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## **Economic Considerations of Animal Welfare Policy**

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# **Economic Considerations of Animal Welfare Policy**

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## **Abstract**

Animal welfare considerations are becoming increasingly important for producers of animal-derived agricultural products. Recent media attention on issues of housing conditions for intensively reared livestock and induced calving in dairy production make it clear that some members of the public feel strongly about the overall welfare of farm animals. In many cases, practices that are now perceived as welfare unfriendly are also associated with lower per-unit costs of production, creating a 'classic' economic trade-off between production and welfare objectives.

In this paper a relatively simple partial equilibrium model is used to illustrate that the distributional impacts of animal welfare regulations (for both humans and animals) depend critically on whether the domestic market is open to international competition. A preliminary case study involving housing options for sows in New Zealand provides an empirical illustration of the possible magnitude of the costs of welfare enhancing policies in a small open economy when the country is a net importer. The fact that welfare enhancing policy is driven by consumers who do not share the resulting economic burden raises important philosophical questions about how society defines what is acceptable on welfare grounds, and whether there is any economic justification for mitigating the costs when they accrue only to one sector of the economy.

Keywords: Animal welfare; partial equilibrium analysis; externality; economic surplus

## **1. Introduction**

Even casual attention to the popular press reveals that farm animal welfare issues are becoming increasingly important to consumers. Because concern over farm animal welfare issues is likely to correlate positively with income levels, animal welfare can be expected to be particularly high on the social agenda in developed countries. However, as the overall level of animal welfare increases, further gains in animal welfare are likely to be associated with higher per-unit costs of production, creating a classic economic trade-off between animal welfare and profit objectives for the producer (McInerney, 2004).

Because increasing animal welfare involves real resource costs for society, farm animal welfare is at least partially within the domain of economics as a discipline. Indeed economic theory has much to offer the animal welfare debate (Bennett, 1997 and McInerney, 2004). Not only does economic theory provide a justification for government involvement in a market-oriented economy, even simple economic models can indicate the magnitude and distribution of the benefits and the costs of policies aimed at improving animal welfare.

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<sup>1</sup> Note that the opinions expressed in this paper reflect those of the author in her capacity as an independent academic researcher, and should not be interpreted in any way as representative of a general NAWAC view.

In this paper attention is focused specifically on identifying the factors that determine the size and distribution of the resource costs of animal welfare policy. The simple theoretical model is then applied to the empirical example of housing options for sows in New Zealand. Results confirm that the marginal cost of increases in animal welfare increase as higher levels of welfare are achieved, and that the distribution of policy costs will depend critically on whether the economy is open to international trade.

Once the magnitude of the aggregate resource costs of improving sow welfare have been presented, attention is focused on the amount of welfare that may be embodied in the pork available for domestic consumption under the different animal welfare policies. In this case where New Zealand can be considered a small open economy that is a net importer of pork, the net gains in the amount of welfare embodied in domestically consumed pork may be small as welfare policies become increasingly strict. This is due largely to the fact that domestic producers facing increasingly high compliance costs must compete with overseas producers who may not face similarly strict welfare standards. This raises important philosophical questions about the precise nature of the value of animal welfare outcomes, and whether they should logically depend on where the animals that contribute to consumptive output reside.

## **2. Animal Welfare Defined**

Despite the increasing public awareness of animal welfare issues, it has been argued that defining the term 'animal welfare' in precise, scientific terms is not possible (Duncan, IJH 2005). However, it is also acknowledged (even by the same scientists) that most people do have an idea of what does (or does not) constitute 'good' versus 'bad' animal welfare. Particularly in recent years, a general consensus has emerged that animal welfare encompasses both the physical and 'emotional' state of the animal.

Under the Animal Welfare Act 1999, people in New Zealand are legally obligated to ensure that the physical, health and behavioural needs of animals in their care are met in a manner that is in accordance with good practice and scientific knowledge (Animal Welfare Act, 1999). They are, in short, required to ensure that their animals exist in a reasonable state of welfare. More specifically, the Act defines physical, health and behavioural needs as having access to and/or the ability to express the internationally recognised 'five freedoms', which can be summarised as follows:

- a) Access to proper and sufficient food and water;
- b) Access to adequate shelter;
- c) The opportunity to display normal patterns of behaviour;
- d) Physical handling in a manner which minimises the likelihood of unreasonable or unnecessary pain or distress;
- e) Protection from and rapid diagnosis of any significant injury or disease.

