together and share information to maximise chain surplus seldom exists because of various forms of chain failure that make chain profit an inadequate measure of whole-chain performance.

To keep matters simple, we shall focus on positive chain production externalities as a form of chain failure. Chain participants can get together to internalise such chain externalities and thereby expand chain surplus by shifting the PPF outwards, by turning the EIC more in favour of the production of valuable goods, or both. We give examples of these positive outcomes in the case studies that follow.

From the above commentary, we conclude that decisions on the mix of responsive and low-cost value chains, and responsive and low-cost attributes within a chain, are influenced by the shape of the PPF and the slope of the EIC. We present two mini case studies that demonstrate how these decisions have been made in practice in different circumstances. Note that all diagrams used in the studies are presented in a stylised manner for illustrative purposes, and are not based on empirical evidence that we have assembled.

Case Study 1. Responsive-low cost mix in the UK fresh potato value chain: market segmentation according to consumers' willingness to pay

Duffy and Fearne (2004) demonstrated how two UK supermarket firms, Asda and Waitrose, have successfully operated dedicated channels within the value chain for fresh potatoes.

Consistent with their competitive and value chain strategies, Asda operates a low-cost channel while Waitrose operates a niche strategy based on service and choice. Each firm forms a different price set for its products, reflecting the differences among consumers in willingness to pay for service and choice in the supply of fresh potatoes at the retail level. In Figure A7, the relevant isorevenue curve is EIC_{A1} for the Asda customer segment and EIC_{W1} for the Waitrose customer segment.

Both firms had identified the existence of a positive chain externality in that the level of coordination along the value chain was sub-optimal and could be improved by engaging strategically with other firms in the chain (that is, the externality could be internalised). In Figure A7 (and assuming both supermarkets operate efficiently to keep the case study simple), the optimal throughput from the base private PPF is at W_1 for Waitrose and A_1 for Asda on PPF_1. Waitrose has a throughput of potatoes with a high degree of responsiveness and Asda has a throughput of potatoes that is predominantly low-cost.

