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Economics of Official Veterinary Services:

The Case of Latin America

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Abbreviations

AE	Animal-Equivalents (1 AE = beef cattle + 0.20 pigs + 0.05 poultry)
DE	Developed Economies
FBD	Food Borne Diseases
FMD	Foot and Mouth Disease
HACCP	Hazard Analysis and Critical Control Point
LDE	Less Developed Economies
OVS	Official Veterinary Services
SPS	Sanitary and Phytosanitary Measures
TFP	Total Factor Productivity
Z&FBD	Zoonotic and Food-Borne Diseases

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Executive Summary

Introduction and Objectives

01. The objective of this paper is to estimate the impact of OVS on the economies of the Latin American region. To this purpose, a conceptual framework is developed for understanding the demand for services produced by OVS. These services are decomposed according to their impacts on production, trade and human health and food safety. A description is presented of the current situation as relates to resource allocation in several countries of the region. Particular attention is put on total quantity of resources used. A Benefit/Cost analysis of additional resources allocated to OVS is carried out.

02. The animal stock existing in Latin America can be valued - in rough terms – in 90 billion US dollars. This number takes into account the existence of 380 million head of cattle, 70 million pigs and a number of poultry which expressed in terms of cattle amount to some 50 million head

03. Official Veterinary Services (OVS) are an important component as regards to protection of the value of this stock. Resources allocated to OVS are – in very approximate terms – of some 350 million dollars per year. These resources have then a critical role: for each of these 350 million dollars has to “take care of” some 250 dollars of animal stock. In other words, the annual expenses of OVS are equivalent to 0.4 percent of the value of the stock to be protected.

04. The role of OVS will expand in the near future. Output trends for 1993-2020 suggest: (a) in DE, and for all output types growth rates that are in general below 1 percent, versus growth rates of 2.5 – 3.0 percent in LDE and (b) growth rates for monogastric animals (pigs and poultry) higher than for ruminants (beef cattle). The growing importance of the developing in world production of meats can be predicted with confidence.

Animal Production, Trade and Consumption in Latin America

05. In Latin America, as in other LDEs animal production in all its forms will have an increased importance in the near future. Animal health problems, as well as human health problems caused by live animals or by foods processed from animal products will be the focus of increased attention.

06. In the last two decades, trade in animal products has increased markedly, contrasting with the slow increase shown for grains in general. In particular, in the case of poultry meat increase (1996-2006) has been 80 percent. For beef and pig meat increase has been smaller but also significant (more than 40 percent). A greater volume of trade implies a greater need for prevention, early warning and control of disease outbreaks. All these are tasks carried out by OVS.

07. In relation to this point¸ many LDE have not been able to profit from these increased opportunities. In particular, they have not been able to adapt their animal health systems to demands of importing countries or trade blocks. Improving the performance of OVS requires not only resources, but continued action through time. Organizational capabilities of OVS can only be improved slowly.

Demand for Services Produced by OVS

08. Resources for OVS are generated via general taxation or (mostly compulsory) charges for services rendered. OVS income does not result from autonomous decisions of firms or consumers but by decision-making at the governmental level. This implies that attention should be focused on the nature of the demand for OVS: demand for these services is not "revealed" via a pricing process. This is particularly important in LDE, where many projects with high rates of returns vie for public funds.

09. Basic economic principles suggest that market failure is a necessary condition for public intervention. In the absence failure, private markets generate results that in general terms are "efficient" in the sense that goods and services are produced up to the point where the value to consumers of these goods and services is equal to the cost incurred in producing them. Therefore, in order to understand the economics of OVS, attention should be focused on the possible existence of this type of failure.

10. In principle, OVS should focus on processes where market failure is particularly important. Other processes where failures do not exist, or where these are only moderate may be left in the hands of the private sector.

11. In order to measure the returns to OVS action, the impact of these on the functioning of markets has to be understood. These may be export, import or domestic consumption markets. They can also be "markets" where what is relevant is not animal products but different measures of human health: in the absence of OVS spontaneous behavior of producers, processors and consumers result in a certain level of human health; with OVS action this human health level may improve.

12. Market access restrictions associated with foot and mouth disease (FMD) are particularly relevant. Indeed, in the region the following situations coexist: (a) FMD-free countries, without vaccination (Chile), (b) FMD-free countries with vaccination (Uruguay), (c) Countries with FMD-free areas without vaccination (Argentina, Brazil, Colombia and Peru), (d) Countries with FMD-free areas with vaccination (Argentina, Bolivia, Brazil, Colombia and Paraguay) and (e) Countries with FMD (Bolivia, Paraguay and Ecuador).

13. Threats resulting from zoonotic diseases cause increasing concern. Indeed, higher population human and animal density, and higher mobility of humans and animal products (international trade) result in favorable conditions for the irruption of a "microbial perfect storm". During the last two decades, 75 percent of emerging diseases affecting humans occurred as a consequence of an animal pathogen migrating into a human host.

14. In addition to pathogens migrating from animals to humans, concern exists related to human health issues arising from food-borne diseases (FBD). Schlundt and others (2004) show an increase in the incidence of bacterial pathogens in European countries (1985 – 1998). For example, Campylobacterosis increased in this period from 30 to 80 cases/100.000 (with a peak of 120 cases/100.000 in 1992). Information for the US shows some 76 million cases annually for FBD, of which 325.000 result in hospitalization and 5.000 in death.

15. Sanitary crisis can have an impact on tourism. The case of FMD in the United Kingdom – even though it cannot be extrapolated to Latin America – serves as a pertinent example. In Latin America the tourism industry generates income of about 38 billion dollars annually (World Development Indicators, World Bank). Income from tourism represents – on a per capita basis – some US$ 20 – 50 in Brazil, Bolivia and Peru, US$ 80 – 90 in Argentina and Chile and US$ 200 in Uruguay. For Latin America as a whole, they average US$ 70. Caribbean countries such as Barbados average about US$ 3000 per capita

Resource Allocation in OVS

16. The economic impact of OVS is a function of resources allocated to these, as well of the use made of these resources. In Latin America research related to these two aspects is not abundant, even though some researchers have analyzed general aspects of these services. Veterinary public health specialists argue that important changes are taking place in the way that OVS carry out their tasks. Indeed, the current trend is to focus increasing attention to prevention, using a population-based approach (veterinary epidemiology).

17. In general, and as compared to developed economies, a greater percentage of veterinarians of countries of the region work in the public sector. But also, in Latin America the ratio between animal population and veterinary personnel is, in general, lower than that existing in DE´s with a strong agricultural sector. It is not possible to develop the implications of these issues here. However a possible hypothesis is that in Latin America there exists a disequilibrium between quantity of human resources, on the one hand, and availability of technical and financial resources on the other. This is particularly important give the trend towards a greater intensity in the use of laboratory, information and applied science.

18. Several Latin American countries spend in OVS less than US$ 0.40 per year and per person. This is the case of Bolivia, Colombia, Guatemala, Haiti, El Salvador and Peru. The lowest spending corresponds to Guatemala (US$ 0.13 per person-year) followed by Haiti (US$ 0.25 per person-year.). Argentina. Brazil, Chile and Paraguay spend in the order of US$ 0.70 – 1.10 per person-year.

19. The major producers and exporters of the region (Argentina, Brazil and Uruguay) allocate between US$ 0.70 and 0.85 per animal-equivalent per year. A comparison can be made between this figure and a (rough) estimate of private animal health spending. As commented in Chapter II animal health inputs (using an Argentine example) total approximately US$/AE 9 in cattle breeding, US$/AE 5 in cattle fattening and US$/AE 32 in dairy. This figures, weighted by number of animals in each class (total national herd) result in some US$/AE 9. Thus, total resource use by OVS is less than 10 per cent of private expenses in animal health incurred by producers.

20. Comparing Argentina, Brazil and Uruguay (important producers) cost of OVS per unit of output varies between US$/ton 7 in Brazil, to US$ 20/ton in Uruguay. Argentina has, in relation to Uruguay, a somewhat lower OVS cost per AE (US$ 0.66 against US$/AE

0.85) but a much lower OVS cost per ton produced (US$ 10 against US$ 20) due to higher productivity. The very low productivity of Paraguayan animal production explains the high OVS cost per ton (higher than Chile) even when OVS per AE is relatively low. The same thing occurs in El Salvador.

21. For important exporters of the region (Brazil, Uruguay and Argentina) OVS costs represent between 1.5 and 2.5 cents per each dollar exported of animal products. The fact that only a part of the income of these services (relatively small, but variable between countries) originates in export taxes implies that the “cost of exporting” is considerably smaller than this figure. This ratio shows considerable variation between countries. This is due – in particular - to the different importance of export demand in total demand of the countries animal sector output. Change in the export status of the country could markedly change the “cost” of the OVS per each dollar produced by exports.

22. Preliminary analysis carried out with data from five OVS of the region allows some inferences to be made on costs as a function of output. Indeed, the “total cost function” of OVS implies substantial economies of size: a 10 percent increase in size of the animal population is accompanied by only a 6.8 percent increase in total costs. For example, Brazil (190 million AE) maintains its OVS with a cost of US$/AE of 0.57, as compared to US$/AE 4.5 for Barbados or Belize (< 0.5 million AE)

Cost-Benefit Analysis of OVS

23. The decision to increase resources to OVS requires careful evaluation, in particular in LDE, where resource availability is particularly limiting. Different types of costs should be compared with resulting benefits. In many cases, human health or primary education projects compete for funds with animal health projects such as analyzed here.

24. The economic impacts of an OVS will vary depending on whether the country participates or not in international trade. Overall economic impacts are a function of: (a) higher productivity, (b) better access to international markets, (c) improved human health. Appendix 1 details basic aspects used for modelling these impacts. The “actual” (baseline) situation is compared to an “improved” situation. OVS budget increases necessary to pass from the baseline to the improved situation are derived by assuming a 30 percent increase in the current OVS budget.

25. The magnitude of the production shift caused by productivity increase depends on the extent to which the OVS reduces impacts of diseases that directly affect productivity. For the OVS to have an impact, “neglected opportunities” have to exist: for example, the individual producer may not face “correct” incentives due to externalities in disease control that lead him to use non-optimal (lower or higher) input levels.

26. The result of a higher budget allocated to OVS is assumed here to impact only on the probability of an event, not on the magnitude of this event. For the “baseline” and “improved” budgetary situation of the OVS probabilities of crisis may be denoted by P[Crisis|baseline] and P[Crisis|improved]. The benefit from improved OVS activities is therefore the difference in (expected) cost of a crisis with the baseline budget, as compared that expected with the improved budget. The assumptions used here are P[Crisis|baseline] = 0.05 (one crisis every 20 years) and P[Crisis|improved] = 0.02 (one crisis every 50 years).

27. Benefits considered here result from the 20-year Net Present Value of improvements in productivity, in reducing the probability of a sanitary crisis and in improving human health. The first benefit is increasing through time due to accumulation of productivity growth. The third benefit is increasing through time due to population growth (no per-capita income growth is assumed here). In contrast, benefits of avoiding a sanitary crisis exist only in the crisis year (or years), and not when the crisis does not occur.

28. In general, B/C ratios vary from 5 and 10:1. The case of Mexico presents a 2:1 ratio, smaller than other cases, probably as a result of the fact that budget of the Mexican OVS is, relative to others, quite high. But also, estimates of crisis costs for Mexico are relatively low. One possible reason for this is the importance of domestic consumption: a sanitary crisis will be "cushioned" by expansion of consumption.

29. Benefit/Cost ratios of Argentina and Bolivia are 10:1. High B/C ratios are explained by important impacts of OVS on productivity: animal stocks in both countries (in particular Argentina) are large.

30. Countries differ in the relative importance of the three components. This is true only comparing countries that participate in international trade. In Brazil, for example, some 60 percent of total benefits of OVS are caused by reduced impacts of crisis. In Argentina and Uruguay relevant figures are 24 and nearly 40 percent. In the case of Mexico, a very important portion of benefits (40 percent) result from improved human health.

I. Introduction

I.1 Objectives

The products of terrestrial animals represent the most important source of high-quality protein to which consumers of many parts of the world have access. In Latin America consumption of meat products varies between 40 and 50 kg per person-year. This is an indicator of the importance of this source of food in the diet of the population (Delgado, Courbois and Rosengrant, 1998). Further, for many households animal stocks represent the most important asset: ups and downs in the value of this asset are of primary importance as determinants of changes in wealth of these households.

The animal stock existing in Latin America can be valued - in rough terms – in 90 billion US dollars. This number takes into account the existence of 380 million head of cattle, 70 million pigs and a number of poultry which expressed in terms of cattle amount to some 50 million head (FAOSTAT).[1] The value of the animal stock in Latin America is particularly important given the regions´ urgent needs for capital. Indeed, the 90 billion dollars mentioned previously are equivalent to several financial assistance programs that in different opportunities have been directed to the region.

As detailed in sections of this paper, Official Veterinary Services (OVS) are an important component as regards to protection of the value of this stock. In Latin America resources allocated to OVS are – in very approximate terms – of some 350 million dollars per year. These resources have then a critical role: for each of these 350 million dollars has to “take care of” some 250 dollars of animal stock. In other words, the annual expenses of OVS are equivalent to 0.4 percent of the value of the stock to be protected. Furthermore, if access to international markets improves – a significant increase in the value of the animal stock can be expected. In this case, expenses of OVS – as a percentage of the value of the animal stock to be protected – will be even smaller.

Animal production – in a greater measure than crop production – is subject to several kinds of diseases. But also, many of the diseases that attack animals also attack humans (zoonoses). The case of avian influenza is probably the most spectacular and feared. However, there exists a wide range of diseases that can be transmitted from

[1] The value of the animal stock was estimated assuming: (a) an average bovine cattle live weight of 250 kg, (b) a pig value equivalent to 20 percent of the bovine cattle value, (c) a poultry value equivalent to 2 percent of the cattle value and (d) a price per kg of bovine cattle of US$ 0.80.

animals to humans. Included among these are brucellosis, leptospirosis, E.colii, toxoplasmosis, salmonellosis and others (Coleman, 2001).

Many agents associated with diseases can spread – under appropriate conditions - at high rates. Control of a geometric growth is very difficult with conventional measures. To a large extent, the key issue is to anticipate diffusion processes that endanger animal health. Prevention, however, requires early warning and decision systems (quarantines, movement restrictions, preventive slaughter) all of which entail a sophisticated organizational framework.

The objective of this paper is to estimate the impact of OVS on the economies of the Latin American region. The paper attempts estimate the impact of injecting additional resources to OVS of countries of the region. To this purpose the following topics are developed:

- A description of the importance of animal and avian production of Latin America
- A conceptual framework useful for understanding the demand for services produced by OVS. These services are decomposed according to their impacts on production, trade, human health and food safety.
- A description of the current situation as relates to resource allocation in several countries of the region. Particular attention is put on total quantity of resources used.
- A Benefit/Cost analysis of additional resources allocated to OVS. This analysis is based on literature review of previous studies, as well as on our own estimates.

The analysis of economic benefits of OVS is undertaken estimating the Net Present Value (NPV) of additional resources allocated to improving animal health. This paper attempts to derive order of magnitude estimates associated with the injection of additional funds to OVS. The results should be considered “possible scenarios” and not precise estimates. However, with the provisos of the chosen methodology, as well as the available data and time frame for research, approximate figures of the relevance of OVS for the region are arrived at.

I.2 Latin America: Population, Development and Animal and Poultry Stocks

The role of OVS can be put into perspective by first describing some basic economic indicators pertaining to the Latin American region.

Human population in Latin America totals some 524 million. The fact that population growth in this region is higher than in developed economies results in an age distribution with higher proportion of children, an age group for which health programs are particularly important. The region presents considerable variation in development indicators: per-capita gross income varies between a maximum of IS$ 5900 (Chile) and a minimum of US$ 450 (Haiti). The countries comprising the region differ in the availability of financial and technical capabilities for implementing improved veterinary services. In some cases, a considerable stock of human and organizational capital exists; in others this is not the case. The analysis of the improvement of OVS should therefore take into account this heterogeneity.

The importance of animal and poultry production differs among different countries. The ratio relating animal equivalents (AE) and human population varies widely: Uruguay has more than 4 AE per person. In the case of Haiti this ratio is only 0.13. These figures suggest that the focus of OVS should not necessarily be the same in different countries: for example, the greater the animal in relation to the human population the greater the importance, *ceteris paribus*, of topics related to animal productivity. In contrast, countries with a relatively small animal population but large human populations may allocate an increased effort to aspects related to food safety and zoonotic diseases.

An important role of OVS is to reduce obstacles to trade. For this reason, countries for which trade in animal products is important have special interest in the performance of their OVS. The available information shows that Brazil, Argentina, Uruguay and Mexico export significant volumes of meat products. Brazil is by far the country with largest volume of exports (Brazilian exports account for 60 percent of exports of the region). In export volume Brazil is followed by Argentina (13 percent), Mexico (11 percent) and Uruguay (6 percent). The rest of the countries account for 10 percent of total exports. Among these Chile and Nicaragua account for 5 percent of exports (Chile 4 percent, Nicaragua 1 percent). In summary: The countries differ substantially in the extent to which they participate in trade of animal products.