There is a qualifier in the Act that the freedoms need to be interpreted in a manner that is appropriate to the species, environment and circumstances of the animal.

## **3. Animal Welfare as an Externality**

In a mixed economy, market mechanisms have been shown to result in efficient outcomes, and therefore unrestricted markets are desirable if the goal is to maximise net social welfare. In some

cases, however, markets will result in less than optimal outcomes. Externalities are one general class of market failure, and their existence is often cited as a rationale for government intervention. An externality exists when the actions of one or more economic agents are able to influence the utility or satisfaction of other economic agents in a manner that is not reflected via price signals in the market in question (Pindyck and Rubinfeld, 2001). Within the current context, the production of animals and animal-related products under different management systems involves various levels or states of animal welfare. It is the joint production of animals (or animal products) and animal welfare that creates the external effect.

McInerney (2004), Bennet (1997) and Carlsson et. al (2003) argue that animal welfare may enter the utility function of a consumer of animal products in two ways. In the first instance, a consumer might experience disutility if she feels that the animals that she consumers have been produced under conditions of low animal welfare. The consumer can internalise this disutility so long as animal products are clearly labelled with respect to the level of animal welfare they embody, and higher levels of welfare can be accompanied by price premiums. However, low levels of animal welfare may also impose a social cost on those who feel disutility due to the consumption choices of others who may support a lower standard of welfare than they are willing to accept. This social cost cannot be reflected in the market, and therefore represents an external effect.

A wide range of potential policy responses to externalities have been promulgated. Broadly speaking, the list includes doing nothing, assisting with the development of a functioning market, creating a system of financial incentives (or disincentives) and regulation or 'command and control' policies. New Zealand takes a statutory approach to ensuring that a reasonable level of animal welfare is maintained. Under the Animal Welfare Act, legally binding minimum standards are established to set a 'lower bound' for animal welfare, and recommended best practices (which are not legally binding) are promoted to encourage a higher level of commitment to animal well being. This approach is consistent with the view espoused by McInerney (2004), that animal welfare exhibits public good characteristics at very low levels, and the government is well justified in requiring that a minimum standard be met.

Setting minimum standards is far from trivial, however, and an economic framework can be a useful way to consider both the costs and the benefits of animal welfare policy. The mere existence of an external effect does not warrant government intervention. In order to determine whether intervention is can be justified on economic grounds, it is necessary to evaluate both the costs and the benefits of intervention. In this paper I will not consider the contentious topic of valuing animal welfare benefits. Rather I will focus on the task of developing a very simple partial equilibrium model that can be used to identify the factors that are likely to affect the magnitude and distribution of the costs of farm animal welfare policy. The model will then be applied to the empirical problem of sow welfare in New Zealand.

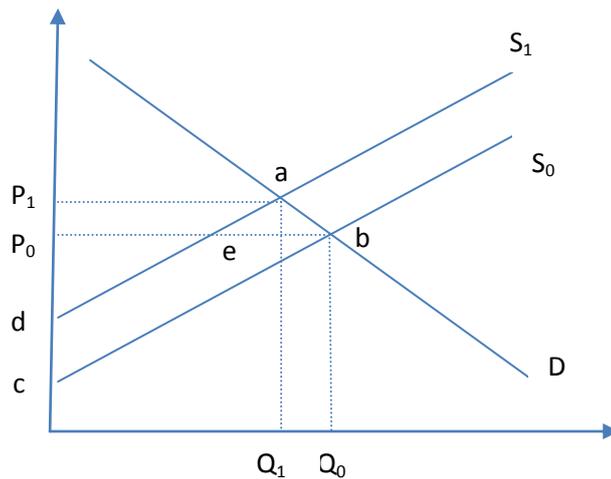
#### **4. Modelling the resource costs of animal welfare policy**

In this section a very simple partial equilibrium model will be used to clarify how the social costs of animal welfare policies can be considered, and the factors that are likely to influence how the costs are distributed across various members of society.

#### 4.1 A closed economy

The model is a very basic economic surplus model of the type that Alston, Norton and Pardey (1998) advocate and develop to calculate the benefits of agricultural research. The obvious difference is that animal welfare policy will generally increase per-unit costs of production, whereas agricultural research is aimed at reducing production costs.