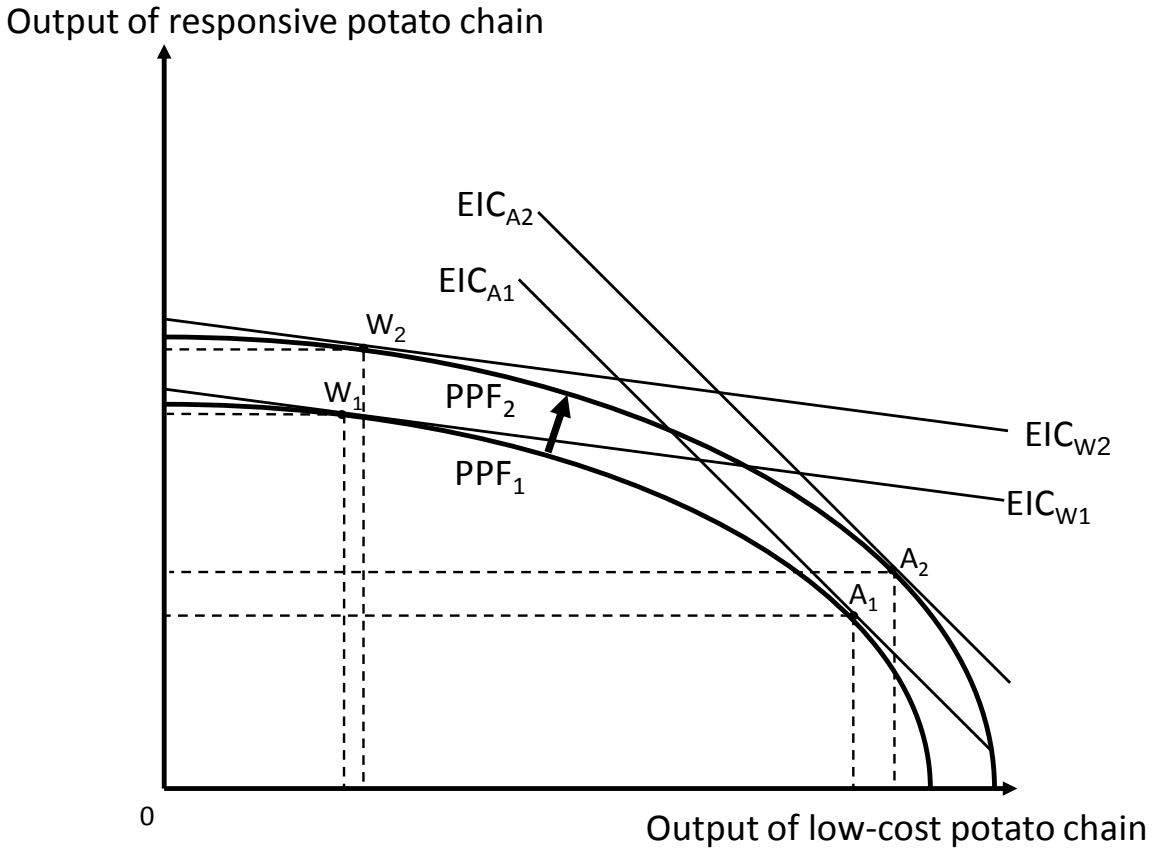


Figure A7. Responsive-low cost mix of Waitrose and Asda supermarket channels for fresh potatoes

Applying the Coase theorem, the two supermarkets found private solutions to the problem of chain externalities through joint action within the value chain.[28] Rather than rely on a whole-of-

[28] Weaver (2009) presents a framework for identifying the optimal pattern of relationships across firms in networks such as value chains, where those relationships comprise an integrated economic network. He provides a microeconomic explanation how interdependence in value creation processes, shared resources and transaction costs result in collaboration between firms. We believe this explanation is consistent with the Coase theorem in that "joint interest would exist across enterprises and *incentives would exist* for development of governance, relationships, and persistence in transactions" [emphasis added] (Weaver 2009, p. 754).

chain solution to internalise this externality, both Waitrose and Asda independently chose Coasian bilateral solutions that entailed closer cooperation with their suppliers, as reported by Fearne (2009, p. 17):

"Solanum [the supplier of potatoes to Waitrose] has a desk in the Waitrose head office and the account manager spends two days per week working directly with the Waitrose team, who encourage open communication with their supply base. Fernmac [the supplier of potatoes to Asda] is entrusted to get it right over time and Asda trust them to take difficult decisions on their behalf. A trusted source of supply means fewer inspections, fewer rejects, better availability and fewer customer complaints."

Both supermarkets were able to become more responsive and improve performance as exemplified by the shifts to point W_2 and A_2 for Waitrose and Asda, respectively, on the higher PPF_2, which was originally the chain PPF above their private PPF (reflecting the existence of a positive externality), but one they were able to reach by private action. The throughputs increased to meet increased demand and/or at the expense of other channels in the value chain for fresh potatoes, and revenue increased to EIC_{W2} and EIC_{A2} for Waitrose and Asda, respectively.

Solutions obtained by applying the Coase theorem are likely to be more feasible within value chains than in society at large because of the shared interest of members in making the chain work better, as in this case study. Nevertheless, three limitations are commonly encountered when applying the Coase theorem in a value chain, mentioned above. First, the involvement of a large number of chain members in bargaining makes the process unwieldy and consensus more difficult to achieve. In this case, the number of chain participants is small, simplifying the bargaining process. Second, unreasonable demands may be made by chain members, especially those with market power. Given the substantial market power of supermarkets, it is interesting that the firms in this case study managed to establish close working relationships with their suppliers that appear to satisfy both parties. Third, all chain members must have full information about the costs and benefits of taking action to internalise the externality, which again appears to be the case given the close working relationships between the supermarket firms and their suppliers.

Now consider what would happen if there were to be exogenous changes in consumer demand, given the differences in responsive capabilities of the two supermarket firms and differences in their abilities to minimise costs. First, with greater wealth comes a greater willingness by consumers to pay for the product of the more responsive channel arising from a growing preference for choice and services. This change would be represented by a swivelling of the EIC to favour the Waitrose channel in which throughput would increase while throughput in the Asda channel would decrease. Second, an alternative scenario in times of economic recession might be a swivelling of the EIC in favour of the Asda channel as consumers experience tighter budgets and opt for the cheaper product that Asda is better placed to supply.

Case Study 2. Responsive-low cost mix in the Australian wheat value chain: chain and public goods

Participants in the Australian wheat value chain are faced with a choice between producing, processing and marketing types of common bread wheat (*Triticum aestivum*) or durum wheat (*Triticum durum* or *Triticum turgidum durum*), which are generally destined for different end uses. Durum wheat is considered to be of high quality because of its low moisture content, low screenings and high protein and test weight. Producers began to grow more durum wheat in

Australia from the 1990s, attracted by the fact that high-quality durum wheat was fetching premiums of $30 per tonne over prime hard wheat and as much as $60 per tonne over premium white wheat (Connell 2004).