Table 1: Latin America – Basic Indicators
(Selected countries)

	Human Population	Animal Population	GNI/Cap
	(million)	(AE)	US$/cap
Argentina	38.7	62.6	4470
Brazil	186.4	225.7	3550
Chile	16.3	7.1	5870
El Salvador	6.9	4.1	2450
Guatemala	12.6	6.2	2400
Mexico	103.1	46.8	7310
Uruguay	3.5	14.4	4360
Peru	28.0	9.9	2650

Source: (1) and (3) World Bank – WDI. PBI/Cap: Atlas method
(2) OIE

I.3 Production and Output Trends

Meat markets are undergoing changes that - without fear of exaggeration - can be labeled as revolutionary. In particular, in less-developed economies (LDE) output growth has been several times as large as those of developed economies (DE): on average, growth has been 5 percent in the former, versus only 1.2 percent in the latter (Table 2). In the early 1980´s total output of meat in DE was greater than that of LDE; however by the year 2020 LDE will produce only 60 percent of the total, DE producing the remaining 40 percent. Notwithstanding the above, an important gap still exists in meat output per capita: In the 1990s this ratio was 29 kg/cap in LDE, versus 89 kg/cap in DE (bovine, pig and poultry meat). What is relevant, however, is the clear tendency for relocation of world production, with an increasing share corresponding to LDE.

Output trends for 1993-2020 suggest: (a) in DE, and for all output types growth rates that are in general below 1 percent, versus growth rates of 2.5 – 3.0 percent in LDE and (b) growth rates for monogastric animals (pigs and poultry) higher than for ruminants (beef cattle). The growing importance of the LDE´s in world production of meats can be predicted with confidence. The above can be summarized as follows: total output of DE was in the early 1990s some 100 million tons, will be 124 million tons in the year 2020. In LDE, in contrast, output was 88 million tons in 1993 and is predicted to be 182 million tons in 2020.[2] This doubling of output will have a favorable impact on the diet of consumers and on the income and asset growth perspectives of producers.

This increased production will also contribute to improving income levels of small producers, as well as making it easier for these to increase their liquid assets. Production increases, however, imply different types of challenges. In particular, this greater production will strain the multiple activities of OVS: among these early warning systems, monitoring, implementation of preventive measures and design of contingency plans. A greater dependence on products of animal origin also suggests increased importance on food safety issues.

In Latin America output growth level forecast to 2020 are lower than those of China, India and south-east Asia (2.1 percent in Latin America versus 2.5 – 3.1 percent in the other regions. These growth levels, however, are more than double than those predicted for the USA and other DE (approximately 1 percent annually). *Summarizing, in Latin America as well as in other LDE all forms of animal production will have an*

[2] Estimates correspond to Delgado, Courbois and Rosengrant (1988).

Table 2: Production Growth Trends

Region	1982-1993	1993-2020
	--- % per year ----	
China	8.3	3.1
India	3.3	2.7
Other E Asia	4.5	2.5
Other S Asia	4.6	2.6
South East Asia	5.4	3.1
Latin America	2.7	2.1
West Africa	3.8	2.5
Sub-Saharan Africa	1.6	2.1
All LDE´s	5.2	2.7
All DE´s	1.2	0.8
USA	2.3	1.1
World	2.8	1.8

Source: Delgado, Courbois and Rosengrant (1998) *increasing importance in the near future*. *Animal health problems, as well as human health problems associated with live animals or with animal-based foods will be subject to increased scrutiny*.

Production of bovine, pig and poultry meat in Latin America totals some 36 million tons annually (Table 3). South America accounts for 80 percent of this total. In turn, Brazil with a production of 19 million tons represents some 50 percent of total production in LA. Production in the region represents – in "animal equivalent terms" – some 85 kg/AE-year. If this output is valued at US$/kg 0.80 total value of production is some 30.000 million dollars or some US$ 68 per AE-year. These estimates constitute a first approximation of the importance of OVS in the region: public resources allocated to OVS may be related to total value of animal stocks (some 90.000 dollars) or to total value of annual output (the 30.000 million dollars already mentioned).

Production and animal stock data for the Latin American region help illustrate the importance, for animal health control, of improved coordination of efforts between countries. For example, important beef cattle producers and exporters such as Argentina, Brazil and Paraguay share frontier borders with Bolivia and Paraguay, countries where the beef cattle industry is important, but where export activity is currently relatively weak. Important sectors of these borders are, in effect, "porous" in the sense that non-negligible probabilities exist of clandestine cattle movements, in particular when significant price differentials exist between countries. The irruption – for example – of FMD in any of the two latter countries will have a consequence on the country where FMD originated (lower productivity, higher costs) but will have – if the infection crosses borders - even greater consequences in the sanitary status of the exporting countries.

In other words, the risk exists that a negative externality will be transferred from countries where control incentives are relatively weak (because of reduced exports) to countries where export potential is considerably higher. In this type of situation, a fluid information exchange, the existence of joint programs or even financial support of poor countries can have important effects. Note that the importance of the negative externality increases with increases in non-authorized cross-border animal flows. In turn, these flows will be greater when the exporting country is able to access higher-priced markets. Paradoxically improved access to international market, results in higher probabilities that this access will be interrupted owing to diseases originating in neighboring countries:

Table 3: Meat Production in Latin America

	Million Tons	% of Total
South America		
Argentina	3.9	10.7
Brazil	19.5	52.9
Colombia	1.5	4.2
Uruguay	0.6	1.5
Venezuela	1.2	3.3
Rest of South America	3.3	9.0
Central America	2.0	5.4
Mexico	4.8	13.0
Total	36.3	

Source: FAOSTAT – Animal Production Statistics inter-country price differentials are the force that “guides” clandestine animal movements between countries.

Output increments mentioned previously are accompanied by a virtual “explosion” in consumption levels of animal products. In the mid 1970s per-capita consumption (beef, pig and poultry) was some 67 kg en DE and 11 kg in LDE. Twenty years later consumption had increased to 78 kg in DE and to 21 kg in LDE. Thus, in two decades consumption increase was 16 percent in DE and more than 90 percent in LDE. In order to grasp the importance of increased consumption at the world level, it should be remembered that three-fourths the worlds population live in LDE´s (Delgado, Rosengrant, Steinfeld, Ehui and Courbois, 1999). Available estimates suggest increases in consumption (1993-2020) of 0.5 – 1.0 percent in DE, versus 2.8 – 3.0 percent in LDE. In a few decades time, LDE will account for more than 60 percent of total world meat consumption.

I.4 Trade

Improvements in animal health have enormous relevance in reducing or eliminating trade barriers. The case of FMD is a good example: countries with an important production potential (such as Brazil and Argentina) have had limited access to markets due to their animal health status. Non-tariff barriers to trade related to animal health issues reduce welfare of producers in exporting countries as well as to consumers in importing countries. A recent study (Leslie and Upton, 1999) summarizes some of the impacts resulting from Uruguay being declared (in 1999) a FMD-free country. During the first 6 months meat exports where 50 percent greater than those of the equal period one year earlier (exports increased from 83 to 113 thousand tons). Prices as well as quantities increased. Uruguay was able to make use of the 20.000 ton quota for exports into the US, as well as negotiating additional trade agreements in FMD-free markets.

Preventive measures of importing countries aimed at reducing the probability of the introduction of diseases have an important justification: in the case of FMD, for example, research suggests that “the impact of the introduction of FMD [into the US] would be devastating (Hunt McCauley and others, 1979). More recently (Ekboir, Jarvis and Bervejillo, 2001) show (for the case of California) that economic losses due to FMD would vary between 6 and 13 billion dollars. The size of these losses justifies that most part of the effort be put into prevention. For countries in the Latin American region the consequences of this are clear: the fact that diseases such as FMD cause – in economies where this disease is absent - significant damage implies that potential exporting countries would do well to go to great lengths to avoid the suspicion that their exports are a potential source of contagion.

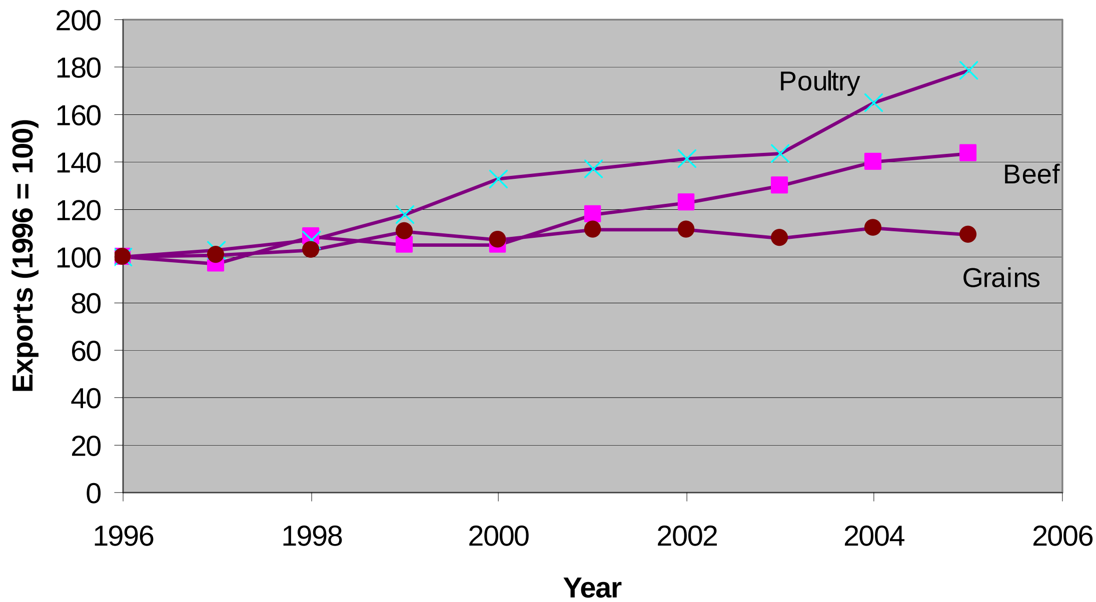
The last decades have witnessed efforts for reducing barriers to international trade. In particular, the Uruguay Round of GATT (ended in 1994) resulted in measures to facilitate market access. Trade trends in beef, pig and poultry are shown in Figure 1. The pattern is clear: trade in animal products has increased markedly, contrasting with the slow increase shown for grains in general. In particular, in the case of poultry meat increase (1996-2006) has been 80 percent. For beef and pig meat increase has been smaller but also significant (more than 40 percent). These trends have the following implication for OVS: greater volume of trade implies a greater need for prevention, early warning and control of disease outbreaks.

Although trade in animal products has increased, trade levels of these represent – in relation to total output – a smaller figure than grain and grain derivative products (USDA, World Supply & Utilization of Major Crops, Livestock & Products). Indeed, in recent years trade (as a percentage of production) of wheat, coarse grains and oilseeds has been 18, 11 and 20 percent respectively. For flours, meals and oils this figure increases to 30 – 40 percent. For animal products, however, the figure is 8 percent for beef and pig meat, and somewhat more (12 percent) for poultry. The smaller importance of meat trade – as compared to total production – is somewhat surprising given that transport costs eat are – as a fraction of transported value – higher for grains than for meat. Indeed, the price of a ton of grain varies between US$ 100 and US$ 250; on the other hand frozen meat imported by the US has a price of US$ 1800 – 2000. In the absence of trade barriers, higher levels of trade (in relation to total production) should be expected for animal as compared to crop products.

The impact of international trade on economic performance has been widely analyzed (Krugman and Obsfeltd, 2000). In relation to this point, there is some reason for optimism: data series longer than those shown in Figure 1 indicate that during the last 4 decades beef trade increased fourfold, from 2 million tons in the early 1960s to 7 million tons in 2000 (Leuck, 2001). A growing role for trade in animal products can be foreseen for the future.

The important meat price differentials existing between countries are a first approximation to the benefits of trade: if the price per ton in one country is is (say) US$

Figure 1: Trends in International Trade



3.000 and only US$ 1.000 in another, a potential benefit from trade of US$ 2.000 (3.000 – 1.000) exists. Tariff barriers, quotas as well as non-tariff barriers (among these those related to animal health) may result in these gains not be achieved.

International meat trade is concentrated in a small number of countries. In the case of beef and pig meat, some 80 percent of imports are accounted for by only 5 countries. Most of these imports occur in middle and high income countries. Concentration is even larger for exports: the five major exporters share between them 90 percent of total exports for pig and poultry meat, and some 70 percent for beef (Table 4). The US and the EU account for half of total exports of pig and poultry meat: in the case of beef the portion is lower. *This situation, however, could change if animal health improvements would take place in LDE. In particular, Latin America has significant potential for participating in international markets for beef, pig and poultry meat.*

In 2001 Mercosur countries (Brazil, Argentina, Uruguay and Paraguay) totaled 19 percent of world exports. By 2006 this figure increased to 42 percent (Steiger, 2006). The importance of the regions exports suggest that increased attention should be given to constraints to further export growth. OVS have a crucial role in this matter. For example, Henson and Loader (2001) point put that although during the last decades trade in agricultural products has increased, many LDE have not been able to profit from these increased opportunities. In particular, they have not been able to adapt their animal health systems to demands of importing countries or trade blocks. The authors indicate that:

> As the liberalization of tariff and quantitative restrictions on trade in agricultural and food products has progressed attention has increasingly focused on technical measures such as food safety regulations, labeling requirements, and quality and compositional standards (p.87). Indeed, given the complexity of SPS issues, many developing countries consider lack of technical expertise to be the major constraint limiting their effective participation in the SPS Agreement.

The work of Henson and Loader is important as relates to the analysis of OVS impacts. The authors show – based on a survey – that SPS requirements, in addition to other technical requirements, constitute the main barrier that LDE face (for example) for entry into the UE. These “technical” problems are seen as more important than import tariffs or quantitative restrictions (quotas). Henson and Loaders´ work has profound implications relative to OVS in LDE. In particular, it can be expected that a progressive reduction in tariff and non-tariff barriers to trade – resulting from the Uruguay round will

Table 4: Meat Imports and Exports

	Imports (% of Total)		
	Pig	**Beef**	**Poultry**
1st 5 Countries	76	79	59
1st 10 Countries	96	94	97

	Exports (% of Total)		
	Pig	**Beef**	**Poultry**
1st 5 Countries	95	72	96
1st 10 Countries	100	98	100

Source: Based on USDA-FAS- PSD Tables

be accompanied by increasing standards relative to sanitary and phytosanitary measures (SPS). In order to make use of the substantial opportunities resulting from trade liberalization, LDE will need to carry out complex projects related to SPS requirements. Henson and Loader (Figure 4, p.92) show that SPS requirements are more important barriers for meat and meat products than for cereals: 50 percent of LDE have seen their exports of meats and meat products restricted by SPS requirements, versus only 10 percent for the case of cereals.

According to Henson and Loader (Table 6, p.93) the lack of technical expertise in LDE, more than the workings of the SPS requirements, funding constraints or lack of information related to SPS is the most important factor relative to the possibilities of these economies have in complying with SPS requirements.[3] It should be noted that lack of expertise cannot be simply solved by sending OVS personnel to "training courses". What are needed are sustained policies and a patient improvement of human resources through time. Part of the needed expertise can be classed as "tacit knowledge" that is only acquired through changes – many of them slow – in organizational routines.

Roberts, Josling and Orden (1999) present a detailed analysis of the impacts of technical barriers on the trade of agricultural products. They argue that increasing income levels of consumers of many importing countries result in an increased demand for aspects such as food safety, information related to product characteristics as well as evaluation of environmental impacts. This demand for "attributes", coupled with a fall in conventional trade barriers can result in an increased relevance of technical vis-à-vis strictly tariff barriers. The authors present a taxonomy that can be useful for classifying barriers of different types.

Measures focused on *risk reduction* have the objective of reducing the expected damage of random events. This expected damage is defined as the product of (a) probability of occurrence and (b) damage in case of occurrence: P(O) x Damage(O). Some events have a low probability of occurrence, but a very high damage in case the event occurs. For example, imports of beef from countries – such as Argentina – free from FMD but subject to vaccination enter into this category. In contrast, other events have a higher probability of occurrence, but damage in case of occurrence is much lower: for example, the presence of certain chemical additives in processed foods.

[3] The authors analyze the case of the EU. However, their findings relative to the lack of expertise are probably applicable to other markets.

The second type of measures attempt to *improve the functioning of markets* in situations where these fail as a consequence of information problems, compatibility needs or resource conservation. For example, regulation may focus on the need that imported products be accompanied by information that allows consumers to distinguish them from high-quality locally produced products. What is achieved in this case is that the market generates different prices for products that are indeed different, but that the consumer cannot distinguish at the time of purchase.