Figure 1 Direct impact of animal welfare policy in a closed economy



Beyond a certain level of welfare, animal welfare enhancing policy is likely to increase per-unit costs of production. This will shift the supply curve to the left, from  $S_0$  to  $S_1$ . Initial equilibrium in Figure 1 occurs where  $S_0 = D$ , at a price and quantity of  $P_0$  and  $Q_0$ , respectively. The impact of the policy is therefore to increase the price and reduce the quantity in a manner that is consistent with a potential Pareto improvement in the presence of a negative production externality. The price impact on the consumers of the animal product is unambiguously negative, and can be approximated by the area  $P_1abP_0$ , which represents that change in consumer surplus. Producers lose the area  $dabc$ , but gain the area  $P_1aeP_0$ . The net annual resource cost to society is the area  $dabc$ . Note that the impact of the welfare enhancing policy does not fall uniformly on producers as a whole. Producers who were already using systems consistent with the policy will gain from the price increase without incurring any additional resource cost.

Under certain assumptions about the functional forms of supply and demand, as well as the nature of the supply shift, changes in consumer, producer and total surplus can be estimated using demand and supply elasticities, along with knowledge of the original equilibrium (Alston and Pardey, YEAR). As with all forms of 'tax', the economic burden of the policy costs will be determined by the relative magnitude of the supply and demand elasticities.

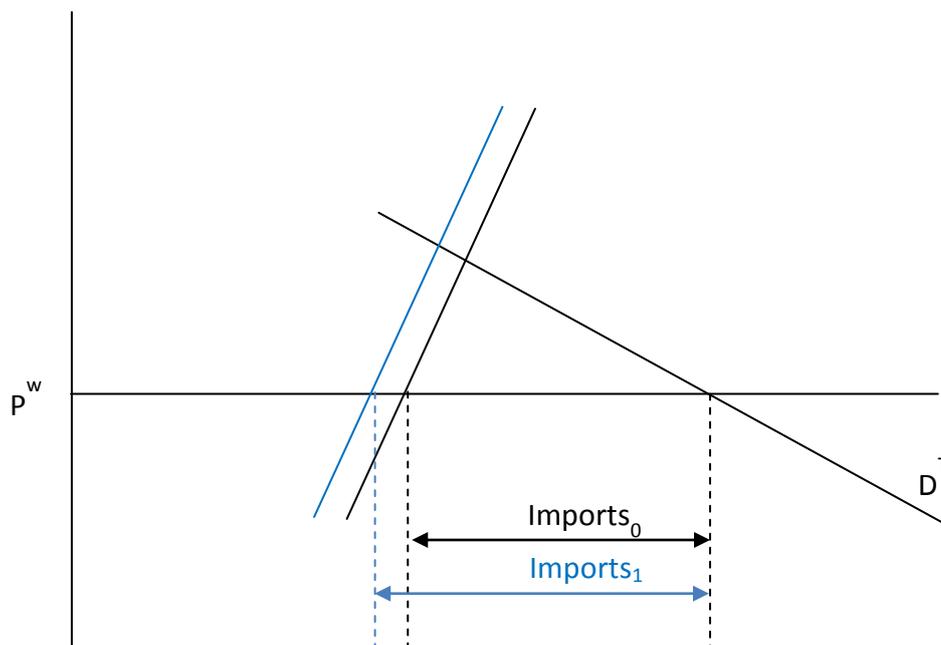
It is possible to enhance this model substantially by explicitly incorporating multiple levels along the supply chain and/or heterogeneous regions or producer groups, but this simple model represents a good starting point for enhancing our understanding of policy impacts. If values are calculated at the farm level, the loss in consumer surplus represents the aggregate cost to consumers of the animal product at all levels. How much of this price increase is actually transferred to increases at the retail level will depend upon elasticities of price transfer.

Note that this model is relatively silent on the transition to the new equilibrium. It implicitly assumes that non-compliant producers will incur the cost of adopting the welfare-enhancing technology. The capital cost of the transition is not a net resource cost to society, but could be a political concern and should therefore be considered at least qualitatively.

#### 4.2 The impact of trade

As emphasized by Alston, Norton and Pardey (1998), when the closed economy assumption is relaxed, the distributional impacts domestic supply shifts change significantly (Figure 2). In the analysis that follows, the country is assumed to be a net importer because this is consistent with the empirical application presented in the next section. Following the traditional 'small country assumption', the domestic supply is now a 'stepwise' function, determined by domestic factors at prices below the world price, but perfectly elastic once the world price ( $P^w$ ) is reached. The direct impact of the policy is still to shift the domestic supply curve to the left. Because domestic price is determined by the world market, however, there is now no price effect for consumers. As a result, domestic producers bear the entire cost of the policy, and any reduction in domestic supply is met by an increase in imports.