Figure A8 depicts a premium for durum wheat, with EIC_1 slightly flatter than a line 45° to the axes. The optimal point of operation for the value chain is initially at point W_1, comprising throughput of $0D_1$ in the durum wheat channel and $0B_1$ in the bread wheat channel of the wheat value chain.

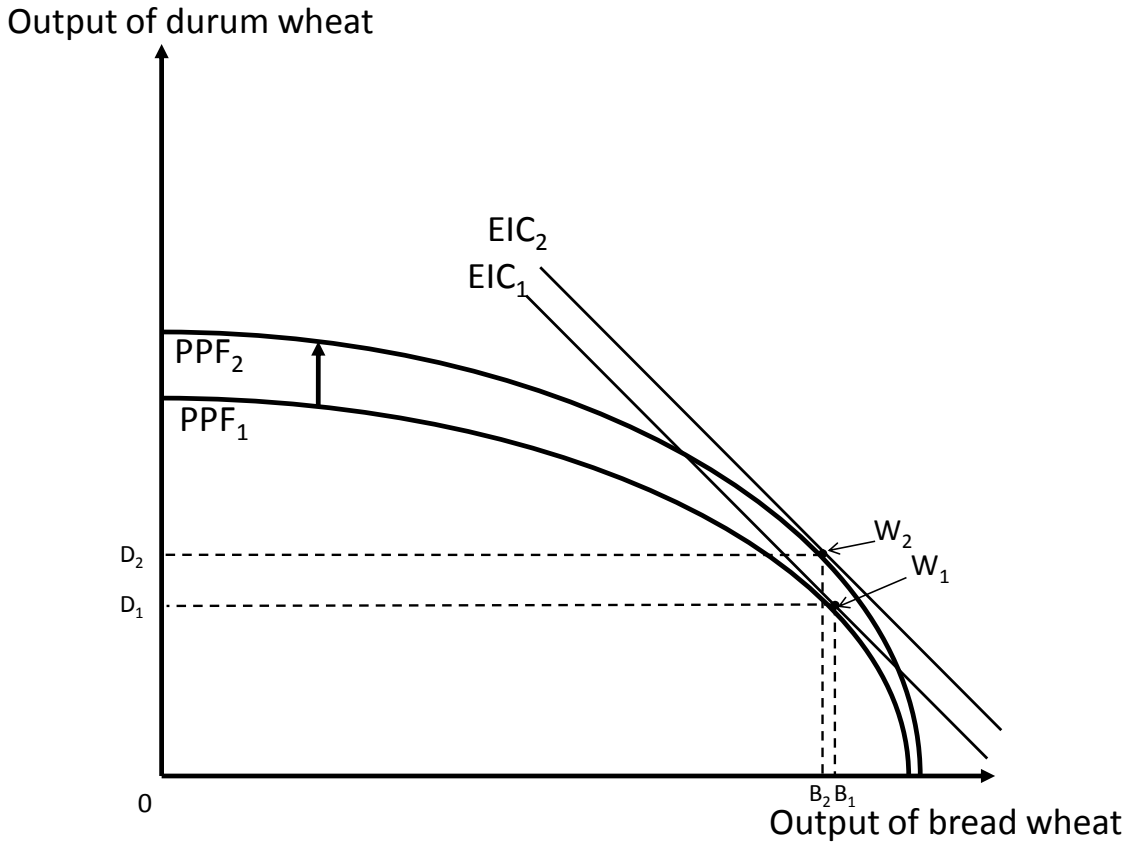


Figure A8. Mix of durum wheat and bread wheat channels in the wheat value chain

Wheat production is a critical stage in the durum wheat channel of the wheat value chain because farmers face additional challenges in the growth stages of durum wheat varieties compared with bread wheat varieties, and durum is a riskier crop for growers than bread wheat varieties (Connell 2004). Figure A8 shows an asymmetric PPF skewed in favour of the production of bread wheat varieties (PPF_1). The potential to develop the durum wheat channel of the wheat value chain was being held back by these difficulties in farm production, creating a positive chain externality. That is, all participants in the durum wheat channel of the chain would benefit from improved production conditions on the farm but the RD&E needed to improve production conditions was not profitable for individual wheat producers to undertake.

