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The Building Block Simulation Approach to Program Assessment: The Case of Agriculture Canada's Meat Hygiene Program, 1970-1984

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The Issue

For many decades a major emphasis in public policy has been the assurance of food safety and security. Measurement of the economic returns to these programs is often difficult and challenging. In many cases the difficulty in obtaining data and the sheer complexity of the issues make the use of traditional econometric and programming approaches impractical for assessing these activities.

Implications and Conclusions

This paper presents a summary of an innovative method for measuring benefits and costs of hard-to-assess programs and activities, such as those that deal with food safety, meat inspection and quality assurance. The building block approach described here for measuring benefits and costs was developed as an alternative method for measuring returns to meat inspection, agricultural grading, agricultural research and seed and seed potato quality assurance. The paper first describes the general nature of the approach and



then presents an assessment of Agriculture Canada's Meat Hygiene Program as a case example. The study showed an overall benefit-cost ratio for the Meat Hygiene Program of 10.3:1.

The Building Block Simulation Approach

The building block simulation approach is a comprehensive, common sense approach to estimating benefits and costs. It essentially involves identifying all the "ground level" impacts of a program, tracking and measuring them throughout the entire system and finally aggregating them as building blocks to develop an overall assessment. The approach consists of the following steps:

1. Thoroughly understanding what the component activities of the program are and what each accomplishes. This is important in establishing the overall conceptual framework and capturing all of the benefits and costs. This step involves carefully assessing the mandate of the program, reviewing relevant literature and interviewing both key people involved with the program and those familiar with its effects.
2. Identifying critical impact points where key changes may occur because of the program. These points may be at the level of producers, different groups of consumers, or exports and imports. They may involve the use of new technology and other changes in behaviour and practices at each impact point.
3. Identifying how each program activity changes or maintains what happens in the industry. For example, with the Meat Hygiene Program, it could mean producers withhold sick animals instead of selling them and consumers eat more meat because it is safer to eat.
4. Identifying impact indicators of each outcome, such as increased production efficiency, improved human health, improved efficiency in marketing, expanded demand, etc.
5. Identifying "per unit" measurements of outcomes for quantifying results. These measurements may include cost savings per unit of production, net value added per unit of sales, costs per unit of sickness, and reduced days of lost work.
6. Identifying changes in volume measurements, such as increased production and consumption of meat, exports or retail sales.
7. Measuring overall outcomes as the mathematical product of per unit impact coefficients X volume coefficients. For example, the impact of increased bacterial infection without the Meat Hygiene Program in place may be represented by

- i) the average cost per case of food poisoning, X
 - ii) the increased rate of food poisoning without the Meat Hygiene Program per kilogram of meat consumed, X
 - iii) the decreased rate (kg) of meat consumption due to reduced demand because of increased risk of food poisoning.
8. Measuring all costs associated with the identified impacts. These involve direct and indirect costs of the program (including the minister's office and public buildings), related costs from other contributors, industry compliance costs, and offsetting recoverable revenues.
 9. Calculating both benefits and costs over time, discounting back to a common base year and calculating a ratio of benefits to costs.

The building block approach may need to utilize a customized approach for each activity, as no single approach will work for every program component. In some cases, direct measurement of benefits may be possible, but most of the time calculation of the benefits depends on assessing what would have happened if the program activities had not been in place. In these cases, it is often necessary to estimate what would have happened without the program to provide a “with and without” comparison. Benefits therefore may not only indicate improved conditions, but also may include the maintenance of current conditions that would have deteriorated in the absence of the activity. Expert opinion may be necessary to estimate the potential “without” scenario, as concrete evidence exists only for what has actually happened.

This approach is not an exact science, as no one can be sure to have estimated all the benefits correctly, especially in constructing the “without” scenario. Nevertheless, it is important to recognize that “no measurement” is not an option and that the task is to do the best job possible – i.e., good estimates are better than no measurements. The test of the measurement in turn often is not the number itself, but whether the approach has followed a comprehensive and detailed method based on common sense and realistic indicators. The key test therefore is the acceptability of the method and measurement, i.e., how well you can justify your measurements as reasonable and appropriate.