This work suggests that those responsible for regulation in importing countries may make "wrong" decisions, in particular when they are subject to criticism in case events with negative consequences to consumers or producers occur. Indeed, in these situations, ambiguity averse behavior on the part of regulators may lead to conservative import protocol decisions. These conservative decisions result from perceptions that the economic and political costs of lost opportunities (e.g., lower costs for consumers, reciprocal liberalization) are less than the economic and political costs of a mistake (i.e., importation of hazards) (Roberts, Josling and Orden, p.14)

The above situation corresponds to a typical decision-making case subject to two types of errors: Error Type I (reject something that should be accepted) and Error Type II (accept something that should have been rejected). What Roberts, Josling and Orden argue is that incentives facing the regulator may lead to decisions aimed at minimizing Error Type II, even at the cost of increased probability of Error Type I. For example, in the case of meat, the regulator will never be accused of contributing to the spread of disease ***x*** if all imports that potentially can give rise to ***x*** are banned outright. But this has consequences (even if "not highly visible") on welfare of the consumers of the country.

The evidence presented in the last sections can be summarized. In the first place, recent studies done by IFPRI (Delgado and others, 1999) have pointed out to a "revolution" related to animal production. This revolution has as a consequence increased participation of LDE in world production. OVS will be under substantial pressure: an increased fraction of production in LDE implies that a growing portion of the worlds meat supply will originate in countries whose OVS do not, in many cases, achieve minimum standards recommended by the OIE.

Secondly, increases in output will be larger than increases in population. As a consequence, per-capita consumption levels will go up. These higher consumption levels will be accompanied by increased urbanization both of which suggest the need for improved food safety. The relatively simple trade patterns that characterize rural areas will give place to more complex food chains, with the associated product movements through space and higher extent of product transformation from the primary producer to the consumer. OVS have a role to play in this process.

Thirdly, negotiations resulting from GATT first and subsequently the WTO have had as a consequence a sustained reduction in tariff barriers to trade. However, this reduction has been accompanied by increased sanitary requirements. Recent research (in particular Henson and Loader cited above) shows that LDE face considerable difficulties in meeting SPS requirements. These difficulties account for the complex nature of the work to be done by OVS.

II. Demand for OVS

II.1 Conceptual Aspects

Resources for OVS are generated via general taxation or (mostly compulsory) charges for services rendered. OVS income does not result from autonomous decisions of firms or consumers but by decision-making at the governmental level. This implies that attention should be focused on the nature of the demand for OVS: this demand is not "revealed" via a pricing process. This is particularly important in LDE, where many projects with high rates of returns vie for public funds.

Basic economic principles suggest that public intervention may improve resource allocation and welfare, in particular when the functioning of markets for goods or services does not result in socially optimum output of these goods/services. In particular, under some conditions private markets may not generate results that in general terms are "efficient" in the sense that goods and services are produced up to the point where the value to consumers of these goods and services is equal to the cost incurred in producing them. [4] *Under this circumstance OVS action is needed to produce "public goods" that would be otherwise undersupplied or not supplied at all.* Therefore, in order to understand the economics of OVS, attention should be focused on the possible existence of this type of failure.

Markets may fail to function effectively by several causes. In particular, the existence of "public goods", externalities, information asymmetries or increasing returns to scale. These concepts may be illustrated with examples related to animal health:

Public Goods: goods or services for which no possibilities exist for exclusion of those who do not pay for them. Further, no rivalry exists in consumption: once produced they may be consumed by all. These conditions imply that no private firm has an incentive to produce them. Example: information on health threats produced by an epidemiologic warning system.

Externalities: Decisions made by one economic agent (producer or consumer) have impacts on other economic agents, impacts not wholly reflected in market transactions among them. Example 1 (positive externality): a producer vaccinating a herd reduces the probability that other herds will pick up the disease. In his decision calculus, however, this

[4] More precisely: the marginal cost of production of the i-th output is equal to the (marginal) valuation that consumers place on that unit of output.

producer does not take into account, the “benefit” of his action on other producers. Example 2 (negative externality): wrong use of veterinary drugs by some producers result in increased antimicrobial resistance in the animal population.

Information asymmetries: two economic agents meeting for an economic transaction may have different access to relevant information. Example: a consumer may not have information available in order to know if certain food is safe

Economies of scale: costs of production falls as output increases. This may result in the existence of a “natural monopoly”: it is more efficient for one firm to produce than for many. Once a firm enters a market, it may choose a price policy resulting in “abnormal” rents.

In principle, OVS should put special emphasis on processes where one or more of the above conditions hold. Other situations may call for different types of actions. Table 5 shows, for selected animal health processes, possible improvements resulting from public action. This analysis shows that clinical attention is an area where the market (professional veterinarians) can act in an effective manner, even when certain economies of scale and externalities are associated with this service. Other processes (for example quarantine services) have important externalities that justify state financing. An important part of research related to animal health problems cannot be patented (it is therefore a “public good”); further it is subject to considerable economies of scale. The first reason, in particular, may justify public financing. Observe that epidemiologic vigilance is subject to several types of market failures, reason that explains that this is an important area for OVS.

In order to measure the returns to OVS action, the impact of these on the functioning of market has to be understood. These may be export, import or domestic consumption markets. They can also be “markets” where what is relevant is not animal products but different measures of human health: in the absence of OVS spontaneous behavior of producers, processors and consumers result in a certain level of human health; with OVS action this human health level may improve. The difference between “before” and “after”, valued in some way, is the gross return attributed to the OVS. This gross return, minus OVS costs is the resulting net return from the health improvement project.

Table 5: Animal Health Services and the Functioning of Markets

	Externalities	Information Asymmetries	Economies of Scale
Clinical intervention	+		+
Vaccine production			++
Veterinary diagnostics			++
Quarantine services	+++	++	
Research	++	++	++
Epidemiological Vigilance	+++	++	+++
Control of drug quality			+++
Food inspection	++	+++	++
Power of coercion			+++

II.2 Economic Impacts of OVS: Production (Argentine example)

Economic analysis of animal health problems can be challenging: multiple interactions have to be considered. Interactions between animal health, on the one hand, and productivity on the other can be quite complex (see Morris, 1999).

The importance of animal health as relates to productivity depends on several variables. Differences exist between tropical and temperate regions, as well as between different animal species. Latin America as a region is particularly heterogeneous. The following paragraphs present some aspects related to this subject, using as examples selected production processes from Argentina. Conceptual issues, more than specific details, are the relevant points to single out.

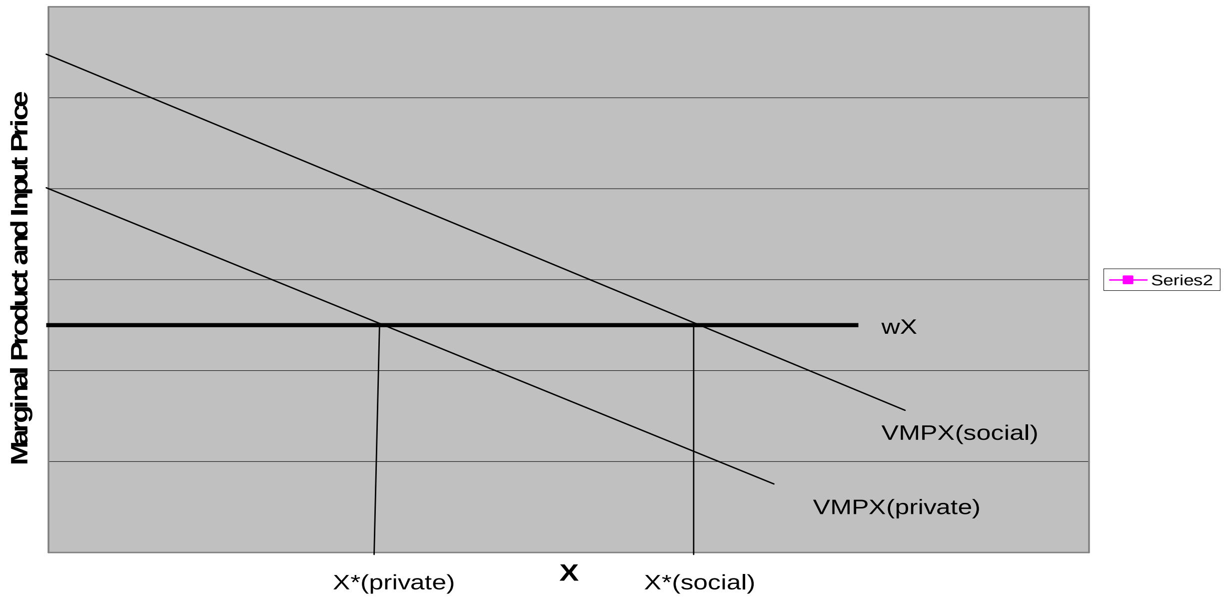
Inputs used to control animal health problems include vaccines and drugs, veterinary assistance, laboratory analysis, and animal management practices. Maximizing business profit requires that these inputs be used to the point where marginal productivity equals input price. An analysis of the impacts of OVS on production requires attention to be focused on the economics of animal health input usage at the firm level. In particular:

- Impact of health inputs on productivity
- Existence of disequilibrium between actual input use and optimum (private profit maximizing) input use
- Existence of disequilibrium between actual input use and those considered optimum from a social standpoint
- Mechanisms through which OVS may act in order to reduce the divergence between actual and socially optimum levels of input use.

Figure 2 illustrates these concepts. Denote by “X” some animal health input (vaccines, parasite control drugs, veterinary diagnostic services), and denote by VMPX the marginal (value) product derived from using X. The producer maximizes profits when VMPX equals the inputs´ price wX. This input level is denoted in the figure by X*(private). However, different factors may result in the producer choosing sub-optimal input levels: XA instead of X*(private). Evidence of this situation is presented below.

But also, when deciding input use the producer does not take into account the impact of his decisions on other producers. For many inputs, when these “externalities”

Figure 2: Optimum Level of Animal Health Input Use (X)



are taken into account marginal input productivity shifts from VMP(private) to VMP(social). The optimum input level, from the point of view of society as a whole, is X*(social). The potential impact of the OVS can be then be decomposed into:

- Contributing to narrowing the gap between XA and X*(private). This is in the best interest of the producer himself; however for several reasons the gap may exist.
- Contributing to increasing the input use from X*(private) to X*(social). This is not in the best interest of the individual producer, but of society in general.
- The economic impact of the OVS is then the increased output resulting from the added input [X*(social) – XA] minus the additional costs of input X minus the costs in which the OVS incurs in order to effect this change.

As suggested by the figure, the economic impact of the OVS depends on: (a) the extent of "private" disequilibrium in input use: X*(private) – XA and (b) the magnitude of the divergence between optimal social and optimal private input use, X*(social) – X*(private). The first type of disequilibrium may depend on aspects such as educational level of producers, firm size and the complexity of animal health technologies.

In turn, the second type of disequilibrium depends on the extent to which the sanitary problem migrates from one farm to another and on the size of production decreases that result when the disease infects a new herd: in other words on the ease with which the disease spreads and the impacts of the disease once it is installed in a new biological organism.

An example can help put the above concepts can be put into perspective. Table 6 shows animal health input use in several livestock activities of a Latin American country (Argentina). Health input use varies according to production enterprise: they are considerably higher in dairy than in cattle fattening or breeding. Health inputs represent a relatively small portion of total costs; however their impact on output is large.

Examples from Table 6 assume "optimum" (in the sense of profit-maximizing) input usage on the part of producers. In the real world, however, producer may choose input levels that are different from the optimum ones. In relation to this point, Figure 3 shows the percentage of firms with a "high" adoption level of animal health technology. Data refer to firms belonging to the same general area as that used to construct Table 6. As shown, no more than 40 percent of cattle-breeding firms can be considered in the "high adoption" class. Medium and large firms show higher levels of adoption than

Table 6: Argentina – Production Expenses (US$/head)

	Cattle Breeding	Cattle Fattening	Milk Production
	------ US$/head -------		
Feed	11	50	331
Animal Health	9	5	34
Labor	7	9	105
Other			72
Total	27	64	542
Health/Total (%)	33	8	6

Source: Agromercado (Buenos Aires) – September 2007

Figure 3: Animal Health Technology Adoption
(Argentina - Temperate Zone)

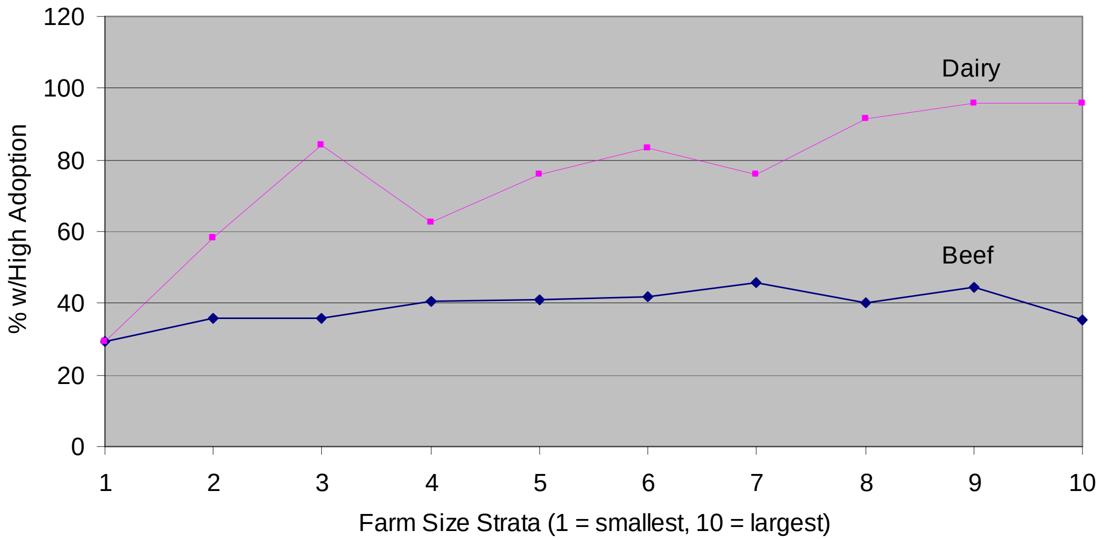
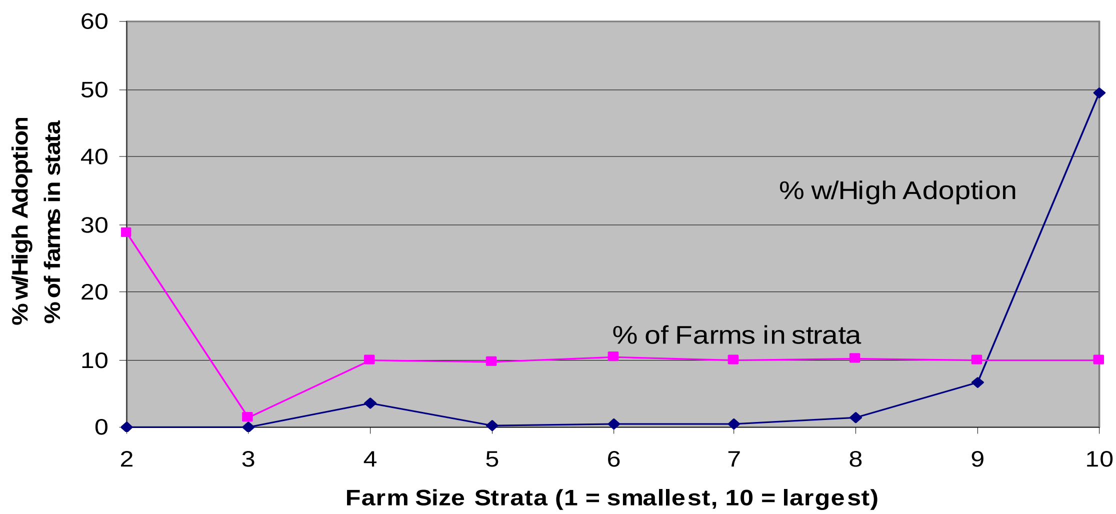


Figure 4: Animal Health Technology Adoption
(Argentina - Sub-Tropical Zone)



smaller firms. In the case of dairy production adoption is strongly associated with firm size: 100 percent of larger firms show “high adoption”, in smaller firms this figure is considerably smaller. The apparent gap between “possible” and “actual” technology adoption is even larger in the Argentine subtropical area (Figure 4). Here, only the largest strata of farms show significant adoption of animal health technology. This figure also shows that “large” farms are relatively few: as a result, most herds are subject to animal health management practices that are probably less than optimum.