Figure 2 Direct impact of animal welfare policy in a 'small' open economy



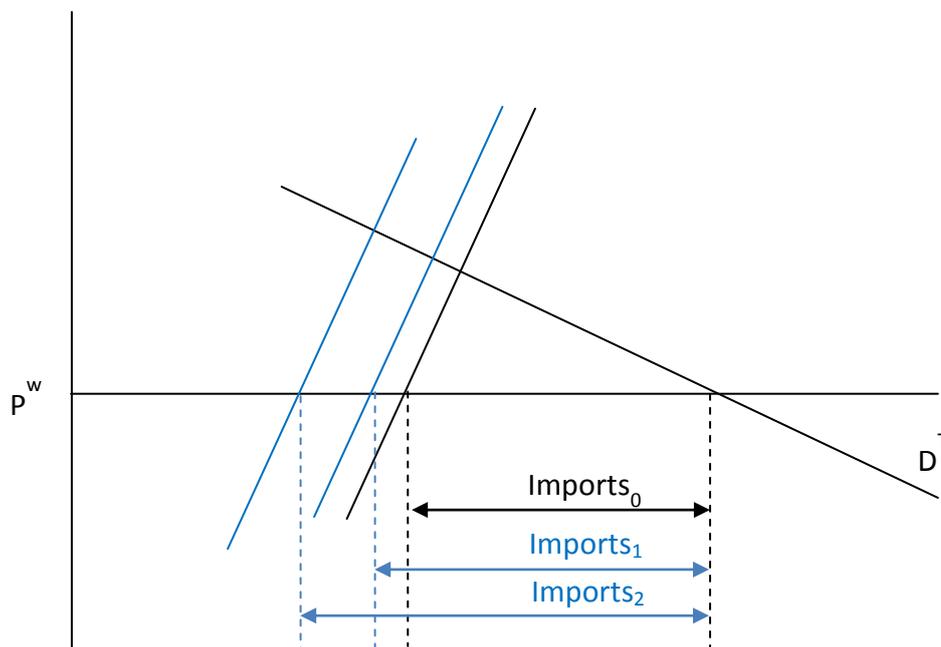
There is an additional complication associated with this open economy assumption. Because the cost increasing policy is not accompanied by a subsequent price increase, it may be difficult for non-complying farmers to secure the finance they require to switch to a new management system. This will be exacerbated by the fact that many of the more welfare-friendly systems are also more management and labour intensive, which further complicates the transition.

As a result, affected producers may decide to exit the industry as opposed to adopting the new technology and remaining in business. While this process may not impose any additional resource

costs on society provided that the pig farmers can find gainful employment elsewhere, it does impose at least a transitional cost on society in the form of pre-mature asset write-off and temporary unemployment.

The magnitude of industry exit may also have important implications for animal welfare on a more 'global' scale, as a reduction in the number of producers will further shift the supply curve (consistent with a move from  $S_1$  to  $S_2$  in Figure 3), which will result in still more imports. If imports are sourced from countries that impose fewer animal welfare restrictions on producers, then it is possible that the welfare embodied in the meat that is consumed within the domestic economy will decline if animal welfare policies are particularly strict by international standards.

Figure 3 The additional impact of industry exit in a small open economy



### 5. Empirical Application: Housing Options for Gestating (Dry) Sows

Housing options for gestating sows provides an interesting empirical application for this simple model. Dry sow stalls are used by pig farmers throughout the world to house pregnant sows. They simplify the management of the pigs, particularly during relatively 'hormonal' periods of time, and they make it easier for producers to ensure that individual dietary and health needs are met. There is increasing public resistance to their use, however, because they provide a particularly barren environment that does not allow the sow to display normal patterns of behaviour.

In New Zealand, the current Code of Welfare for Pigs allows for the unlimited use of dry sow stalls until 2015, when the use of dry sow stalls must be limited to no more than four weeks after mating (NAWAC, 2005). The four week restriction recognizes the balance of opinion in the scientific literature, which suggests that production losses associated with group housing can be mitigated if sows are confined for 28 days after mating. In practice, this means that it is currently possible for domestic producers to confine sows for their entire gestation, which lasts approximately 16 weeks.