Changes have occurred to the wheat PPF and EIC at different stages in the value chain over the past three decades, reflected in Figure A8 by the upward shift of the frontier to PPF_2, above the private PPF_1 (assuming a much smaller change in wheat bread production possibilities). As a result, the optimal position for the wheat value chain in responsive-low cost space in Figure A8 moved from W_1 to W_2. Farm-level RD&E – internalising positive chain externalities associated with superior wheat production technologies – were crucial in overcoming the farm-

level constraints to achieving a high-quality and stable throughput in the durum wheat channel of the wheat value chain. These improved production technologies are expected to have lessened the degree of skewness in the PPF through productivity gains leading to quality improvements, enhancing the competitive position of the durum wheat channel relative to the bread wheat channel. The outcome in Figure A8 is that the throughput of durum wheat increased to $0D_2$ and the throughput of bread wheat declined slightly to $0B_2$ despite the small improvement in production possibilities in the bread wheat channel.

Unlike the situation with the fresh potato value chain, the Coasian solution to sub-optimal performance in the durum wheat channel of the wheat value chain partly required outside assistance to internalise the positive chain externalities because, as noted above, it was not profitable for a single participant, or group of participants, to do so. Kneipp (2008) outlined the breeding programs that led to the release of new durum wheat cultivars by the New South Wales Department of Primary Industries from 1982. These cultivars enhanced yields, protein content, pasta-making quality, disease resistance and tolerance to climatic variability. More careful selection of soils on which to grow durum wheat, crop rotation and disease control methods, especially for crown rot, led to higher yields and more stable output (Penny 2000) reducing asymmetry in the PPF.

Production has not been the only stage at which progress has been made in altering the shape of the PPF. Other stages in the value chain are also important, especially in influencing the quality of the end products and changing the slope of the EIC in favour of durum wheat. Most of these processes proved privately profitable but relied on past RD&E work, some of which had been publicly funded. Troccoli et al. (2000) explained how the quality of durum wheat changes according to the processing technology and end use. They reported on quality aspects evaluated at different levels from the farm to the consumer. Durum wheat has proved particularly receptive to quality improvements from debranning prior to milling (Dexter and Marchylo 2000), a process of adaptation that was built on previous technological advances in processing other grains.

As for fresh potatoes, exogenous factors have altered consumer demand for wheat products. One such change has been a switch in consumer preferences from traditional white bread (made from white refined flour) to whole-wheat bread (made from whole wheat – bran, endosperm and germ), despite the higher costs in the value chain of the latter. This trend has partly been a response to growing awareness of the nutritional merits of whole-wheat bread. The trend in consumer preferences towards whole-wheat bread is represented in Figure A9. The shift in consumer preferences is shown by the swivelling of the EIC from EIC_1 to EIC_2, and the consequent reduction in throughput of traditional bread from T_1 to T_2 and an increase in throughput of whole-wheat bread from Wh_1 to Wh_2. EIC_1 could be construed to be the private isorevenue curve while EIC_2 may be regarded as a chain (and, more broadly, social) isorevenue curve that reflects the social benefits of better diets from consuming whole-wheat bread.