Surveys among veterinarians (Table 7) suggest that nation-wide (Argentina) losses caused by animal diseases are probably significant: output loss due to brucellosis is probably around 25 percent of actual output (minimum estimate 20 percent, maximum 30 percent), for viral diseases the figure is 10 percent (range: 5 – 15 percent). More detailed work (also done in Argentina) estimate “avoidable” losses of the order of US$ 264 million in breeding herds, US$ 84 million in fattening and US$ 60 million in dairy (Berra and Mate, 2007). These estimates have not been obtained by the use of a formal economic model. However they constitute a first approximation for the topic. Total losses of the above are US$ 390 million, in a national herd of some 50 million head of cattle. This results in an “avoidable loss” of some US$ 8 per head.

Assume that this “avoidable loss” results (using the conceptual framework presented in Figure 2) in the difference between X*(social) and XA: X*(social) – XA. This simple example allows some results to be derived:

- If the OVS is able to eliminate 30 percent of this disequilibrium, value of production would increase (assuming a perfectly elastic demand for output) in US$ 2.5 per head.
- Assume that this output increase requires a per-head input increase (X*(private) – XA) equivalent to US$ 1.5 per head.
- Assume also that this increase requires an increase in the Argentine OVS (SENASA) of the order of US$/head 0.30. This figure is 50 percent of the (2006) animal health budget of the institution

Using the above assumptions, the rate of return obtained by the producer is 100*[2.5/1.5 – 1] = 67 percent. The total rate of return of the project will be 100*[2.5/(1.50 + 0.30) – 1] = 39 percent.

Table 7: Argentina – Impact of Diseases
(% production drop caused by disease)

Disease	Min	Most Likely	Max
	%	%	%
Parasites	10	20	40
Brucellosis	20	25	30
Salmonella	1	5	10
Brucellosis	5	10	15
Venereal	10	20	30
Viral	5	10	15

Source: Estimates by 20 private veterinarians (Argentina)

The above results are hypothetical, however they allow attention to be focused on magnitudes relevant to the impact of OVS on production, and on the type of data that has to be gathered in order to understand the economics of OVS.

II.3 Economic Impacts of OVS: Exports (example: Brazil, Argentina and Uruguay)

For Latin American countries, international trade opens important possibilities for progress. However, as mentioned in Chapter 1, possibilities of participating in trade of animal products are in many cases limited by animal health problems. Market access restrictions associated with foot and mouth disease (FMD) are particularly relevant: in Latin America, FMD constitutes an important focus of OVS. Indeed, in the region the following situations coexist: [5]

- FMD-free countries, without vaccination (Chile)
- FMD-free countries, with vaccination (Uruguay)
- Countries with FMD-free areas, without vaccination (Argentina, Brazil, Colombia and Peru)
- Countries with FMD-free areas, with vaccination (Argentina, Bolivia, Brazil, Colombia and Paraguay)
- Countries with FMD (Bolivia, Paraguay and Ecuador)

The previous classification suggests the importance of effective epidemiological vigilance in order to detect the possible presence of the virus, and to implement measures aimed at avoiding its diffusion. For example, in February 2006 a FMD outbreak was detected in the province of Corrientes (Argentina), possibly originating in a neighboring country. This outbreak resulted in the sacrifice of 800 animals.[6] Rapid response to the

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[5] OIE (http://www.oie.int/eng/info/en_fmd.htm?e1d6)

[6] See SENASA (http://www.senasa.gov.ar/contenido.php?to=n&in=466&ino=466&io=2044)

outbreak, coupled with preventive measures taken by the Argentine OVS (SENASA) resulted in the disease-free status being maintained, with continuity of exports to FMD-free markets (for example, the EU).[7] As relates to OVS, the importance of coordinated international efforts is therefore evident.

Latin American beef exports are concentrated in five countries: Brazil (60 percent of total), Argentina (13 percent), Mexico (11 percent) Uruguay (6 percent) and Chile (4 percent). Total exports of beef and pig meat (both susceptible to FMD) represented (in 2005) some 12.5 billion dollars (FAOSTAT). Impacts of FMD on trade flows depend on the existence of both (a) sanitary as well as (b) non-sanitary trade barriers. For example, the impact of a FMD outbreak will be different if the USA maintains a maximum import quota for Argentina and Uruguay of 20.000 tons (current situation) or if, on the contrary, trade (possibly as a result of Mercosur/Nafta agreements) is liberalized. Clearly, the lower the tariff or quantitative restrictions to trade, the higher the impact of inefficient OVS on trade possibilities.

The analysis of the impacts of FMD is complex: price differentials between FMD-free and FMD-endemic markets has not been constant over the years; they depend on a number of factors. Some evidence of price convergence exists (Jarvis, Cancino and Bervejillo, 2005). However, even if this is the case even “moderate” price differentials (say 20 percent) result in enormous impacts, in absolute terms, in export income of exporting countries.

Several studies have addressed the problem of the impact of changes of FMD status on prices and quantities (for example, Ekboir and others [2006], Jarvis and others [2004], Correa and Naranjo [2005]. The first of these papers estimates price increases (for Argentina and Uruguay) that could reach 40 percent if they could access FMD-free markets (Ekboir and others, p.14). Meat prices finally obtained also depend on other factors: among these, EU export subsidies are particularly important.

Brazil

Work by Correa and Naranjo (who work for PANAFTOSA) shows that between July 1997 and March 2005 price increases of the order of 120 percent, as compared to 80

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[7] See SENASA (http://www.senasa.gov.ar/contenido.php?to=n&in=466&ino=466&io=2064)

percent increase in the consumer price index. According to the authors the real price increase of some 50 percent is explained due to the fact that Brazil can access the FMD-free circuit. Figure 5 shows the inverse relationship between exports, on the one hand, and FMD outbreaks, on the other. Indeed, in the early 1990´s exports of this country averaged 500 thousand tons, and outbreaks between 100 and 2000 per year. The sharp decrease in outbreaks is accompanied by an increase in exports, these reaching more than 2.5 million tons in 2004.

Uruguay

Leslie and Upton (1999) analyze the impacts resulting from Uruguay being declared FMD-free in 1996. According to the authors, the country could immediately make use of the 20.000-ton US market quota, which resulted in improved income due both to an increase in average price as well as in quantities. In the first 6 months of 1996 exports totaled US$ 195 million, compared with US$ 165 million in the same period of the previous year (Leslie and Upton, p.449). Impacts of change in sanitary status can obviously increase through time. Further, estimates made by the Uruguayan Ministry of Agriculture indicate that the 2001 FMD crisis could have resulted in a cost of US$ 730 million. (OIE 2006). The same source shows (Figure 6) that before Uruguay being declared FMD-free exports per year averaged some 150 – 200.000 tons. Once FMD-free status was achieved, exports increase to more than 250.000 tons, reaching 480.000 tons in 2005. In 2001 (disease outbreak) exports fell to 170.000 tons, a drop of some 80 – 100.000 tons from the previous 3-year average trade level. In percentage terms, this drop was approximately 32 percent (100 – 170.000/250.000).

Argentina

Biondolillo and others (1991) study the impacts of FMD in Argentina. The following costs of the disease are identified: (a) output loss (morbidity), (b) vaccination, (c) lower export prices. By far, the greatest impact is (c), followed by (b). The authors estimate that elimination of FMD would result in annual value increases of the order of 360 million dollars, of which 70 percent correspond to trade and the rest to vaccination cost savings. Consumer prices would increase approximately 10 percent.

Figure 5: Brazil - FMD Outbreak and Exports

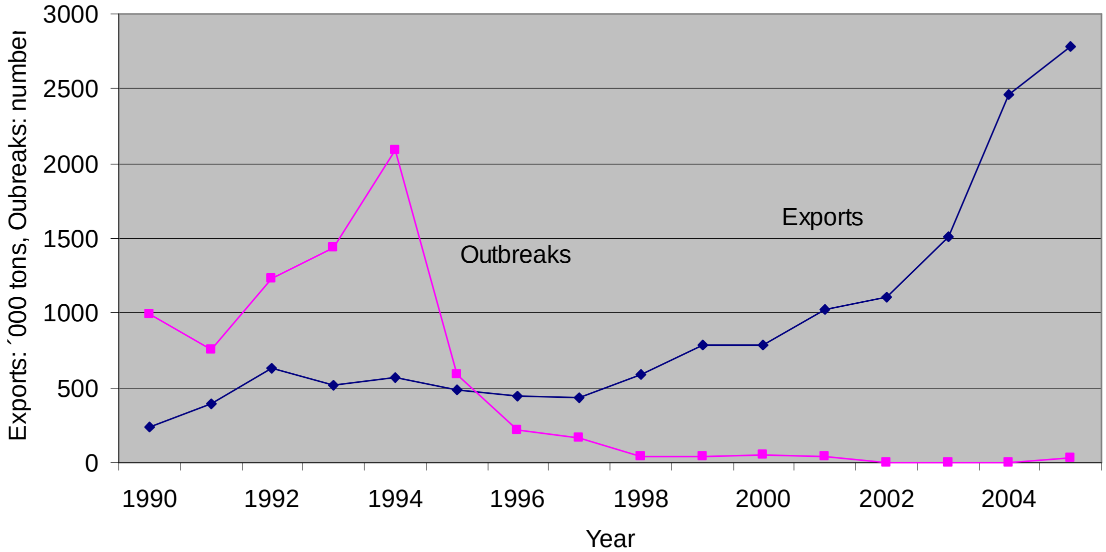
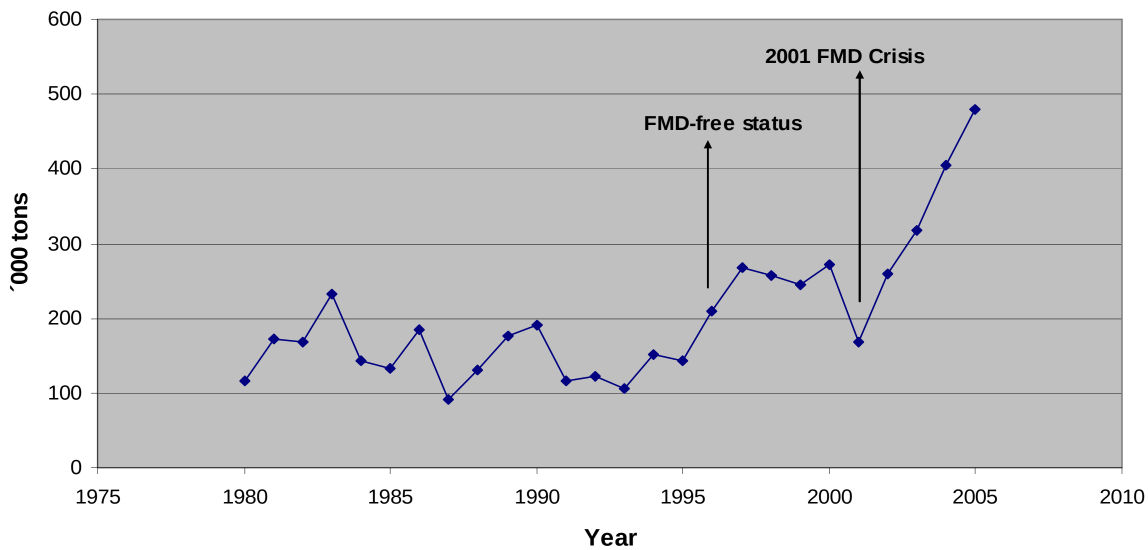


Figure 6: Uruguay - FMD Outbreak and Export Volume



Argentina was declared FMD-free by the OIE in 1999. In 2001 an outbreak occurred in the country. The economic impact of this crisis was analyzed by Corradini, Cecilio and Corradini (2006). According to the authors, economic losses for 2001 (March - December) total some US$ 1.600 – 2.100 million (Table 8). Of these, US$ 500 million correspond to trade reduction in current markets, and US$ 200 and 500 million to less growth in the North American and Southeast Asian markets.

An additional analysis of the FMD crisis of 2001 can be made by analyzing Argentine export data. Figure 7 shows price, quantity and value indexes (1996 = 100). Table 9 summarizes these indexes for the "before" (1999 – 2000) and "after" (2003-2004) period. Indexes for 2001 are also shown. These figures show that in 2001 prices fell to half their previous levels, export quantities fell by 35 per cent and total value of exports by more than 60 percent. In absolute terms, the value of exports of beef was in 2001 some 280 million dollars. In the "before" and "after" period it was, respectively, 677 and 848 million dollars. Fall of exports as compared to the average value of these two last figures was then some 482 million dollars. It can also be argued that an important part of export increases registered between 1996 and 2005 (see Figure 7) are a result of the FMD-free status of argentine livestock production. In 2005 total value of exports was 75 percent greater than that of 1996. This represents an increase of export value of some US$ 700 dollars

II.4 Economic Impacts of OVS: Human Health

Threats resulting from zoonotic diseases cause increasing concern. Indeed, higher population human and animal density, and higher mobility of humans and animal products (international trade) result in favorable conditions for the irruption of a "microbial perfect storm" (Brown, 2004). During the last two decades, 75 percent of emerging diseases affecting humans occurred as a consequence of an animal pathogen migrating into a human host. Of the 1415 pathogens that affect humans, 61.6 percent have an animal origin (Brown, 2004). Of emerging diseases in humans, 75 percent originate from pathogens that migrate from animals to humans (Brown, 2004). Examples of zoonosis with high damage potential include the Ebola virus, BSE, Nipah virus and Rift Valley Fever.

According to Thiermann, emerging zoonosis can have a very important impact on commerce even though risks resulting from them are, for importing countries, very low.

Table 8: Argentina - Impact of 2001 FMD Outbreak (I)

	Min	Max
	------- Mill US$ --------	
Lower livestock value	167.7	670.8
Reduction demand current markets	474.5	474.5
Less market growth North America	216.0	216.0
Less market growth North America	540.0	540.0
Price differences between FMD-free And FMD-present markets	103.2	133.6
Mortality/Morbidity	57.3	58.8
Total	1558.7	2093.7

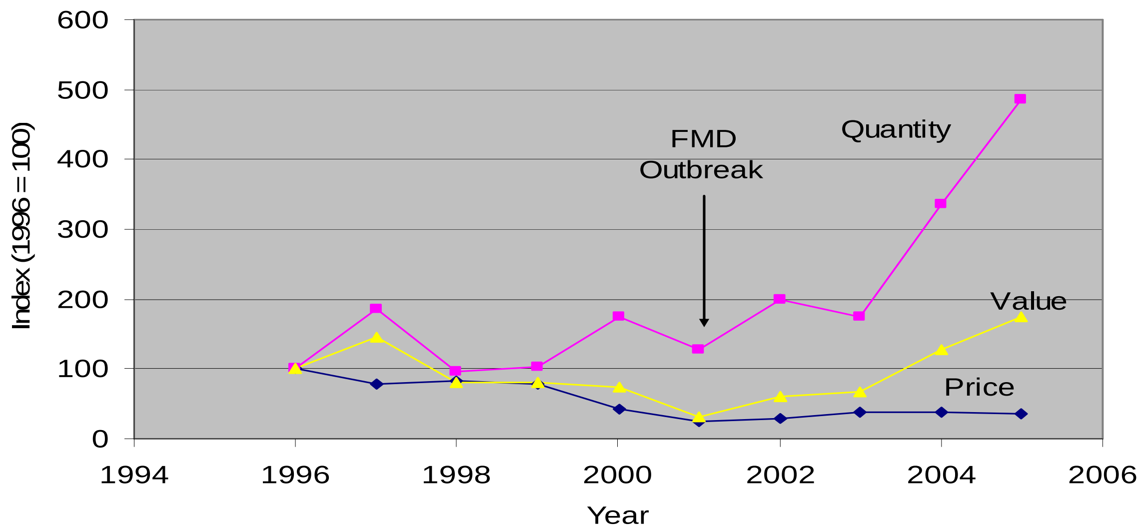
Source: Corradini, E., G.Cecilio an E.M.Corradini (2006), Impacto económico de la epizootia aftósica y su plan de contención.

Cuadro 9: Argentina – Impact of 2001 FMD Outbreak (II)

	Pre-Outbreak (1999-2000)	Post-Outbreak (2003-2004)	2001	2001/ [(Pre+Post)/2]
Price Index	61	38	25	0.50
Quantity Index	139	255	127	0.65
Value Index	78	98	32	0.36

Source: Calculations based on FAOSTAT data

Figure 7: Argentina - FMD Outbreak and Export Volume



This is especially true when diseases can cause mortality, even when morbidity is very low. These impacts can be controlled if OVS of exporting countries act promptly and with effectiveness. Among other things, these OVS must have an adequate epidemiological vigilance system (Thiermann, 2004).