In 2009, the National Animal Welfare Advisory Committee (NAWAC) extensively reviewed the 2005 Code of Welfare for Pigs. In early 2010 a new Draft Code was released for public consultation. In the Draft Code it was suggested that the four week restriction on dry sow stall use be brought forward to 2012, and that dry sow stalls be entirely phased out from a date to be determined after consideration of public submissions (NAWAC, 2010).

## 5.1 Farm-level impact

### 5.1.1 Financial cost of restricting the use of sow stalls

The economic analysis (MAFBNZ, 2010) that accompanied the public release of the Draft Code indicates that a four week restriction on the use of dry sow stalls will cause a slight increase in labour and feed costs. Banning stalls altogether will have a further impact on variable costs, and also reduce sow productivity. In both cases reducing the use of stalls also requires additional capital investment and resource consents.

The estimated cost increases, combined with farm budget information produced by Lincoln University, provide an indication of the magnitude of the farm-level financial impact of the alternative housing options for a 250-sow operation:

Table 1 Financial cost of animal welfare policies at the farm-level

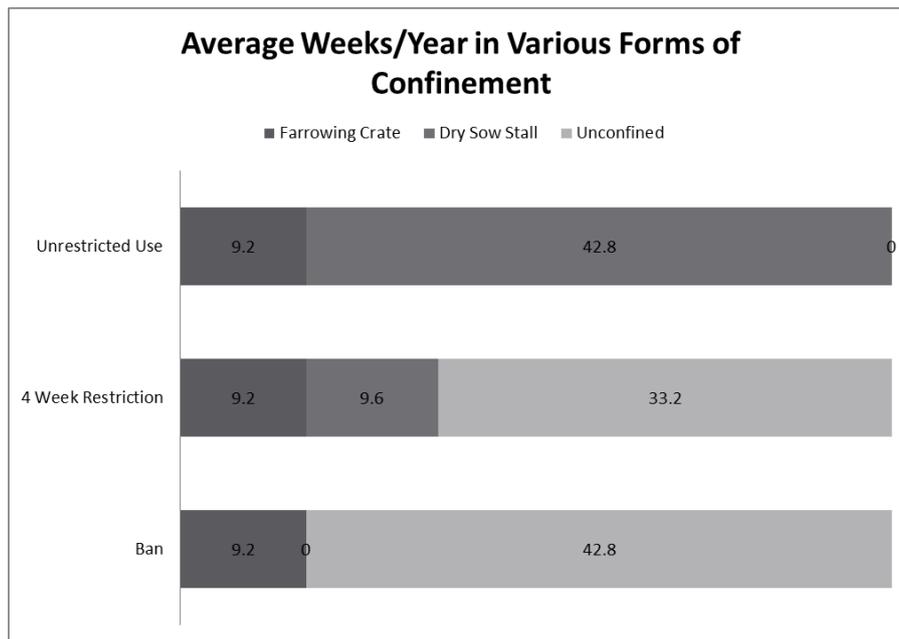
	4 Week Restriction	Ban
Increase in feed costs	\$8,100.00	\$10,500.00
Increase in labour costs	\$5,000.00	\$6,700.00
Reduced productivity	\$0	\$60,600.00
Increased capital investment <sup>a</sup>	\$11,400.00	\$14,700.00
Total Cost	\$24,500.00	\$92,500.00
Resource consent costs	\$2,000 - \$10,000 +	\$2,000 - \$10,000 +