Case Study of Agriculture Canada's Meat Hygiene (Inspection) Program

Overview of the Study

The assessment of Agriculture Canada's Meat Hygiene Program originally was undertaken for the federal government in 1986 (Brinkman et al., 1986). It is summarized here both to provide a description of the method and to provide a benchmark for returns to a food safety program. The framework used in the study for measuring the benefits and costs of the program was to evaluate the different impacts throughout the food system that

would occur over the 1970 to 1984 period with and without government meat hygiene activities, but with the possible emergence of some private-sector meat packer quality control activities to promote private branded products. The assessment of the “without” scenario was based on the assumption that public meat hygiene activities had never been undertaken, rather than on the assumption that ongoing meat hygiene activities stopped in 1970.

Understanding the Scope of Meat Hygiene Activities

At the time of the study, meat hygiene activities were undertaken by Agriculture Canada’s Meat Hygiene Division, Veterinary Inspection Directorate, Animal Pathology Division and Animal Health Division. These units were involved in activities associated with veterinary anti-mortem and post-mortem inspection, the humane slaughter of animals, detection of biologic residues, inspection on sanitation, destruction of diseased material, proper labelling and control of ingredients permitted in meat products. Agriculture Canada’s activities also involved certification of meat and meat food products for export, inspection of imports, prevention of foreign diseases and eradication and control of all livestock diseases. In addition, Health and Welfare was involved in setting tolerance levels for drugs, additives and contaminants, as well as control of diseases that can be spread to humans either from live animals or meat.

Critical Impact Points

Based on the meat hygiene activities described above, extensive interviews of public and private participants in the Canadian meat industry, and elaborate assessments of reports/literature, eight critical impact points were identified. These points are summarized in figure 1. Changes in the practices of producers and packers were identified as initial critical impact points, which in turn would be likely to cause changes in meat quality and consumer health. Changes in meat quality, fraud, spoilage and health risk were in turn identified as causing changes in domestic demand, export sales and imports. Finally, changes in demand and export sales affect the volume of operations at the producer, packer and retail levels.

Impacts, Outcomes and Impact Indicators

This section briefly summarizes the key changes in practices, meat quality, and product volumes estimated to occur in the *absence* of the Meat Hygiene Program. In the original study, each item is individually assessed in much more detail. The key changes involve

1. Changes in producer practices to: send sick animals to market rather than treat them, feed more additives and hormones and disregard recommended withdrawal periods for drugs. In addition, producers would market more hogs as virgin boars, since these animals exhibit higher feed efficiency than barrows. Undetected virgin boars, on the other hand, may create meat with “boar taint” which would eventually reduce demand for pork.