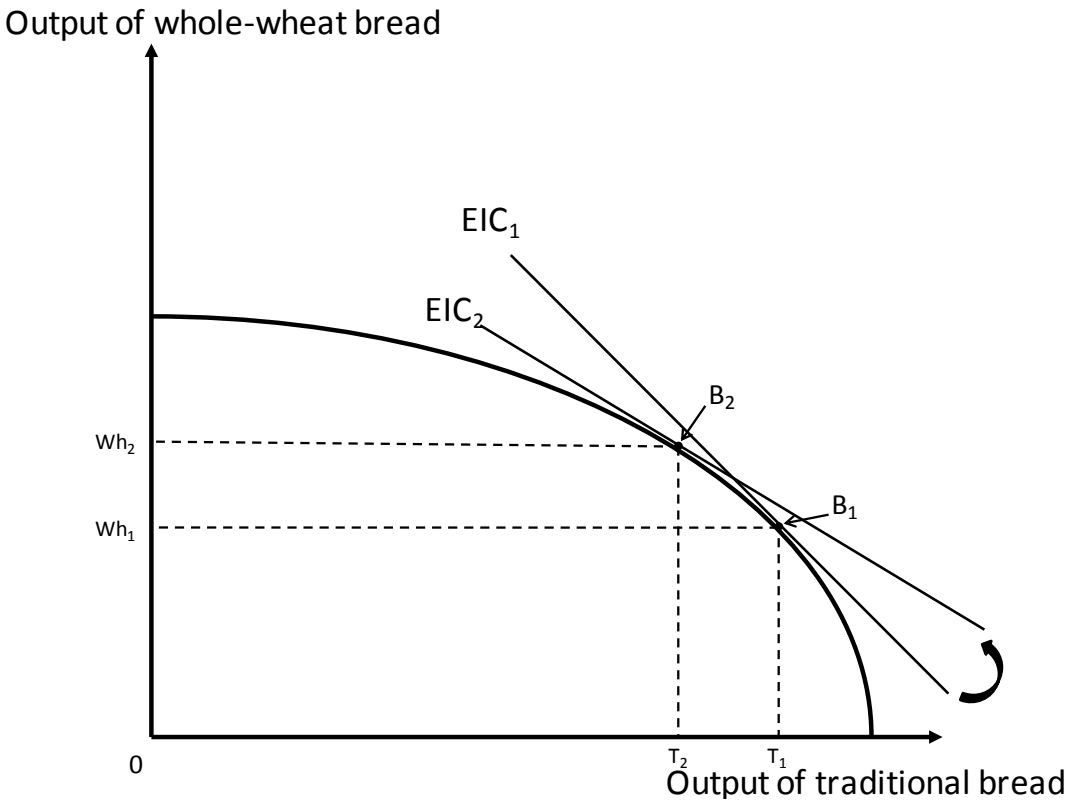


Figure A9. Change in the mix of whole-wheat bread and traditional white bread channels in the wheat value chain

Summary

We have demonstrated how a decision maker can use normal microeconomic principles to optimise the level of responsiveness in a value chain. They can achieve this outcome by (a) drawing a distinction between responsive and low-cost chains, (b) enhancing analytical usefulness, (c) accounting for technical inefficiency, and (d) establishing the appropriate extent of strategic scope. We have provided an outline of how we think the optimal level of responsiveness should be determined for a food value chain and discuss examples of the Australian beef and wheat industries and the UK fresh potato industry. These examples demonstrate some of the responsiveness attributes that currently exist in food value chains or which could be added if the expected additional revenues exceed the additional resource costs of providing them.

The proposed framework is based on the well-tested concepts of PPFs and EICs. The three mini case studies reported above demonstrate that actual decisions on the mix of responsive and low-cost value chains, and responsive and low-cost attributes within a chain, appear to have been made in accordance with this framework, in a range of circumstances.

If such decisions are influenced by the shape of the PPF and the slope of the EIC, the next challenge is to undertake the detailed empirical work necessary to define these curves across different channels within meat value chains, and across meat value chains, regions and governance structures. A particularly testing challenge, given the variations in quality between responsive and low-cost channels or chain, will be in developing objective measures of quality change.

Another challenge broached by Chopra and Meindl (2013, p. 41) is to develop a model to optimise the responsiveness-low cost mix at each stage in the value chain as well as for the whole chain, and to analyse the distribution of rewards between stages. This would entail extending Weaver's (2009) microeconomic model to incorporate the modifications to the PPF that take place as products move along the channels within a value chain.

Appendix 6. Pricing Chain Goods

Treating a meat value chain as a 'club' should enable a chain-governing agency to collaborate with governments to use pricing mechanisms that maximise both chain surplus and social welfare by applying a two-part tariff for shared services that the agency provides to chain members. The advantage of such a tariff is that it enables members of the 'club' to convert latent demand for services into effective demand by sharing services that otherwise would not have been satisfied. Pindyck and Rubinfeld (2012) called the first part of the tariff an entry fee, which is charged to all 'club' members.

Such collective action to supply goods and services need not be confined to within chain borders. It is possible to use a combination of public finance or funds provided by chain members, which can be calibrated to provide goods and services that are currently sub-optimally supplied to society as a whole, resulting in a net gain in social welfare.

MLA membership is free to producers of grass or grain-fed cattle, sheep, lambs and goats who pay MLA levies:

MLA is primarily funded by transaction levies paid on livestock sales by producers. The Australian Government also contributes a dollar for each dollar MLA spends in R&D. This is supplemented by cooperative contributions from individual processors, wholesalers, foodservice operators and retailers. Processors and live animal exporters also pay levies under contract to MLA.