<sup>a</sup> Amortised and expressed as an annual flow

### 5.1.2 Benefits of restricting sow stall use

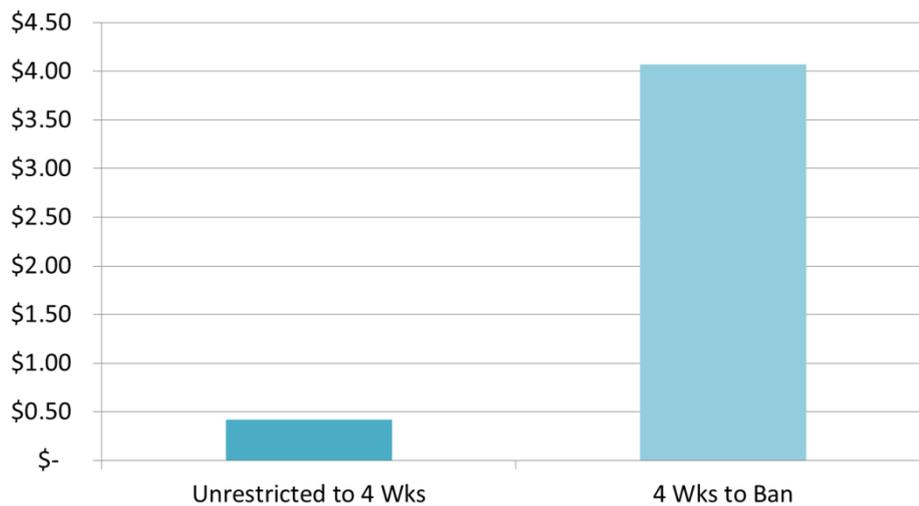
The primary benefit of reducing the use of dry sows is the additional opportunity that sows have to display normal patterns of behaviour. One measure of the 'output' or 'benefit' of these housing policies is therefore the number of 'crate days saved'. Given the reproductive biology of a sow, unlimited use of dry stalls implies that a sow will be confined in a stall for an average of 42.8 weeks (or approximately 300 days) per year. Restricting the use of stalls to four weeks after mating reduces that time to approximately 67 days, for a reduction of 233 days. Banning stall use altogether reduces confinement time a further 67 days. Confinement time in various housing options is shown in Figure 4, which highlights the large marginal gain associated with a four week restriction relative to a ban.

Figure 4 Confinement time associated with various housing options



Because 1) a four week restriction is associated with a relatively large gain in the number of 'crate-free days', and 2) a total ban on the use of stalls is associated with relatively large productivity loss, the marginal cost per unit of welfare gained of a total ban is very high (Figure 5). This data therefore confirms the theoretical prediction that the marginal cost of improving animal welfare is likely to increasing.

Figure 5 Marginal cost of increasing welfare (cost per crate-free day)



## 5.2 Industry level impact

Empirical application of the simple partial equilibrium model requires an estimate of the vertical shift in the supply curve due to increasing per-unit costs of production, as well as an estimate of the horizontal shift in the supply curve due to policy-induced industry exit.

A four week restriction on the use of dry sow stalls is expected to impose a relatively minor resource cost on society. An estimate of the vertical shift in the supply curve resulting from this policy can be obtained by combining the variable cost impact with estimates of the number of pigs affected by the restriction. The result is a vertical supply shift of less than 1%. This policy is assumed to be accompanied by relatively low industry exit because the overall financial implications are relatively minor when compared to a complete ban. For illustrative purposes, industry exit under this scenario was assumed to cause a 5% vertical shift in the supply curve.

The aggregate resource cost associated with increasing the variable cost of production for non-complying farmers is approximately \$400,000 per year. Expressed in NPV terms over a 20 year time horizon, the aggregate cost of the four week restriction is approximately \$4.3 million. The capital adjustment costs required to either exit or comply with the ban impose an additional one-off financial cost of approximately \$4,000,000. Once again, this loss of economic surplus is borne entirely by producers in the open economy model.

By contrast, a complete ban is expected to have a more dramatic effect on both the vertical and the horizontal shifts of the domestic supply curve. More specifically, the combination of increases in variable cost and a drop in productivity for affected farmers are assumed to shift the aggregate supply function vertically by approximately 4%. For illustrative purposes it was assumed that more of the affected farmers would fail to obtain the finances and/or management skill necessary to adopt stall-free management practices, causing the supply curve to shift horizontally by 10%

The aggregate resource cost of a ban on sow stalls (relative to the status quo), is nearly \$4 million per year. The capital adjustment costs required to either exit or comply impose an additional one-off cost of similar magnitude to the four week restriction when the four week restriction comes into effect, and then an additional \$1 million when the ban is imposed. The NPV of this policy is just over \$30 million over a 20 year time horizon using a five percent discount rate.