In addition to pathogens migrating from animals to humans, concern exists related to human health issues arising from food-borne diseases (FBD). Schlundt and others (2004) show an increase in the incidence of bacterial pathogens in European countries (1985 – 1998). For example, Campylobacterosis increased in this period from 30 to 80 cases/100.000 (with a peak of 120 cases/100.000 in 1992). Information for the US shows some 76 million cases annually for FBD, of which 325.000 result in hospitalization and 5.000 in death. For Great Britain figures are 2.4 million cases, 21.000 hospitalized and 718 deaths (Perez and others, undated). Expressed as number of cases per 100.000 population, the above figures represent:

Hospitalization: US = 128, GB = 36

Death: US = 2.0, GB = 1.2

Discussion in the previous paragraph corresponds to DE´s. In LDE these figures can be quite higher. Table 10 shows, for selected countries in Latin America, results from some studies relative to the prevalence of zoonotic and food-borne diseases (Z&FBD). Figures correspond to number of cases per 100.000 population. For illustration purposes some calculations can be made:

- Total population in Latin America is 524 million persons
- Assume that data from this table is representative of the prevalence of Z&FBD in Latin America. Adding listed diseases, a value of 69.2 cases of Z&FBD per 100.000 population results. [8] This figure, extrapolated to the Latin American population results in 360.000 cases.

[8] The above assumes that no person suffers more than one disease at the same time.

Table 10: Zoonotic Diseases in Latin America – Results From Some Studies

	Number of cases per 100.000 persons			
	Average	Max	Min	n
Anthrax	0.12	0.12	0.12	1
Bovina TB	35.33	35.33	35.33	1
Brucellosis	0.14	0.40	0.01	7
Hydatidosis	2.14	2.14	2.14	1
Pulmonary Hantavirus	1.28	2.14	0.22	2
Leishmaniosis	23.22	42.14	0.31	4
Leptospirosis	2.59	9.34	0.01	5
Lysteriosis	0.03	0.03	0.03	1
Q Fever	0.64	0.64	0.64	1
Rabies	0.01	0.01	0.01	3
Salmonellosis	0.45	0.76	0.13	2
Toxoplasmosis	2.30	6.57	0.12	3
Triquinellosis	0.34	0.34	0.34	1
Equine Encefalomielitis	0.63	0.63	0.63	1
Total	69.58	10.50	40.23	33

Source: OIE – WAHID Interface – zoonoses in humans
http://www.oie.int/wahid-prod/public.php?page=country_zoonoses&year=2005

The above figure is only useful as a starting point for research. It does not take into account: (a) presence of diseases for which no diagnosis exists, (b) under-reporting of cases of diseases included in the table. For example, for Campylobacter the ratio between real and reported incidence can vary between 8 and 10. For E.collii (EHEC) in the US, the ratio can be 30 (Schlundt, 2004). Also observe that the 69.2 cases of Z&FBD per 100.000 population is lower than the 128 cases/100.000 existing in the US only for FBD reported in Perez and others (n/d).

It is only possible to speculate with respect to the impact of the issues raised above. However, it is probably safe to assume that the prevalence of Z&FBD is considerably higher than de 69.2/100.000 figure reported above. Indeed, in most countries of the region rudimentary systems of public health exist. If for every reported case 10 cases are not reported, the number of cases per 100.000 population jumps to 760. This results in some 4 million people in Latin America as a whole.

Once again, previous figures are speculative, their use is only to suggest lines of inquiry. These 4 million cases result in costs that can be approximated in several ways. For example, an estimate could be derived of the willingness to pay of those affected in order to free themselves of the disease. Or, losses due to premature death, morbidity, medical costs and human suffering could be estimated.

In relation to FBD, the SIRVETA ("Sistema Regional de Vigilancia Epidemiológica de Enfermadades Transmitidas por Alimentos) of the Pan-American Health Organization/World Health Organization has carried out some estimates. For example, in the 1999 – 2002, 77.600 cases and 70 deaths were notified; between 1995 and 2003 notifications were 250.000 cases (of these, 317 resulted in deaths). As mentioned previously, however, the actual number of cases is probably considerably higher: the 250.000 cases reported in 9 years results in 28.000 cases per year. This number, in relation to the regions population is less than 6 per 100.000. This is only 1/20th of cases reported for the US by Perez and others. Severe information deficiencies exist in Latin America. However as of August 2007 SIRVETA´s web page (http://www.panalimentos.org/sirveta/e/index.htm) appeared to be inactive.

The importance of controlling zoonotic diseases is made clear by considering that for many of these diseases a high correlation exists between disease prevalence in animal and in human populations (see Schlundt and others, 2004, Fig.4). This emphasizes the importance for the prevention of human infection, on health control in animals.

II.5 Other Impacts: Tourism

In Latin America the tourism industry generates income of about 38 billion dollars annually (World Development Indicators, World Bank). Income from tourism represents – on a per capita basis – some US$ 20 – 50 in Brazil, Bolivia and Peru, US$ 80 – 90 in Argentina and Chile and US$ 200 in Uruguay. For Latin America as a whole, they average US$ 70. Caribbean countries such as Barbados average about US$ 3000 per capita (see Table 11).

In February 2001 FMD virus irrupts in the United Kingdom. This resulted in different kinds of actions aimed at avoiding spread of the disease. The tourism industry was affected (Morris, 2003). A fewer number of tourists visited the region; however those who did so had to curtail their activities (in particular those involving trips to rural areas). Some estimates put losses at 5 billion pounds in England and 350 million in Scotland (Morris, 2003; see also CAST 2005). These figures jointly represent some 24 percent of total income revenues from tourism (according to the World Bank, tourism receipts in United Kingdom are some 40 billion dollars.

The wide geographical dispersion existing in Latin America suggests that impacts of a animal health event (on a percentage basis) would be smaller than those occurring in the United Kingdom. Even so, reduction in tourism caused by animal health events or by FBD in a country such as – for example – Argentina (annual tourism receipts 3.2 billion dollars) could represent a considerable loss. In the case of an economy highly dependent on tourism, such as Barbados (tourism receipts US$ 900million, or US$ 3.000 per capita) the effect could be even more significant.

Table 11: Tourism Income – Selected Countries of Latin America

	Total Tourism Income	Income/capita
	(Million US$)	US$/cap
Argentina	3241	84
Brazil	4169	22
Chile	1570	96
El Salvador	838	121
Guatemala	883	70
Mexico	12801	124
Uruguay	690	197
Peru	1371	50

Source: The World Bank – World Development Indicators

http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20394811~menuPK:1192714~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html

III. Resource Allocation in Latin American OVS

III.1 Organization of OVS

The economic impact of OVS is a function of resources allocated to these, as well of the use made of these resources. Research (for Latin America) related to these two aspects is not abundant, even though some work has been done (for example, see Gimeno, 2003). Veterinary public health specialists (for example Marabelli and Caporale, 2003) argue that important changes are taking place in the way that OVS carry out their tasks. Indeed, the current trend is to focus increasing attention to prevention, using a population-based approach (veterinary epidemiology). According to Marabelli and Caporale, the current approach includes:

- Increased emphasis in the food chain, from “conception to dinner table”
- Increased attention to environmental problems related to human health
- Science-based action (epidemiology, microbiology, parasitology, pathology, food safety)
- Change in work patterns: for example, a shift from “pathology control” to “epidemiological observation” in abattoirs

The adequate design of OVS is an exercise of considerable complexity, exercise that many LDE (including some in Latin America) may have difficulty in completing in an adequate manner. Organizational, financing and jurisdictional problems overlap with more specific technical matters. These problems also exist in DE, however in these multiple mechanisms are in place which allow these problems to be approached with effectiveness.

The director of the Canadian OVS (Canadian Food Inspection Agency, CFIA) summarizes some issues that are useful for Latin American countries engaged in improving their OVS (Evans, 2003):

- The CFIA has a mandate that includes not only food inspection but also animals, animal feeds, seeds and fertilizers. The CFIA was created in 1997 as a result of reorganization of functions carried out by several agencies

- Activities of the CFIA include the reduction of the prevalence of disease requiring treatment. An important social benefit of this action is reduced antimicrobial resistance.
- A central aspect of OVS (in this case the CFIA) is related to reporting and accountability systems. Institutional design must allow these two aspects to be carried out in an effective manner.
- Important challenges exist relative to the need of OVS to maintain objectivity, on the one hand, and to be able to take into account political and economic consequences of decisions, on the other.

III.2 OVS in Latin America

In order to improve OVS developing countries (including Latin America) face particular problems. On the one hand, a greater percentage of veterinarians of countries of the region (see Table 12) work in the public sector. But also, in Latin America the ratio between animal population and veterinary personnel is, in general, lower than that existing in DE´s with a strong agricultural sector (see table). A possible hypothesis is that in Latin America there exists disequilibrium between quantity of human resources, on the one hand, and availability of technical and financial resources on the other. This is particularly important give the trend towards a greater intensity in the use of laboratory, information and applied science.

The existence in a country of a “network” of organizations whose work relates to animal health improves the effectiveness of an OVS. These organizations include universities with research programs in veterinary public health, research institutes in animal production and private-sector (food industry, private labs) R&D activities. In some Latin American countries this network exists, in others it does not. In this latter case, activities related to veterinary public health may be more difficult to implement.

OVS the region differ in their organizational structure. In the case of Brazil, for example, the VS has a federal structure: the federal government is responsible for a set of tasks, delegating other to states and municipalities. During recent years financial resources (excluding salaries) at the federal level varied between 10 and 50 million dollars per year. In turn, state resources average 20 – 30 million dollars (see Figure 8). On average, during 2000 – 2005 federal funding has represented up to 65 percent of funding, the remaining 35 percent being provided by the individual states. Note in the figure the important inter-year funding variability of state-provided resources.

Countries such as Argentina, Chile, Paraguay, Bolivia, Uruguay and Colombia are characterized by a centralized (at the national level) resource allocation system. In some cases (for example Argentina) initiatives are underway for de-centralizing part of the decision-making and budgeting procedures. The possible impacts on OVS efficiency of these initiatives deserves to be explored.

Table 12: Veterinary Services of Some Latin American Countries – Human Resources

	AE/Vet (*)	**Offic Vet/TotalVet**
Selected Latin American Countries		
Argentina	21000	0.23
Bolivia	58000	0.10
Chile	13000	0.10
Costa Rica	25000	0.09
Mexico	9000	0.19
Paraguay	42000	0.16
Selected Developed Economies		
Australia	90000	0.07
Canada	43000	0.06
USA	57000	0.05
New Zealand	76000	0.13

Source: OIE – Regional Office for the Americas
(*) Rounded to ´000

AE = Animal Equivalents (beef cattle + 0.2*pigs + .05*poultry)

III.3 Comparative Ratios

Additional resources should be allocated to OVS as long the rate of return of these resources is higher than that attainable in other uses. In this paper, Benefit/Cost analysis is carried out in the next chapter. In this section selected ratios relative to operation of these services are discussed. These ratios can serve as an introduction to the Benefit/Cost analysis done later.

Table 13 shows basic statistics of OVS belonging to several countries of the Latin American region. Data for two Caribbean countries (Barbados and Haiti) as well as for a developed economy (Canada) are also presented. Data shown in the table attempts to address the following question: ¿Do resource allocation patterns differ among OVS of different countries? This question allows a first step in the direction of understanding the economics of OVS in the region. Ratios – per se – do not constitute a justification for increasing or reducing the use of funds; however they might suggest relevant aspects to be considered for such a decision. Attention is focused here in five ratios. These are described below. In the discussion, the term “Latin America” is used to denote countries listed in Table 13 (with the exception of Canada). Information relating to other countries is lacking.

OVS Budget/Animal Population: the functioning of an effective OVS can improve livestock, pig and poultry productivity. This index attempts to measure efforts allocated to these improvements, expressed per animal-equivalent. This index can also be compared to private health care costs per animal-equivalent, putting into perspective public vs. private efforts at improving animal health.

The major producers and exporters of the region (Argentina, Brazil and Uruguay) allocate between US$ 0.70 and 0.85 per animal-equivalent per year (see Figure 9). A comparison can be made between this figure and a (rough) estimate of private animal health spending. As commented in Chapter II animal health inputs (Argentine example) total approximately US$/AE 9 in cattle breeding, US$/AE 5 in cattle fattening and US$/AE 32 in dairy. This figures, weighted by number of animals in each class (total national herd) result in some US$/AE 9. Thus, total resource use by OVS is less than 10 per cent of private expenses in animal health incurred by producers.

Bolivia and Paraguay, two countries with significant animal production, allocate considerably less resources than mentioned previously: in the case of Bolivia, budget

Table 13: OVS of Latin America – Ratios

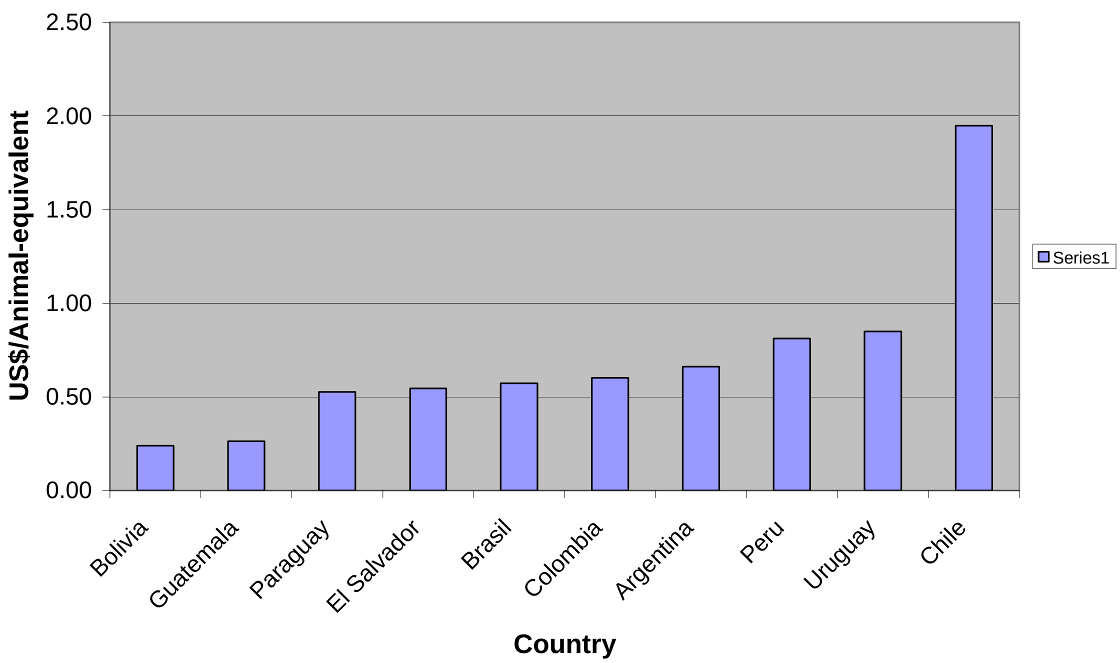
		Belize	Chile	Brazil	Argentina	Uruguay	Peru	Guatemala	Bolivia	Paraguay	Canada	Mexico	Colombia	Barbados	El Salvador	Haiti
Basic Data																
Human Population (2004, millions)		0.3	16.3	186.4	38.7	3.5	28.0	12.6	9.2	5.9	32.3	103.1	45.6	0.3	6.9	8.5
GNI/Cap (US$/capita, Atlas Method, 2004)		3570	5870	3550	4470	4360	2650	2400	1010	1040	32590	7310	2290	S/D	2450	450
Animal Population(millions)																
	Cattle	0.06	4.7	197.9	56.9	11.58	4.49	2.5	6.5	9.5	14.7	31.4	21.6	0.012	1.2	0.75
	Sheep	0.01	3.7	13.4	13.5	9.87	12.1	0.3	6.7	0.44	0.99	6.4	1.57	0.035	10	0.35
	Pigs	0.02	1.7	26.9	2.3	0.29	2.2	1.5	1.99	1.47	14.6	15.12	2.5	0.035	0	0.8
	Poultry	8.00	41.2	710.2	70.5	9.9	72	130	82.67	16.7	265.7	402.4	238.5	8	15	3.9
	Total	0.3	7.1	225.7	62.6	14.4	9.9	6.2	10.7	10.4	25.2	46.8	28.6	0.2	4.1	1.1
Animal Production (thousand tons)		16.67	1098.0	19629.0	4227.0	618.0	1029.0	273.0	466.0	371.0	5339.0	5424.0	1727.0	17.0	148.0	97.0
International Trade (Animal Products) (US$ millions, standarized value)																
	Exports	746	497431	7534392	1666713	789897	3616	20442	6527	146510	6126674	1354563	127691	6672	19694	40
	Imports	7516	487633	110255	63245	26749	28250	112877	5255	4924	1485597	2130201	43796	25474	98290	38796
Tourism:																
Revenues	**US$ (millions)**	sd	1570	4169	3241	690	1371	883	346	96	15830	12801	1570	905	838	s/d
Number of tourists	**Turists (thousands)**	sd	933	5358	3895	1808	1486	1316	504	341	18770	21915	933	548	1154	96
OVS Budget																
	Year	1999-03	2004	2005	2007	2004	2003	2005	2004	2004	2004	2005 (?)	2007	2007		
	US$ x 10^6	1.2	13.8	129.3	41.4	12.2	8.0	1.6	2.6	5.5	430.0	124.9	17.2	1.0	2.2	2.2

Table 13 (cont): OVS of Latin America – Ratios

Basic Ratios		Belize	Chile	Brasil	Argentina	Uruguay	Peru	Guatemala	Bolivia	Paraguay	Canada	Mexico	Colombia	Barbados	El Salvador	Haiti
OVS Budget/Human population	US$/hab	4.00	0.85	0.69	1.07	3.49	0.29	0.13	0.28	0.93	13.31	1.21	0.38	3.33	0.32	0.25
OVS Budget/Animal population	US$/EA	4.52	1.95	0.57	0.66	0.85	0.81	0.26	0.24	0.53	17.04	2.67	0.60	4.36	0.54	1.89
OVS Budget/Production	US$/ton	72.0	12.6	6.6	9.8	19.7	7.8	6.0	5.5	14.7	80.5	23.0	10.0	58.8	15.0	22.2
Production/AE	kg/ea	62.7	155.1	87.0	67.5	43.0	104.3	44.0	43.4	35.7	211.5	115.8	60.4	74.1	36.3	85.5
OVS Budget/Exports	US$/US$	1.609	0.028	0.017	0.025	0.015	2.212	0.079	0.394	0.037	0.070	0.092	0.135	0.150	0.113	53.750
OVS Budget/Tourism Receipts	US$/US$		0.009	0.031	0.013	0.018	0.006	0.002	0.007	0.057	0.027	0.010	0.011	0.001	0.003	

		Belize	Chile	Brasil	Argentina	Uruguay	Peru	Guatemala	Bolivia	Paraguay	Canada	Mexico	Colombia	Barbados	El Salvador	Haiti
Ratios with OVS Budget Corrected According to GNI/capita																
Corrected OVS Budget	(US$ x 10^6)	7.1	51.5	763.9	197.7	59.6	62.2	13.9	50.8	105.0	430.0	384.1	153.7	s/d	18.6	94.3
Corrected OVS Budget/Human F	US$/hab	23.5	3.2	4.1	5.1	17.0	2.2	1.1	5.5	17.8	13.3	3.7	3.4	s/d	2.7	11.1
Corrected OVS Budget/Animal P	US$/EA	26.5	7.3	3.4	3.2	4.1	6.3	2.2	4.7	10.1	17.0	8.2	5.4	s/d	4.6	83.1

Figure 9: Budget Allocation - US$/Animal-equivalent



per AE is 1/3 of the three countries mentioned previously, in Paraguay allocation is 30 percent lower. In turn, Guatemala has an animal herd of a similar size as that of Chile , however its budget is only 12 percent of the Chilean.