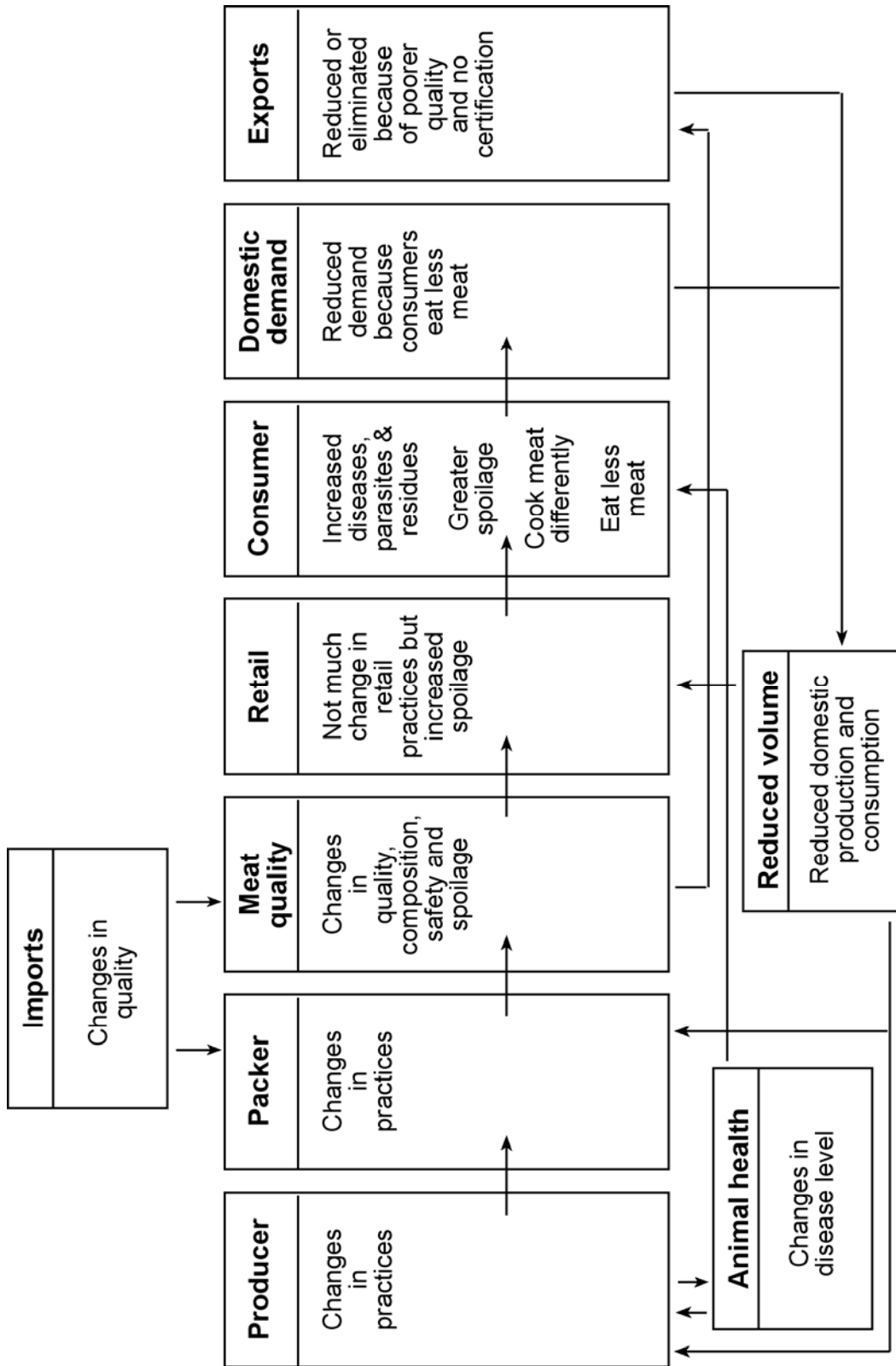


Figure 1 Critical impact points: the integrated effect throughout the food system of no meat hygiene program

2. Changes in the packer slaughtering and handling practices to: more washing of contaminated meat instead of trimming, less use of hot water for cleansing and greater acceptance of poor quality or condemnable carcasses for processing.
3. A reduction in meat quality through an increase of bacteria and residue levels to five times present levels, inferior quality meat in processed products, more fat and fillers in processed products, and an increase in spoilage by 2 percent of total product.
4. An increase in fraudulent practices such as mislabelling, misrepresenting products, overextending non-meat components in processed products, etc.
5. An increase in human health risk to 2.5 times the present incidence for food poisoning, 2.5 times the present incidence for trichinosis, and 5.0 times that for cancer, with large increases of beef tapeworm and human infection of tuberculosis and brucellosis from cattle.
6. The development of a bipolar meat system consisting of private branded product with strict quality control on the one hand and a less controlled system with poor quality and high health risk on the other. This would result in increased health risk overall and decreased meat consumption.
7. A decrease in domestic consumption of meat to 75 percent of historic levels in 1970, increasing slightly with growing imports of safer foreign meat to 80 percent in 1984.
8. Complete loss of exports of meat because of lack of proper testing and export certification.
9. Likely loss of live animal exports for slaughter because of unacceptable residues and hormones, with livestock exports consisting primarily of calves for feeding in the United States since these animals could be fed long enough to meet proper withdrawal periods for drugs, etc.
10. Changes in the levels of domestic production to 71.75 percent of historic domestic demand in 1970, decreasing with rising imports to 68 percent in 1984.
11. Packer volumes declining to the level of domestic production for domestic consumption.
12. Retail volume declining to the reduced level of domestic demand.

Quantifying Impacts

In the original report, detailed calculations are provided for 19 different measurements of benefits and 7 different components of costs. These measurements and components are briefly summarized here with several examples to illustrate the procedures used.

Producer-level Benefits

Producer benefits from the Meat Hygiene Program were calculated as increased value added¹ in production, changes in feed efficiency from marketing regulations and restrictions on additives, and improved animal health. The value added in production was measured as the difference between the value added from livestock production and the value added from only using the feed as grain for export, multiplied by the decrease in livestock units produced in the absence of meat hygiene each year.