Table 2 Aggregate impact of animal welfare policies

	Four Week Restriction	Ban
Resource Cost	\$406,000/year	\$3.78 million/year
One-off financial cost	\$3.7 million	\$3.6 million + \$1 million
Change in domestic supply	2.2% reduction	9% reduction
Change in imports	3.5% increase	16.1% increase

## 5.3 Animal Welfare Embodied in Pork Consumed in New Zealand

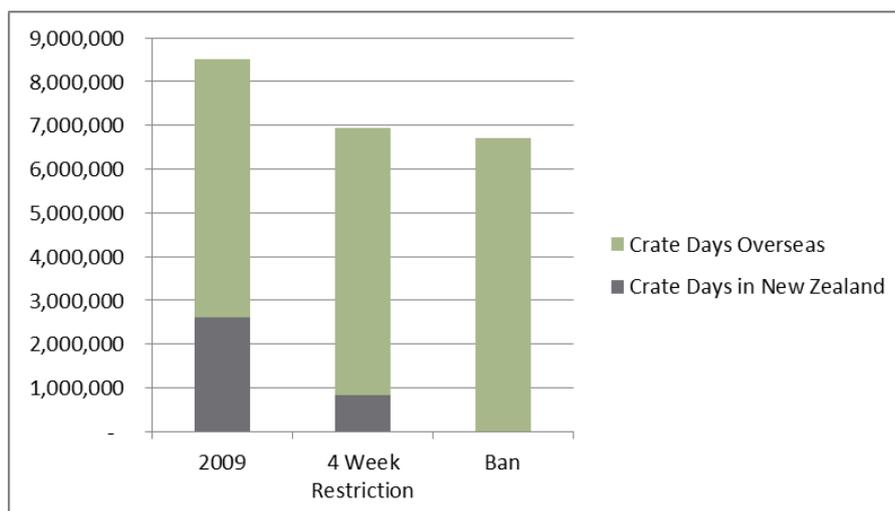
A question worth asking is whether the meat that is available for consumption in New Zealand will embody higher levels of welfare after more welfare friendly policies are imposed. There are no tariffs applied to pig meat imported into NZ from Australia or Canada, while the USA enjoys 'most

favoured nation' status with NZ, so processed pig meat from the USA is subject to a 5% tariff. Import substitution is therefore possible, particularly in the processed market where 'shelf-life' is less of an issue. Non-tariff (sanitary) restrictions severely limit the importation of fresh pig meat, although imports from Australia are allowed.

Recent trends show that imports of pig meat into NZ have doubled over the past 10 years, and in 2008 amounted to approximately 30 thousand tons, or nearly 40% of what is consumed domestically. The vast majority of the pig meat imported into NZ is for the processed market. Approximately 75% of the processed pig meat eaten in NZ is now imported. Most pork (product weight) imported into New Zealand comes from Canada, the EU, Australia, or the USA. Australia and the EU have both indicated that they will be moving to restrict (but not ban) the use of dry sow stalls within the next 5 or ten years. Although concern has been raised about the use of stalls in North America, neither Canada nor the USA have indicated that they will ban the use of stalls at the national level in the foreseeable future.

Using some relatively simple conversion ratios for sow productivity and carcass weight, it is possible to calculate the number of 'crate days' required to produce a particular amount of pork under different housing assumptions. This done for the status quo (which currently imposes no active restrictions on sow stall use), a nationally imposed four week restriction, and a national ban (Figure 6). For this preliminary analysis, additional imports are assumed to be produced in countries such as the USA and Canada, where welfare standards are low. Clearly changes in this assumption will have an impact on the results, but the main issue of 'embodied sow welfare' relates to the level of import substitution and how New Zealand policy compares to that of her trading partners.

**Figure 6**     **Crate Days Embodied in Pig Meat Consumed in NZ under different domestic welfare policies**



Under the assumptions governing this preliminary analysis, the overall welfare status embodied in the pork consumed in New Zealand is, in fact, higher under a complete ban than a four week restriction. It is worth noting, however, that the marginal gain in overall welfare status (as measured by a reduction in crate-days) is relatively small relative to the additional cost imposed by a ban.

Overseas experience with animal welfare policy provides an indication of how other countries have chosen to approach the contentious distributional impacts of animal welfare policies. The approach taken differs among countries, and includes subsidizing welfare friendly management systems and assisting affected producers to exit the industry. Sow gestation stalls have been banned in Norway, Sweden and the UK, and their use has been severely restricted in Switzerland and the Netherlands. Because Switzerland and Norway are not members of the EU, it is relatively easy to obtain country-specific information about the degree to which pig farmers are supported in these countries.

In 2009, the Producer Single Commodity Transfers for pig meat in Norway and Switzerland were approximately 47% and 54%, respectively. Market price support made up the bulk of this figure for both countries. In other words, producers in those countries derived in the neighbourhood of half of their income directly from government programmes that support the price of domestic pork. Domestic prices are maintained at high levels in these countries with high tariff barriers to trade.