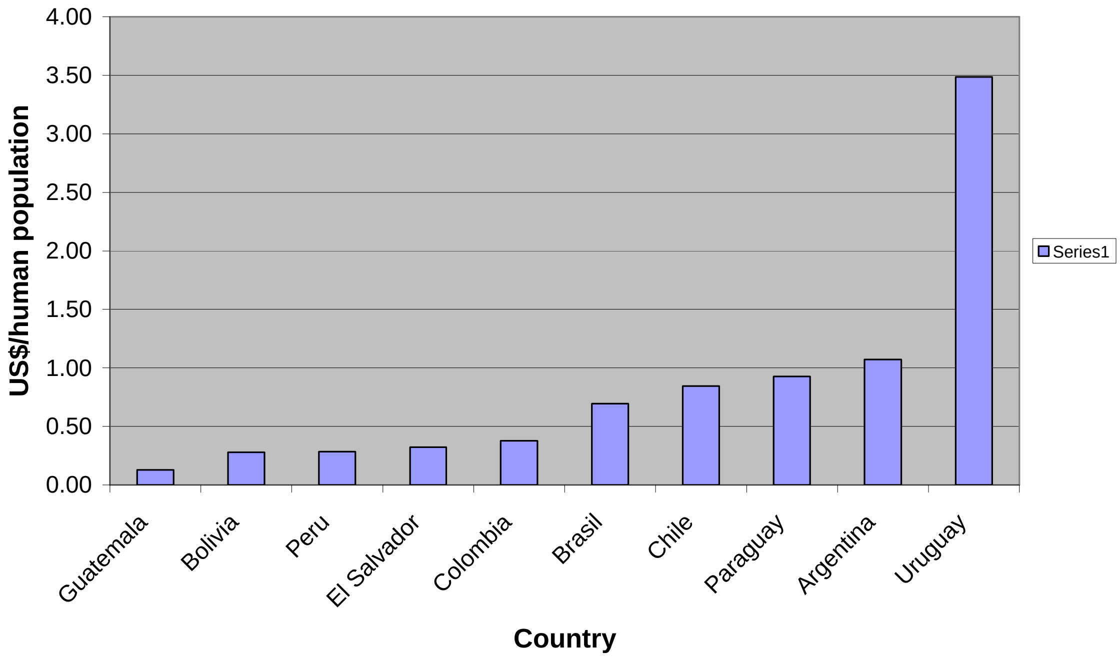
OVS Budget/Human Population: This ratio measures the intensity of OVS resource use in relation to the number of people that can benefit (through improved food safety or reduced exposure to zoonotic diseases) from these services.

Several Latin American countries spend in OVS less than US$ 0.40 per year and per person (see Figure 10). This is the case of Bolivia, Colombia, Guatemala, Haiti, El Salvador and Peru. The lowest spending corresponds to Guatemala (US$ 0.13 per person-year) followed by Haiti (US$ 0.25 per person-year.). Argentina. Brazil, Chile and Paraguay spend in the order of US$ 0.70 – 1.10 per person-year. In part, these higher allocations reflect the fact that some of these countries have large animal as relates to human populations. Uruguay, in particular, has a high OVS budget in relation to population, possibly due to the fact that this country has more than 4 animal-equivalents per capita, as compared, for example to 2 for Argentina, 1.2 for Brazil and 0.35 for Peru.

OVS Budget/Output: animal productivity differs between countries as well as between different animal species. But also, output per AE depends on the intensity with which factors of production are used: animal feeds, private veterinary services etc. This index measures the intensity of the use of OVS in relation to achieved animal output. In a sense it constitutes an indicator of "average cost" (in terms of OVS inputs) for each unit of obtained output.

OVS cost per unit of output is affected not only by the "abundance" of OVS in relation to animal population, but also by attained productivity. Comparing Argentina, Brazil and Uruguay (important producers) cost of OVS per unit of output varies between US$/ton 7 in Brazil, to US$ 20/ton in Uruguay. Argentina has, in relation to Uruguay, a somewhat lower OVS cost per AE (US$ 0.66 against US$/AE 0.85) but a much lower OVS cost per ton produced (US$ 10 against US$ 20) due to higher productivity. The low productivity of Paraguayan animal production explains the high OVS cost per ton (higher than Chile) even when OVS per AE is relatively low. The same thing occurs in El Salvador.

Figure 10: Budget Allocation US$/human population



<u>OVS Budget/Exports (animal products)</u>: potential exporters have much to lose if, due to failure of their OVS, sanitary events result in restrictions for market access. The index “OVS cost per dollar exported” shows the effort expanded in maintaining/improving access to international markets.

For important exporters of the region (Brazil, Uruguay and Argentina) OVS costs represent between 1.5 and 2.5 cents per each dollar exported of animal products. The fact that only a part of the income of these services (relatively small, but variable between countries) originates in export taxes implies that the “cost of exporting” is considerably smaller than this figure. This ratio shows considerable variation between countries. This is due – in particular - to the different importance of export demand in total demand of the countries animal sector output. Change in the export status of the country could markedly change the “cost” of the OVS per each dollar produced by exports.

<u>OVS Budget/Tourism Income</u>: the case of FMD in the UK commented in the previous chapter indicates that animal health problems can affect foreign exchange inflows from tourism. The index measures resources allocated to OVS in relation to the countries´ tourism industry. It measures the relative importance of efforts made to reduce the probability of animal health events affecting this industry.

Income from tourism in Latin America is of considerable magnitude. For the case of Brazil, the worlds´ largest exporter of animal products, income from the former is equivalent to 55 percent of those resulting from the exports of the latter. In Uruguay and Argentina (two other important exporters) for each dollar exported of animal products between 0.87 (Uruguay) and nearly 2 (Argentina) dollars result from tourism. In other countries, tourism income is several times larger than export of animal products: in Guatemala, for example, tourism income is some US$ 880 million, against some 20 million of export of animal products.

Guatemala and Peru – countries were tourism income is of considerable importance for the economy – spend in OVS less than one cent for each dollar of tourism income generated. The same occurs in Chile, even though the OVS of the country has – in comparison to the other two – much higher availability of resources.

III.4 Economies of Size

Many processes are subject to “economies of size”: as output of goods or services increases, average costs of producing these services decrease. Multiple reasons explain the existence of economies of size: resource lumpiness and advantages from specialization are two important ones. It is to be expected that production of OVS be subject, at least in some output range, to these types of economies. Under economies of size, “small” countries will have to invest, in relation to bigger ones, a higher level of resources in order to obtain the same “quality” of OVS for their animal and human population. Available information does not allow economies of size to be estimated with precision. However, some preliminary observations may be presented.

Consider the case Brazil, Argentina and Uruguay. It can be assumed that these countries have OVS that are roughly “equivalent” in terms of types of services produced. Two other countries (Belize and Barbados) are also included for comparison purposes.

The relation between “size” of the national animal stock and resource allocation per animal-equivalent is shown in Table 14. The same data are shown in Figure 11. Average costs” (costs per AE) of countries with very small animal populations (less than 0.5 million AE) are approximately US$/AE 4.5. Unfortunately, our data base does not include countries (having “equivalent” OVS) with animal stocks in the 1 – 10 million AE range as this would allow a more accurate picture to be derived. Our data “jumps” from very small countries (Barbados and Belize) to one with a considerable animal population (Uruguay, with 14 million AE). If this data set is provisionally accepted, substantial economies of size are detected. The Uruguayan OVS budget is less than 20 percent of the two smaller countries. Economies of size persist for with size increases: Argentina and Brazil have lower OVS cost per AE than Uruguay. “Savings” associated with size, however, seem to decrease: in Brazil animal population is 16 times than of Uruguay, however the budget (per AE) of the first is only 30 percent lower.

A regression analysis of the type OVS Total Cost (US$) = f(animal equivalents) results in the following estimates:

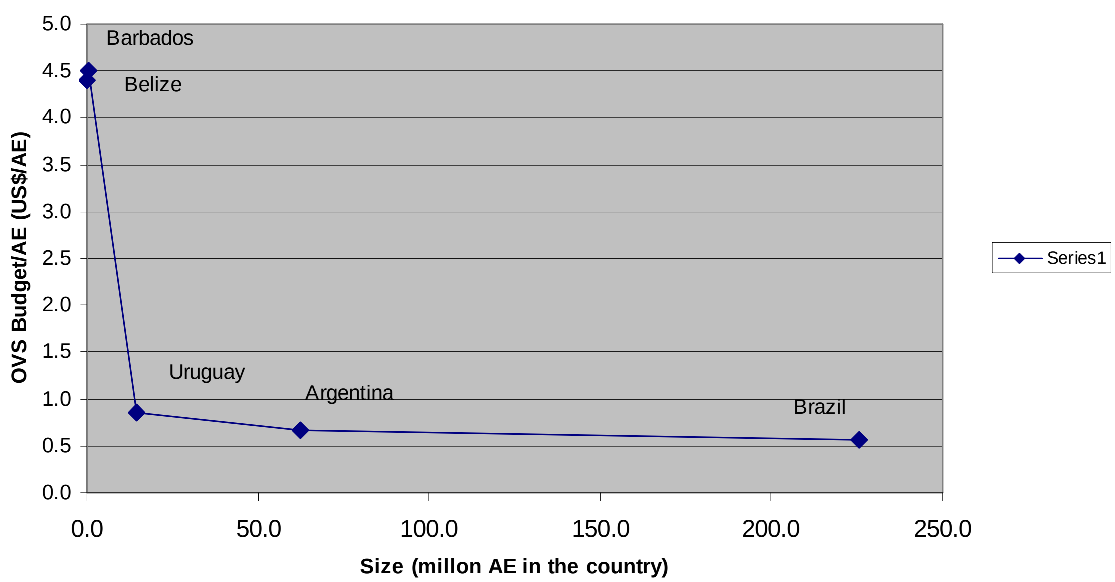
[1] Total Cost (US$) = 1.52 $AE^{0.68}$

Table 14: OVS of Latin America – Economies of Size

	Animal Population	OVS Budget/Animal Population
	(Million AE)	US$/AE
Barbados	0.2	4.4
Belize	0.3	4.5
Uruguay	14.4	0.85
Argentina	62.6	0.66
Brazil	225.7	0.57

Source: Based on data of Table 13

Figure 11: OVS - Economies of Size



This “total cost function” implies substantial economies of size: a 10 percent increase in size of the animal population is accompanied by only a 6.8 percent increase in total costs. An “average cost” function (cost per AE) may be derived:

[2] Cost/AE (US$/AE) = 1.52 $AE^{-0.32}$

This expression can be used to predict – with the limitations imposed by the type of data used - costs per AE of OVS of countries with animal populations of sizes intermediate between those considered previously. For example, calculations comparing “actual” OVS budget with OVS budget predicted from [2] above result in the following:

- For Guatemala (animal population 6.2 million AE), the estimated budget should be US/AE0.83. The “real” budget, however, is US$/AE 0.26, that is only 32 percent of that “adequate” for achieving the standards similar to the 5 countries considered above.
- For Bolivia (animal population 10.7 million AE) the relevant figures are: predicted budget = US$/AE 0.71, real budget = US$ 0.24 so real budget is 34 percent of what “should be”. In the case of Paraguay the ratio between “actual” and “predicted” is 75 percent, or 25 below what “should be”.
- For other countries (e.g. Peru) OVS budget is approximately equal to predicted. Lastly, in the case of Chile, an OVS “equivalent” to the ones above would result in a budget of US$/AE 0.81. Actual budget for this country is US$/AE 1.95. This resource allocation suggests that – assuming similar resource use efficiency – Chile has an OVS considerably more sophisticated that the ones of the other countries.[9]

III.5 Comparison with a Developed Economy

Countries of Latin America have, in general, veterinary public health systems considerably less sophisticated than those existing in high-income countries. In many countries, an improvement in OVS will require the injection of additional resources. These resources can be of different types: computer equipment, laboratories, advanced

[9] Observe that Chile, a country limited on one side by the Andes and by the Pacific Ocean on the other is probably exposed to less risk of transboundary diseases than countries with easier to cross frontiers.

training etc. Resource allocation to OVS should be done taking into account the rate of return resulting from these resources, and comparing these returns with other alternatives. This is particularly true in LDE, where funding restrictions result in many projects competing for the available resources.

Comments related to resource allocation in Latin America and in a developed economy (Canada) are presented below. As mentioned previously these comparisons should be interpreted with care. Derived ratios are useful as catalysts for further research, more than of indicators of what is "correct" in relation to OVS funding.

The Canadian OVS (Canadian Food Inspection Agency, CFIA), carries out several functions related to animal health, food safety and the relationship of these with the environment.[10] Responsibility includes inspection of domestic production and imports, export certification, quality control, auditing, risk analysis, the establishment of standards and the implementation of a diverse set of programs of animal health, veterinary public and plant health. The programs and mandate of the CFIA have been carried out for a long time (they started out before the creation of the Confederation of Canada in the middle of the XIX Century) however the CFIA takes its current legal form in 1996, starting to operate in 1997. The CFIA consolidates a variety of inspection and quarantine services previously provided by several organizations. Organizational characteristics of the CFIA include the following:

- It is an independent agency (not a conventional public department). This results in considerable independence as relates to human resource and financing decisions.
- Its creation was not a result of a "confidence crisis" but of the need to simplify a complex and multi jurisdictional problem
- Food safety is a top priority for the CFIA. Work in this direction involves producers, processors, distributors, retailers and consumers.

- The CFIA is also responsible for protecting Canada from OIE-listed diseases

[10] The description of the CFIA is based on Evans and other (2003).

The organization employs 5,600 people with a budget (expressed in US$) of 460 million.[11] As relates to the role of the CFIA Evans and coauthors point out that (p.413):

The public heath outcome extends beyond the limitations of risks associated with known and emerging zoonotic diseases to include the indirect benefits that result from a prevalence of regulated diseases. Among these benefits is the consideration that, when the prevalence of animal diseases requiring treatment is reduced, the development of antimicrobial resistance becomes less likely.
(…) if disease control measures take into consideration the prudent use of therapeutants, and deal carefully with the issues of carcass disposal and bio-containment parameters, such as farm quarantines, buffer zones and disease handling methods the potential exposure of the human population to adverse health consequences from contaminants in water sources or the environment wull be greatly reduced.