Measurements of changes in feed efficiency were based on changes in practices in the absence of the Meat Hygiene Program to use more hormones in beef production and to market more hogs as virgin boars to improve feed efficiency. For this component, therefore, meat hygiene regulations would produce a negative benefit. For cattle we estimated that up to 50 percent of cattle would be fed hormones, with a 10 percent increase in feed efficiency, resulting in an average 5 percent decrease in feed efficiency with the Meat Hygiene Program. We also estimated that one-eighth of all market hogs would be marketed as virgin boars, which would have an average 8 percent better feed efficiency than barrows. This would result in an average decrease in feed efficiency with the Meat Hygiene Program of 1 percent. In addition, we estimated that the raising of more boars would have increased the genetic pool, resulting in increased feed efficiency over time of 0.5 percent per year beginning in 1970 and increasing to 7.5 percent by 1984.

Measurements of general improved herd health benefits for beef, swine and turkeys were based on improved general feed efficiency of 0.5 percent per year from information feedback on animal health through meat hygiene activities. Benefits for controlling tuberculosis were based on a 4.5 percent infection rate without meat inspection (a situation that existed in the twenties and thirties), and a share of prevention due to meat hygiene activities of 40 percent for beef cattle and 10 percent for dairy cattle. An estimate of the cost per case of tuberculosis was obtained from the literature (Management Consulting Services, 1979) and applied after adjustments for inflation to determine an annual benefit. A similar procedure was used for benefits from brucellosis, based on an estimated 1940s infection rate of 10 percent and a 15 percent share of prevention due to the Meat Hygiene Program.

Packer/Processor-level Benefits

The benefits from meat hygiene activities at the packer/processor level were based on the increased volume of throughput that would be possible because of greater domestic demand and exports of meat products. The change in volume was estimated as the increase in domestic consumption from the 75 to 80 percent level estimated without the program to the actual level with meat inspection, plus the current level of exports, which would have been totally lost without certification. We estimated that the *net* benefits would be only 50 percent of the increased value added from meat processing, however,

since much of the reduced meat consumption in the absence of the program would be made up by greater consumption of legumes, breads, pastas, potatoes, and eggs, which would contribute a substitute but lower level of value added.

Retail-level Benefits

The benefits at the retail level were also based on the increased sales of meat products (for domestic consumption only) due to the Meat Hygiene Program. Since the markup for meat products is typically greater than for other products, higher sales of meat products generate greater benefits. From discussions with grocery personnel, it was estimated that the net increase in sales markup was 57.5 percent. This figure was further multiplied by 85 percent to account for expenditures on advertising, hydro, and packaging, and then applied to the average retail markup revenue from the increased volume of consumption due to the Meat Hygiene Program.

Benefits from Reduced Spoilage

We estimated that the spoilage of meat throughout the food chain (from packer to consumer) would be reduced by 2 percent with the Meat Hygiene Program because of a lower level of bacterial contamination. The benefits from reduced spoilage were calculated as 2 percent of the total volume of meat consumed, valued at the average of the wholesale and retail price/kg per year.

Benefits from Fraud Reduction

The benefits from the inspection of labels and product composition under the Meat Hygiene Program are more likely to occur from the prevention of alteration of processed products (by adding extra fat or other fillers) than as human health benefits. Based on extensive interviews and evidence of altered products even with the Meat Hygiene Program, it was estimated that the protein level in processed products would be reduced from 11 percent protein to 10 percent protein, with a resulting overcharge for value of 6 percent. We therefore estimated the benefits of fraud reduction from the Meat Hygiene Program as 6 percent of the wholesale value of processed meat products (75 percent of pork and 25 percent of beef and poultry) consumed each year.

Human Health Benefits

Human health benefits were calculated for the reduction in diseases directly transferred from animals (tuberculosis and brucellosis), parasites (beef tapeworm and trichinosis), residues causing cancer, and food poisoning. The increase in the incidence of disease (per kg of meat consumed or contact with animal) that would have occurred in the absence of the Meat Hygiene Program was first estimated. The new infection level (per kg of meat consumed) was then multiplied by the level of consumption or contact occurring in the absence of the Meat Hygiene Program. Net benefits were then calculated by

multiplying the net increase in disease cases (without the program) by the average cost per case derived from the literature.

The costs of reduced human health without the Meat Hygiene Program included hospitalization and medical costs, physician costs, loss of productive output, loss of leisure (when specified), and value of life. The latter cost was based on the modified-human-capital/willingness-to-pay-to-avoid-death approach of Landefeld and Sisken (1986). None of the costs included charges for pain and suffering, willingness to pay to avoid sickness, or travel time for health care; therefore, the true overall social costs were likely underestimated.