In the UK, where direct commodity support and steep tariffs are less of an option, a programme was instituted to assist farmers in exiting the industry. This at least partially explains why, in the years following the ban on gestation stalls, pig meat production in the UK declined by approximately 40%. Because consumption remained relatively static, the difference between domestic production and consumption was made up via imports from Denmark, which restricts but does not ban the use of stalls.

## **6. Conclusion**

This paper is not unique in maintaining that economics can make an important contribution to the on-going farm animal welfare debate. McNerney observed some time ago that, although the relationship may be complementary at low levels of welfare, eventually there is a trade-off between further gains in animal welfare and efficiency objectives for society. Science and innovation produce a continual stream of cost reducing technologies, and the profit motive provides incentive for their adoption (McNerney, 2004). It has been argued that while the external or public good characteristics of animal welfare outcomes provide one of the necessary conditions for government intervention, they certainly do not provide a sufficient condition (Carlsson, et. al, 2003). At the very least economists can assist with identifying and valuing the range of costs and benefits associated with animal welfare, thereby assisting with the development of efficient welfare policies.

This paper does, however, make at least three distinctive contributions. The first is to provide empirical support for the theoretical claim that the marginal cost of supplying welfare outcomes is increasing as the overall level of welfare rises. This paper also illustrates that the distribution of policy costs will be strongly influenced by the presence of international trade. Finally, the paper uses empirical data to begin to explore the question of whether domestic animal welfare policies could possibly have the 'perverse' effect of actually reducing the amount of welfare embodied in the meat we consume. While the tentative answer to that question is 'not necessarily', it highlights the critical role of ethical assumptions and raises additional philosophical questions about the equity of imposing the entire cost of a public good on one sector of the economy. This is particularly the case when policies set in other arenas – which may place different weight on ethical versus efficiency considerations – require the same group to compete in an international marketplace where different cultural norms towards animals set alternative welfare standards

## References

- Alston, JM, GW Norton and PG Pardey (1998) *Science Under Scarcity: Principles and Practice of Agricultural Research Evaluation and Priority Setting*, CAB International and ISNAR, New York
- Animal Welfare Act, 1999, available at  
<http://www.legislation.govt.nz/act/public/1999/0142/latest/DLM49664.html>
- Bennett, RM (1997), "Farm animal welfare and food policy", *Food Policy*, vol 22, pp 281-88.
- Carlsson, F, P Frykblom, CJ Lagerkvist (2003) "Farm animal welfare: testing for market failure", *Working Papers in Economics no. 119*, Department of Economics, Göteborg University.
- Duncan, IJH (2005) "Science-based assessment of animal welfare: farm animals", *Rev. sci. tech. Off. Int. Epiz.*, Vol 24 (2), pp 483 – 492.
- Frank, JM (2002) "The Actual and Potential Contribution of Economics to Animal Welfare Issues", *Society and Animals*, 10:4, pp 421 – 428.
- Lusk, JL and FB Norwood, *Speciesism, Altruism, and the Economics of Animal Welfare*, Policy Paper, Department of Agricultural Economics, Oklahoma State University, available on-line at  
<http://aede.osu.edu/resources/seminars/Papers/Policy%20Paper%205%20-%20Ohio%20State.pdf>. Contact jayson.lusk@okstate.edu
- MAFBNZ (2010) "Review of the Animal Welfare (Pigs) Code of Welfare. Draft Economic Analysis for Consultation, MAF Biosecurity New Zealand Discussion Paper No: 2010/02, Wellington, New Zealand.
- McInerney, J (2004) "Animal Welfare, Economics and Policy" Report on a study undertaken for the Farm & Animal Health Economics Division of Defra.
- NAWAC (2005), *Animal Welfare (Pigs) Code of Welfare 2005*, 1 March, 2005, Wellington, New Zealand (available at <http://www.biosecurity.govt.nz/files/regs/animal-welfare/req/codes/pigs/pigs-code-of-welfare.pdf>).
- NAWAC (2010), *Animal Welfare (Pigs) Code of Welfare 2009, PUBLIC DRAFT*, 3 March, 2010, Wellington, New Zealand (available at <http://www.biosecurity.govt.nz/files/biosec/consult/draft-pigs-welfare-code.pdf>).
- Pindyck, RS and DL Rubinfeld (2001) *Microeconomics*, 5<sup>th</sup> Edition, Prentice-Hall, New York).