The comparison of selected ratios of the CFIA with Latin American countries results in the following:

- Canada has a human somewhat smaller population than – for example - Argentina. Animal population is half of that of Argentina. However, the CFIA budget (US$ 430 million) is four times greater than that of Argentina (Total SENASA budget = US$ 100 million, SENASA budget for animal health = US$ 41 million).
- Canada allocates some US$ 17 for each animal equivalent, as compared to less than US$ 1 for most Latin American countries. As relates to the OVS budget/human population ratio, Canada allocates US$ 13 against US$ 0.29 (Peru), US$ (0.70 (Brazil), US$ 1 (Argentina) and US$ 3.5 (Uruguay)
- In Canada, OVS cost per ton of animal product is US$ 80, as compared for example with Brazil (US$ 7), Argentina (US$ 10), Uruguay (US$ 20), important producers of the region.

The comparison between the Canadian budget and those of Latin American countries can be made “normalizing” each countries budget by its per-capita gross national income. This normalization roughly corrects the fact that if one country has a higher income than another, cost of human resources in the first are higher than those in the second. Without this correction, observed differences in budgets between countries

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[11] Data from Evans and others (2003). Original data in Canadian dollars, transformed here by $Can = US$ 0.94.

may reflect not differences in amounts of resources used but of prices of these resources. Normalization is done "correcting" the OVS budget with the following:

[3] Corrected $Budget_i$ = [0.40 $Budget_i$] + [0.60 $Budget_i$]*GNI_C/GNI_i

where $Budget_i$ is the corrected budget of the *i-th* country, $Budget_i$ is the "nominal" (uncorrected) budget for the country and GNI_C and GNI_i are, respectively per-capita gross national income in Canada and in the i-th country. The correction assumes that OVS of Latin American countries allocate 40 percent of their budget to resources whose prices are similar than those of the same resources in Canada (basically, "tradeable" resources such as computers, laboratory drugs and vehicles) and 60 percent to non-tradeable resources (basically personnel) whose price is proportional to the countries per capita income level.

Results show the following. OVS budget per animal-equivalent is at the most 50 percent of the Canadian (Mexico and Chile). For the rest of the Latin American reported here, budget is between one-eight (Guatemala) and one-fourth (Argentina, Brazil, Uruguay, El Salvador, Bolivia) of the one reported for Canada.

The case of Haiti, the country with lowest per-capita income of the continent, deserves further comment. If the Haitian OVS budget is normalized according to [3], budget levels result in US$ 11 per capita and US$ 83 per animal-equivalent. Respective figures for Canada are US$ 13 and US$ 17. In other words, the Haitian OVS has more "favourable" ratios than Canada. These results are caused by Haiti having a per capita income of US$ 450, as compared to US$ 32.000 for Canada. This result serves to illustrate the difficulty of poor countries in allocating funds to investment projects (including among these those of OVS). Indeed, very modest resource allocations represent a substantial effort. The fact that OVS output can be considered a "global public good" emphasizes the importance of financial assistance channelled from developed economies.

Another comparison that can be made is OVS budget per inhabitant in the country. This ratio is important due to the trend of increasing involvement of OVS in aspects related to food safety and zoonosis control. For example, the CFIA allocates approximately 60 percent of its budget to this area, as compared to 33 percent to animal health. The Canadian budget is US$ 13 per capita, as compared to less than 6 for most Latin American countries. Countries of the Central America region, in particular, have per capita OVS budget levels ranging from US$ 1 (Guatemala) and US$ 2 (El Salvador), in other words allocations that are between 8 and 15 percent of the one observed for Canada.

Uruguay is an interesting exception. Its OVS budget (corrected by expression [3] above) is higher than the Canadian. This is probably due to Uruguay having a higher number of animal-equivalents in relation to population: 4 AE/person, as compared to 0.80 AE/person in Canada. Uruguay has a “well-funded” OVS in relation to its population, but at the same time (on a per animal-equivalent basis) only 25 percent of resources available in Canada.

IV. Cost-Benefit Analysis of OVS

Evidence presented in previous sections suggests that OVS have an important role to play. A relevant question is then: ¿What is the economic impact of additional resources allocated to strengthening these services? Resources allocated to OVS have other alternative uses: professionals, buildings, computers, laboratory materials. The decision to increase or not these resources requires then careful evaluation, in particular in LDE, where resource availability is particularly limiting. Different types of costs should be compared with resulting benefits. In many cases, human health or primary education projects compete for funds with animal health projects such as analyzed here.

IV.1 General Aspects

OVS action results in multiple products. Among these: (a) field observation regarding the status and evolution of different diseases, (b) sampling of animals and laboratory diagnosis, (c) design and execution of preventive measures (restriction to animal movements, quarantines, animal sacrifice), (d) regulation related to marketing conditions of animal products, (e) quality certification and (f) contingency planning. These generate results: for example, reduction of the impacts of endemic diseases, reduced probability of epidemics, or if these appear reduction of losses. Processes (a) – (f) above imply costs. The benefit-cost analysis focuses attention in comparing these costs with (in many cases multiple) resulting benefits.

IV.2 Taxonomy of Situations

The following taxonomy of situations may be presented. The first three cases correspond to OVS impacts on market transactions; the last refers to impact not included in conventional market analysis. For convenience, the term “meat” is used to refer to all animal products.

IV.2.1 Animal Production in the Absence of International Trade

For different reasons, some countries may choose not to interact as exporters or importers in the international market. In this case – and ignoring for the moment impacts on human health - the impact of the OVS is channelled through higher levels of production. Efficiency (the ratio of output to all inputs) increases. This is called “Total Factor Productivity” (or TFP) increase. The result of this shift will be higher levels of production and lower consumer prices. The magnitude of the production increase, as well as the fall in prices will depend on the sensibility of demand to price (the price elasticity of demand). The lower this elasticity, the more prices will fall and the smaller the increase of output. Also, the lower this elasticity the more the benefit of productivity increase will be captures by consumers´ vis-à-vis producers.

The magnitude of the production shift depends on the extent to which the OVS reduces impacts of diseases that directly affect productivity. For the OVS to have an impact, “neglected opportunities” have to exist: for example, the individual producer may not face “correct” incentives due to externalities in disease control leads him to use non-optimal (lower or higher) input levels.

IV.2.2 Country Open to Trade – Importing Country

Assume that the action of the OVS of a (large) exporting country leads to a shift (increase) in market supply. This will result in increased production volumes and larger exports. Prices in the importing country will fall. Consumers of this country will benefit (through lower prices) from the OVS activity. Even when the output of the exporting country does not increase, OVS activity may result in improved trade flows through a reduction in sanitary barriers to trade. Indeed, these barriers are “transaction costs” that tend to maintain meat price differences between markets. The lower the transaction costs, the lower price differentials between exporting and importing countries will be: prices fall in the latter and increase in the former.

IV.2.3 Country Open to Trade – Exporting Country

The impact of an OVS on a country that has (potential) “complete access” to international markets will benefit – in a first instance – the producing sector. *Via taxation, however, part of this benefit can be redistributed to other segments of the population*. If the OVS has an impact on production, supply will increase resulting in higher exports. Prices received by producers may stay the same or fall, according to demand for their product in the international market is perfectly elastic or not. If the countries exports are "small" relative to total imports the former will happen.

The impact of OVS is particularly important when – as a consequence of its activities – a country passes being excluded to being able to participate in trade. In this case in addition to a supply shift, international demand will be added to domestic demand. Increases in supply will not result now in price falls, or if prices fall, the falls will be smaller than those which would have occurred in the absence of trade. The beneficiaries of OVS will be producers. The impact of OVS results then in: (a) increased supply and (b) change in demand conditions, the situation changing from a domestic demand with elasticity generally below one, to an international demand with elasticity greater than one.

IV.2.4 Human Health

The previous analysis focuses attention on the impact of the OVS on demand and supply in the meat market. Impacts on human health have also to be considered both for the possibility of humans being infected with diseases originating in animals, as well as for the possibility of the impact of food-borne diseases.

Damages resulting from morbidity are associated with loss of work time, medical attention (medical services, capital costs for medical equipment), medical drugs, as well as human suffering. In turn, mortality is frequently "valued" considering income loss and other factors. It is important to point out that epidemic diseases such as Avian Influenza are not the only relevant ones. A wide range of zoonotic diseases have impacts that are for the moment much greater (Coleman, 2001; WHO/FAO/OIE, 2004).

Growing urbanization has taken place during the last decades. According to FAOSTAT in Latin America urban population will pass from 57 percent (in 1970) to 84 percent (in 2010). Increased distance from producers to consumers will result in challenges related to food safety. Contamination risks may increase as animals or their products are transported to urban centres. Urbanization, with increasing complexity of the food chain, justifies preventive measures on the part of OVS. These measures include control, sanitary norms, information gathering, assistance for firms engaged in implementing systems such as HACCP, etc.

IV.3 Modelling

Appendix A.1 details basic aspects related to modelling and the assumptions used to derive the Benefit/Cost of increasing OVS resources. Additional aspects are detailed here.

A comparison is made between that “actual” and “improved” situation. The difference in both is related to increase in OVS budget. In order to estimate increases in OVS budget, actual budgets (Table 13) are used as a benchmark. A 30 percent budget increase is assumed necessary in order to shift from the actual to the improved situation.

Economic impacts from TFP increase: part of the gap between “potential” and “actual” TFP increase is assumed here to be explained by OVS resources. It is assumed here that an increase in these resources will contribute to narrowing this gap.

Economic impacts from trade: an increase in resources allocated to OVS impact the probability that a sanitary event occurs. This sanitary event results in a fall in export prices. The reduction is prices is assumed to be distributed during three years: 100 percent of the impact during the first, 40 percent during the second and 20 percent during the third.

The OVS does not impact directly on import quantities and prices of animal products. The impact can be indirect: a sanitary event that reduces exports will simultaneously increase domestic consumption.

The action of the OVS will reduce both the prevalence of endemic zoonotic diseases, as well as health problems caused by food borne illness. No mention is made here, however, on epidemics such as Avian Influenza.

The analysis done here assumes a 20-year time frame.

IV.4 Results

Selected countries of Latin America are discussed here. These cases can be taken as “representative” of what occurs in the region as a whole. Table 15 shows some results. These can be summarized:

Table 15: Benefit-Cost Ratios

	Benefits				Costs					Partition of Benefits		
Country	**Productivity**	**Sanitary Crisis**	**Human Health**	**Total**	**Budget Change=** 30 (%)				**B/C**	**Productivity**	**Crisis**	**Human Health**
	NPV (Million US$)	**per crisis** (Million US$)	**per year** (Million US$)	**NPV** (Million US$)	**Actual Budget/AE** US$/AE	**Budget Change/AE** US$/AE	**Total AE** (Million)	**Increased Costs NPV** (Million US$)	**(Marginal)**	**%**	**%**	**%**
Argentina	660	994	25.6	957	0.66	0.20	60.0	96	10	69	24	7
Brazil	488	4635	98.0	1816	0.57	0.17	225.7	312	6	27	59	14
Uruguay	91	257	2.3	156	0.85	0.26	14.4	30	5	58	38	4
Mexico	426	86	111.6	737	2.67	0.80	46.8	303	2	58	3	40
Chile	79	153	14.2	151	1.95	0.59	7.1	34	5	52	23	24
Paraguay	39	107	0.9	66	0.53	0.16	10.4	13	5	59	37	4
Colombia	75	239	15.5	171	0.6	0.18	28.6	42	4	44	32	24
Bolivia	43	76	1.4	64	0.24	0.07	10.7	6	10	67	27	6

Productivity

An increase in TFP resulting from OVS action can have significant impacts. This is particularly true in countries that: (a) have an important animal stock and (b) have a low current TFP. Argentina and Uruguay are two countries for which the above holds: in the case of Argentina the Net Present Value (r = 10 %) of productivity improvements is US$ 660 million. In the case of Uruguay the result is US$ 90 million.

Brazil, by far the most important meat producing country of the region, will not obtain, according to expression 2 of the Appendix, TFP improvements due to OVS action. This is because TFP growth in Brazil (3.61 percent) is higher than the limit (3 percent) assumed here as the "potential" TFP growth that can be achieved. Given the preliminary nature of calculations, a "potential" TFP growth of 4 (instead of 3) percent will be assumed for Brazil. Under this assumption the impact of OVS on productivity is estimated to be US$ 488 million. Note that this impact results from a productivity gap of only 0.39 percent (4.00 – 3.61). OVS action eliminates 1/10 of this gap, or 0.039 percentage points, a very small increase in productivity.

Countries with smaller animal stocks obviously will attain smaller additional incomes through increases in TFP. However, these countries also require smaller increases in OVS budget to achieve stated results.

International Trade

Three groups of countries can be distinguished: (a) Exporters, (b) Potential Exporters and (c) Importers. In (a) we include only Argentina, Brazil and Uruguay. The case of Mexico is analyzed separately: it is an important exporter; however imports are even larger than exports.

Costs off a sanitary event – measured as changes in total surplus (consumer plus producer) are calculated as per Appendix 1. The simple model used here assumes that the sanitary event causes a fall in export prices of 20 percent, with 100 percent impact in the first year, 40 percent in the second and 10 percent in the third.

Argentina, Brazil and Uruguay: total loss for the three countries is some 5.8 billion dollars. Brazil accounts for some 80 percent of this total, Argentina 16 percent and Uruguay the remaining 4 percent.

Mexico and Chile: the case of Mexico (and to a lesser extent Chile) is different from the ones considered previously: in these countries total imports exceed exports. Costs of a sanitary event in these countries are, respectively, 86 and 153 million dollars. The relatively low costs of crisis (in particular in the case of Mexico) is explained by the nature of the model used here (partial equilibrium market model). This model results in crisis costs that are larger the more important the difference between total supply and domestic demand. In Mexico and Chile total supply is similar to demand.

The five countries mentioned above account for 94 percent of exports and 80 percent of output of animal products. It may be relevant to make some comments with respect to the countries that follow in importance.

Nicaragua, Paraguay, Colombia and Costa Rica: these countries total some 4 percent of exports of the region. Price shocks resulting from sanitary events cause falls of US$ 107 million (Paraguay), 239 million (Colombia), 43 million (Nicaragua) and 39 million (Costa Rica).

Human Health

Very little information exists that allows estimation of the human health impacts of zoonotic and food-borne diseases (Z&FBD). Some preliminary figures may be presented. Impacts of Z&FBD can be expected to be proportional to human population of the country. Indeed, assuming equal disease pressure over human population, total pressure will be larger the larger the population.

In Chapter 3 evidence was presented of number of cases of disease per 100.000 population. It should be emphasized that these figures are only useful for triggering lines of inquiry. With this in mind, assume that the figure of 770 cases per 100.000 population adequately represents the prevalence of all types of Z&FBD. These cases include a wide range of situations regarding morbidity, mortality, human suffering, etc.

In its simplest form, the cost of Z&FBD can be assume to be the product:

[4] Total Cost of Z&FBD = Cases/100,000 x Population/100,000 x Cost/case

In the above expression, the “Cost/case” summarizes all costs that (on average) are generated by the presence of Z&FBD. Thus, costs of mortality, morbidity and human suffering are “averaged out” in this number.

Assume that the Cost/case of Z&FBD can be approximated by per-capita gross national income times (1/52): i.e. the loss of one week average production per person. For a country such as Argentina (GNI = US$ 4470) this value is US$ 86. If it is assumed that this figure approximates – for Argentina – the “Cost/case” total cost produced by Z&FBD would be:

[5] Total Cost of Z&FBD (Argentina) = 770 x 38,700,000/100,000 x 86

= US$25.6 million

In order to refer the above result to the 20-year horizon considered for our calculations, NPV (r = 10 percent) has to be derived. Further, population growth has to be taken into account. Assuming for the Argentine example 1 percent population growth, NPV results in US$ 235 million.

Table 15 shows that (yearly) costs of Z&FBD range from a maximum of US$ 111.6 million (Mexico) to a minimum of US$ 0.9 (Paraguay).

Benefit/Cost Analysis

Benefits considered here result from the 20-year Net Present Value of: (a) improvements in productivity, (b) reducing the probability of a sanitary crisis and (c) improving human health. The previous sections describe basic assumptions and some results related to these three types of benefits.

Benefits of higher productivity and those associated with human health costs of diseases occur every year. The former grows through time due to accumulation of productivity growth; the second is increasing through population growth. In contrast, benefits of avoiding a sanitary crisis occur only in the year of the crisis, not when the crisis does not occur. It is assumed here that an improved OVS reduces the probability of crisis: with the current OVS one crisis will occur every 20 years, with an improved

OVS every 50 years.[12] The impact of larger quantity of resources allocated to the OVS is then to reduce the probability of crisis: from 0.05 for OVS with the current resource level, to 0.02 with increased resources.