MLA is not the only beneficiary of transaction levies - it is one of three organisations, including Animal Health Australia and the National Residue Survey, that receive a proportion of the funds.

… Transaction levies are charged on the sale of livestock (cattle, sheep and goats). The money raised is invested back into the industry to assist in research and development, marketing and market access activities.(MLA 2012)

The Australian government's matching funds that represent society's contribution are presumably for benefits provided within the value chain that spill over to members of society outside the chain. The second part of the tariff comprises fees for a specific service, what Pindyck and Rubinfeld (2012) referred to as a usage fee. Chain members pay for any such service according to their individual needs.

Figure A10 demonstrates how maximising chain surplus through the application of a two-part tariff can be achieved (assuming for simplicity that the application is confined to chain members). Modifying the explanation provided by Pindyck and Rubinfeld (2012) and considering (again for simplicity) a single shared service, the total profit π obtained by a governing agency in the chain is the sum of the profit from the entry fee π_a and the profit from sales of the service π_s. Because π_a and π_s depend on the entry fee:

$$\pi = \pi_a + \pi_s = n(T)T + (P - \mathrm{MC})Q(n)$$

where n is the number of chain members, which depends on the entry fee, T, P is the usage fee for the service, MC is the marginal cost of providing the service and Q is the rate of sales of the service, which is greater the larger is n. T^* in Figure A10 is the profit-maximising entry fee, given P. The optimum values for P and T can be calculated by using an iterative process: begin with a

number for *P*, find the optimum *T*, and then estimate the resulting profit; change *P* and recalculate the corresponding *T*, along with the new profit level until profit is maximised.

A two-part tariff works best, according to Pindyck and Rubinfeld (2012), when consumers (in our case, meat value chain members or sections of thereof) have very similar demands, which is likely to be the case for a number of the services that could be provided by the governing agency.

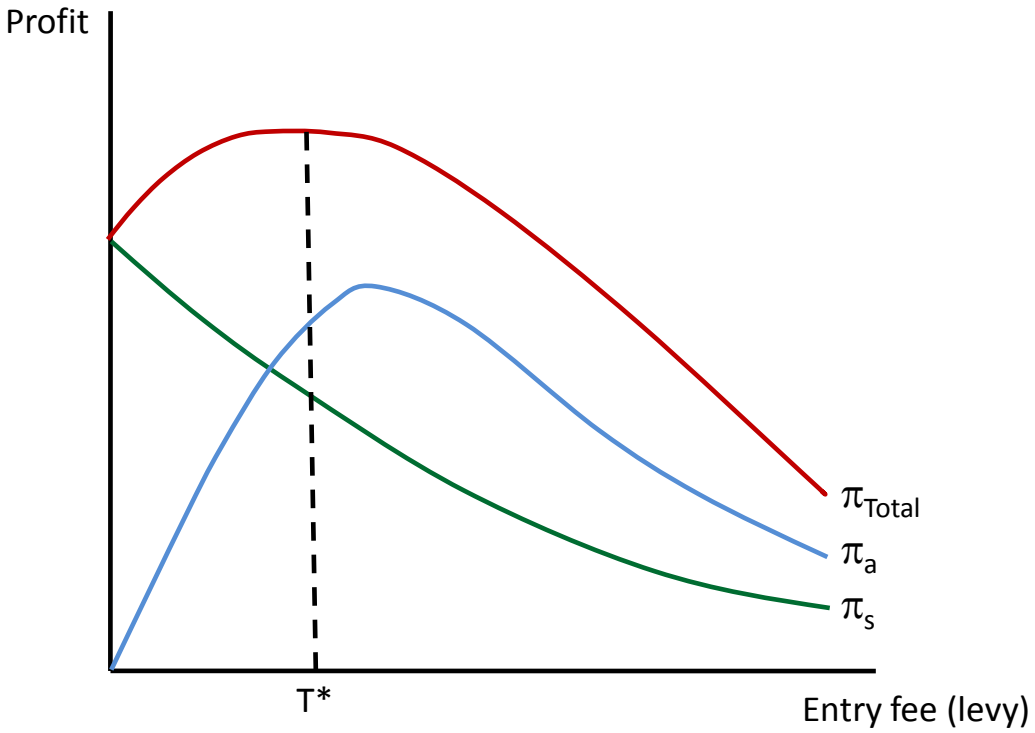


Figure A10. Two-part tariff with many different consumers of a shared service