Measurement of Costs

The costs of the overall Meat Hygiene Program were calculated as Agriculture Canada's program costs for the National Inspection Service and Foreign and Import Inspection, plus 12 percent for overhead costs for building rental and a share of the expenses for the operation of the minister's office. Agriculture Canada's Animal Pathology Meat Safety Program expenditures were also included because these activities provide diagnostic services and research and development for improved meat safety. In addition, provincial inspection costs were estimated at 7.5 percent of the federal costs including overhead. Finally, additional costs for industry compliance and meat carcass salvage were included as well. Industry compliance costs represent costs for practices required by industry in excess of what industry reported as "normal" business practices. These costs included overtime inspections, physical changes to facilities, additional hot water and refrigeration expenses, loss of yield from trimming meat instead of washing (if contact was made with the ground), additional labour charges and labelling charges. Meat carcass salvage was included to account for carcasses condemned under the Meat Hygiene Program that would be marketed without the program, even though their use throughout the food system might lead to reductions in consumer demand. Meat carcass salvage values were estimated as one-third of the value per red meat carcass and one-half the value per poultry carcass, multiplied by the number of condemned carcasses per year.

Overall Benefits and Costs

The benefits from the Meat Hygiene Program are large and are widely distributed throughout the economy. The cumulative benefits over the 1970 to 1984 period are shown in table 1.

The aggregate benefits were calculated with and without the impact of domestic fraud benefits because these benefits represent income transfers from consumers to processors rather than net benefits and do not contribute to a net increase in overall benefits within Canada. Fraud-reduction benefits from foreign sources, on the other hand, are treated as net benefits to Canada because these payments would have been made to processors

Table 1 Cumulative Benefits from the Meat Hygiene Program, 1970-1984
(Constant 1974 Dollars)

Producer-level benefits	
Value added in production	\$ 7,329,335,000
Decreased feed efficiency from restrictions	
Beef cattle (fewer hormones with M.H.)	(869,216,000)
Swine (raising barrows instead of virgin boars)	(402,819,000)
Improved herd health	
Cattle	
general	86,922,000
tuberculosis	782,606,000
brucellosis	472,554,000
Swine	
general	84,007,000
Turkeys	
airsacculitis	6,222,000
Total production benefits	\$ 7,489,831,000
Processing net value added	4,169,204,000
Retail net value added	6,102,149,000
Reduced spoilage	1,556,505,000
Reduced fraud	2,179,051,000
Human health	
tuberculosis	2,302,032,000
brucellosis	30,424,000
beef tapeworm	39,787,000
trichinosis	5,525,000
residues/cancer	116,949,000
general food poisoning	721,717,000
botulism	15,675,000
Total human health	\$ 3,216,334,000
Aggregate total	24,713,074,000
Minus transfer benefits from domestic fraud	- 2,061,804,000
Aggregate net benefits	\$ 22,651,270,000

outside of Canada. Overall, the aggregate net benefits from the Meat Hygiene Program and related activities over the 1970 to 1984 period amounted to \$22.7 billion in 1984 constant dollars, excluding domestic fraud benefits.

It also should be noted that the producer, packer and retail benefits are net value added, not profits, and are distributed widely as salary and wages, capital returns and product sales.

Table 2 Cumulative Costs of the Meat Hygiene Program, 1970-1984
(Constant 1984 Dollars)

Agriculture Canada Meat Hygiene Program	\$ 781,635,000
Meat Hygiene Program overhead	93,796,000
Red-meat packer compliance costs	781,548,000
Poultry packer compliance costs	238,288,000
Meat value from carcasses that would be salvaged with no program	158,662,000
Provincial government meat inspection	65,657,000
Animal pathology meat safety	31,936,000
Aggregate total	\$ 2,151,522,000

Table 2 shows the cumulative costs over the 1970 to 1984 period.

The annual total benefits compounded to 1984 values by a 2.0 percent real rate of discount were divided by the annual total costs compounded to 1984 values to generate the ratio of benefits to costs of 10.3. At alternative real discount rates of 5.0 percent and 10.0 percent, the ratios of benefits to costs were 10.1 and 9.6, respectively. These high benefit-to-cost ratios indicate that government meat inspection has been a very good use of public funds.

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Endnotes

- ¹ Value added was chosen instead of profits for the measurement of benefits, since it represents the net contribution to all economic activity by all factors of production. In addition to profits, value added includes payments to labour, interest, depreciation and taxes, as these components represent returns throughout the economy, even though they may be considered as costs to the individual firm.