For the 20 year horizon, the Expected Value of the moment in which the crisis appears is the year 10 (a uniform distribution of crisis probability through time is assumed). The cost of the crisis should then be discounted by $1/(1 + r)^{10}$. For the “improved” OVS, the assumption of one crisis every 50 year is equivalent to 2/5 = 0.40 crisis also in year 10. Therefore an increase in additional funds results in a “savings” of (1 – 0.40) = 0.60 crisis in the 20-year period under consideration. Costs necessary for achieving these benefits are assumed to be equivalent to a increase of 30 percent in the operating budget of the OVS. Thus, both benefit and costs are estimated in “marginal” terms.

Figure 12 shows results from calculations. In general, B/C varies from 5 and 10:1. In the case of Mexico, the B/C ratio is 2:1. This is lower than other cases, probably as a result of the fact that budget of the Mexican OVS is, relative to others, quite high. But also, estimates of crisis costs for Mexico are relatively low. One possible reason for this is the importance of domestic consumption: a sanitary crisis will be “cushioned” by expansion of consumption.

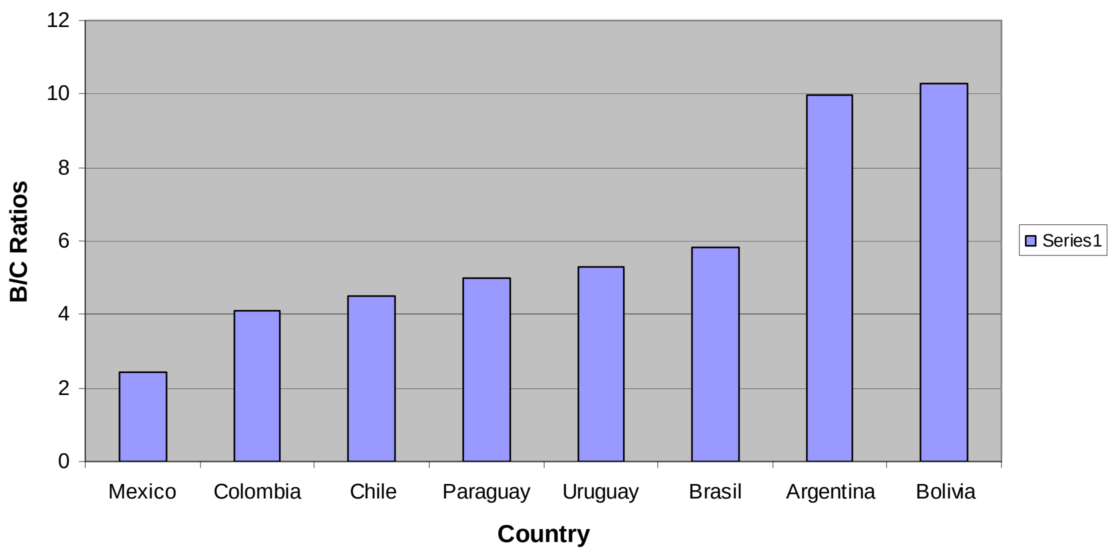
Benefit/Cost ratios of Argentina and Bolivia are 10:1. High B/C ratios are explained by important impacts of OVS on productivity: animal stocks in both countries (in particular Argentina) are large.

Table 15 shows partition of benefits in their three components: productivity, crisis and human health. These figures are for illustrative purposes only, however they suggest that countries differ in the relative importance of these components. This is true even when the comparison is restricted to countries that participate in international trade. In Brazil, for example, some 60 percent of total benefits of OVS are caused by reduced impacts of crisis. In Argentina and Uruguay relevant figures are 24 and nearly 40 percent. In the case of Mexico, a very important portion of benefits (40 percent) result from improved human health. Much more research is needed on these issues. However, improved information may help budget allocation decisions among different projects in OVS of the region.

Estimates presented above assume – among other things – that a “sanitary crisis“ will affect export price received by the country but not the possibilities of re-

[12] Argentina, Brazil and Uruguay had, in the period 1996-2007 (12 years) on FMD crisis.

Figure 12: Benefit/Cost Ratios
(+ 30 % OVS Budget)



directing output from the international to the domestic market. However, it is possible to imagine situations where a crisis will reduce demand in the domestic market as well: for example a crisis caused by Avian Influenza, BSE or a highly contagious emergent zoonosis. In these cases, economic impacts of a sanitary crisis will be much larger: to the reduction in international demand, a reduction in domestic demand should be added. In extreme cases, output may need to be destroyed. In order to present "conservative" estimates of OVS activity, impacts of sanitary crisis affecting domestic demand are omitted.

V. Conclusions

This paper presents evidence of the increased importance OVS will play in the near future. Increasing animal production in LDE, as well as increasing meat consumption and trade all suggest important challenges for OVS. The fact that real incomes are increasing in many parts of the world will result in additional issues to be addressed: in particular, demand for food safety as well as for environmentally safe animal production practices.

Latin America, in particular, stands to gain from improved OVS. Indeed, excellent conditions for growth of animal and poultry production exist in many countries of the region. This is true both for “extensive” (i.e. grass fed) as well as more intensive production activities. Animal production offers a real possibility of improving both incomes as well as the diet of the Latin American population.

To our knowledge, this paper constitutes the first attempt to estimate total resource use by OVS in Latin America, as well as Benefit/Cost ratios resulting from these resources. Results derived here indicate high returns to additional resources allocated to these services.

Benefit/Cost ratios derived here are preliminary, useful as a stepping-stone for further research to be undertaken in the future. In relation to this point, considerable attention should be focused on the construction of data sets appropriate for Benefit/Cost analysis. Inter-country comparisons require a significant improvement in this type of data. Data sets to be used include information on OVS themselves, on the animal and poultry production sectors, on trade and consumption and on human and animal health. Some data gathering methods, such as “Delphi” consultation with experts have as yet not been tapped, but offer considerable promise.

Economic analysis seems to be a useful tool for understanding OVS. Multidisciplinary work involving public health veterinarians, epidemiologists, food safety scientists, OVS administrators and economists is likely to have high payoffs.

VI. Appendix 1: Economic Model

The estimation of benefits and costs of OVS requires modeling of basic aspects associated with the functioning of these services. The model includes basic assumptions, the more important of which are detailed below. Benefits, as well as costs of OVS analyzed here assume a horizon of 20 years.

VI.1 Impacts on Production

The action of the OVS results in a productivity (TFP) increase. This TFP increase results in increased output. Output growth is:

$$[A.1]\ Y_t = Y_{t-1} * (1 + \Delta TFP)^t - Y0$$

where Yt is output in year "t" and ∆TFP is annual increase in TFP caused by the action of the OVS. In order to assume values for ∆TFP, data produced by Flavio Dias and Robert Evenson are employed. The authors analyze productivity increases in the livestock sector of Latin America. They find (for the period 1980-2001) an average TFP growth of 2.1 percent for the region as a whole. This TFP growth shows important inter-country variation (low 0.4 – 0.5 percent - TFP growth is reported for Argentina and Uruguay; a very high level of 3.6 for Brazil). Lacking better information, for all countries we will assume that they will be able to improve TFP growth through OVS activity. OVS will narrow the gap between they current TFP growth and a "maximum" TFP growth, assumed here (with the exception of Brazil) of 3.0 percent. For the i-th country, the impact of improved OVS will be:

$$[A.2]\ \Delta TFPi = \alpha \min[3.0 - \Delta PTFi, 0]$$

A value of α of 0.10 will be assumed here: in other words, OVS action results in eliminating 1/10 of the gap between maximum and historic TFP growth. Observe that even if OVS by themselves are not able to increase TFP growth, they may well be a sufficient condition for this increase to occur: in other words, the impacts of farm management, types of animals used or in the availability of feeds may be small or n egligible when animal health problems exceed control measures taken at the individual farm level.

For, the case of Brazil, and given the high historic TFP that is observed, a maximum TFP of 4.0 will be assumed.

VI.2 Impacts on Trade

Assume a sanitary event that impacts exports through a temporary reduction in price received. This reduction occurs during three years: total effect takes place in year 1, in years 2 and 3 impacts are, respectively, 40 and 20 percent of impact in year 1.
For country I, lets Srpls0i and Srpls1i be the total (producer + consumer) surplus existing in the absence and presence of a sanitary event. For country I, the “cost” of the crisis is the difference between total surpluses in both periods: $\Delta Srpls = Srpls_{0i} - Srpls_{1i}$. In Figure 13 the area ***abef*** represents the increase in consumer surplus due to fall in export prices. In turn, ***acdf*** represents losses in surplus incurred by producers. The net loss (ΔSrpls) is the difference between loss to producers and gain to consumers***: bcde*** = ***acdf*** – ***abef***.

This loss can be approximated from: (a) price change caused by the sanitary event, (b) quantities supplied and demanded in the domestic market before the event and (c) elasticities of supply and demand in the domestic market. Let:

P_0 = export price before the sanitary event

ΔP = percent change in prices caused by the event ($\Delta P < 0$)

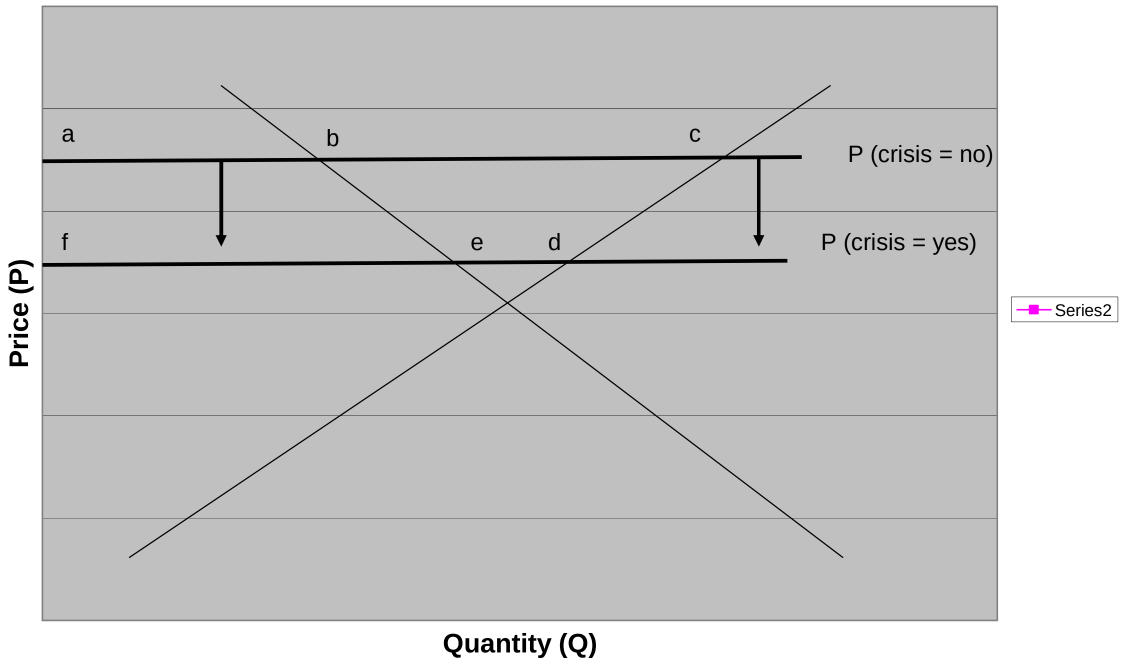
QD_0 = domestic quantity demanded before the event

QS_0 = domestic quantity supplied before the event

Es = elasticity of supply

Ed = elasticity of demand

Figure 13: Impact of Sanitary Crisis



The change in total surplus produced by the event is the sum of changes in consumer plus producer surplus. These changes can be approximated with:

Change in consumer surplus

[A.3] $P_0(1 + \Delta P/100)[QD_0 + (-\Delta P)(Ed)(QD_0)/2]$

Change in producer surplus

[A.4] $P_0(1 + \Delta P/100)[QS_0 - (-\Delta P)(Es)(QS_0)/2]$

We will assume in our estimations ES = 0.4 and Ed = 0.2. These highly inelastic values are used due to the short-run (and not foreseen) nature of the event under consideration. Further, our analysis assumes Δ P is somewhat larger in the export than in the domestic market: for Argentina, Uruguay and Brazil Δ P is 20 percent for export prices but only 15 percent for domestic prices. For the case of Mexico and Chile values are 20 and 10 percent respectively. This assumption attempts to take into account that product in the export and domestic market are not perfect substitutes. The estimates of cost of crisis are – using this assumption – higher than they would be when Δ P is equal in both markets.

The result of a higher budget allocated to OVS is assumed here to impact only on the probability of an event, not on the magnitude of this event. For the "baseline" and "improved" budgetary situation of the OVS probabilities of crisis may be denoted by P[Crisis|baseline] and P[Crisis|improved]. The benefit from improved OVS activities is therefore the difference in (expected) cost of a crisis with the baseline budget, as compared that expected with the improved budget:

[A.6] $EV[\Delta Srpls_i] = P[Crisis|baseline]\ \Delta Srpls_i - P[Crisis|improved]\ \Delta Srpls_i$

[A.7] $EV[\Delta Srpls_i] = \{P[Crisis|baseline] - P[Crisis|improved]\}\ \Delta Srpls_i$

thus, the expected benefit from the OVS is equal to the cost of the crisis multiplied by the change in probability that the crisis occurs. As mentioned previously, a 20-year horizon is assumed here. If the probability of crisis is distributed uniformly, the "expected crisis date" will be year 10. Impact of the crisis should then be discounted. If a 10 percent discount rate is assumed, the discount factor is $1(1+0.10)^{10} = 0.38$.

Observe that according to equation [7], the impact of the OVS is to reduce (not eliminate) probability of suffering a crisis. We assume here:

[A.8] P[Crisis|baseline] = 0.05 (one crisis every 20 years)

[A.9] P[Crisis|improved] = 0.02 (one crisis every 50 years)

This methodology is used in order to emphasize: (a) the random nature of sanitary crisis and (b) the fact that crisis can occur even with an OVS with an improved budget. The impact a higher budget is to reduce the probability of crisis. The previous analysis results in the increased budget of OVS having the following impact:

[A.10] Reduction in damage caused by crisis = $\Delta Srpls_i$ [0.38][0.03][20]

[A.11] Reduction in damage caused by crisis = $\Delta Srpls_i$ [0.22]

Where:

$\Delta Srpls_i$ = economic damage caused by one crisis

0.38 = Present Value of $1 received in year 10 $(1/(1 + 0.10)^{10})$

0.03 = P[Crisis|baseline] - P[Crisis|improved]

20 = temporal horizon

Summarizing: the reduction in damage caused by the improved budget of the OVS is the product of: (a) total damage caused by the crisis, (b) discount factor for time lag of crisis occurrence, (c) difference in probability of crisis due to improved budget and (d) number of periods under consideration.

Observe, in expression [A.11], that a downgrading of an OVS will increase the first and third term of the equation: fall in total surplus will be larger, and probability of crisis will be higher. For example, if the probability of crisis with the current budget is 0.20 (one crisis every 5 years), and maintaining unchanged the other terms of the expression, the impact of the OVS would be:

[A.12] Reduction in damage caused by crisis = $\Delta Srpls_i$ [0.38][0.18][20]

[A.13] Reduction in damage caused by crisis = $\Delta Srpls_i$ [1.368]

Thus, an increase in the budget of this “downgraded” OVS will have a considerably (1.368/.22 = 6.2 times) higher impact than a budgetary increase to a OVS with better performance levels.

Estimation of the impacts of sanitary crisis does not include costs for: (a) mortality and lower animal productivity (other than that considered in relation to TFP). (b) costs due to restrictions of animal movements, (c) increased sanitary costs, (d) costs of animal sacrifice and subsequent carcass disposal. Two justifications can be given for not including these costs here: (a) difficult or impossible generalization, each type of crisis generating a different magnitude for these costs, (b) the impact of OVS on TFP (already considered) takes into account several of these aspects.

VI.3 Impacts on Human Health

Estimations presented here are rudimentary. Zoonotic and food-borne diseases (Z&FBD) are directly proportional to human population and per-capita income. Per-capita income is used as a proxy for mortality, morbidity and other costs associated with illness. As a first approximation, a disease burden of 69 cases per 100.000 population is assumed (see Table 10). This figure results from adding disease occurrence from the WAHID-OIE database for Latin American countries. [13]

It is assumed that for every reported case other 10 cases go unreported. Ths would increase the burden of disease to 760/100.000. This divergence between reported and not reported cases is smaller than what is mentioned in some literature.

[13] See OIE: http://www.oie.int/wahid-prod/public.php?page=country_zoonoses&year=2005

It is assumed that each case results in an economic loss of 1/52 of per-capita income: one week of individual production. Obviously, the impacts of Z&FBD varies widely: from minor sickness such as diarrhea to death. The assumption used here is probably “conservative”. It is also assumed that an increase in the OVS budget reduces, but does not eliminate, health costs produced by Z&FBD. The “reduction coefficient” used here is 0.30: that is, total damage caused by Z&FBD will be reduced in 30 percent as a consequence of higher OVS budget.

The previous assumptions are loosely based on a review of the literature. Subsequent investigations should allow better estimates to be derived. There is a long road ahead.

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