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A recent outbreak of Rift Valley Fever in East Africa has led to an export ban by Saudi Arabia and other Gulf countries on livestock products from Ethiopia. An evaluation of the costs of the ban on Ethiopia's main exporting region (Somali) and their distribution among different types of households, producers and traders is conducted using a CGE model. Investment strategies to regain access to the Gulf market and reduce the probability of future bans are also evaluated. Results show that Somali's GDP is reduced by 36 percent as a consequence of the ban. In addition, poor and better off producers experience total losses in value added of around 50 percent of their respective levels in a normal year. The evaluation of an animal health program to minimize the impact of future bans shows that it increases welfare and benefits poor livestock producers.

Introduction

Until 1998, several million sheep and goats were exported every year to Saudi Arabia from ports in Somalia, during a four-month period correlating with the Haj activities in Mecca. Pastoral populations in Ethiopia's southeastern lowlands depend heavily on livestock exports to Somalia for their livelihoods, most of which are re-exported to Saudi Arabia and other Gulf States. The trade has proceeded for many years, until an outbreak of Rift Valley fever (RVF) in the region of the Horn of Africa (Sudan, Kenya, Somalia, Eritrea, Ethiopia and Djibouti) prompted two consecutive bans by Saudi Arabian authorities in 1998 and 2000 (see Ahrens, 1998 and Aklilu, 2002) with dramatic consequences on the economies of the region.

RVF is an infection that causes abortions and mortality in sheep and goats, cattle and camels, and fever and acute infection in humans in whom a lower incidence of more serious symptoms occur including blindness and hemorrhaging. Most livestock are infected by mosquitoes, whereas most humans are infected either through handling, aborting animals or by slaughtering acutely affected animals. Signs of the disease in animals tend to be non-specific, making it difficult to recognize individual (clinical) cases of RVF. The simultaneous occurrence of numerous cases of abortion and disease in ruminants, together with disease of humans, following ecological and meteorological changes such as heavy and prolonged rainfall or in the presence of irrigation schemes, have been suggested as characteristic of RVF.

As a list A[1] disease among the OIE classification of contagious diseases being threats for international economy, RVF is a major stake for the establishment of non-tariff barriers. The ban on livestock imports from the Horn of Africa was apparently imposed for public health reasons because of concern that slaughter of RVF virus infected livestock could result in disease transmission to people attending the Haj. Exports resumed after 16 months of the imposition of the ban. Two years later, in September 2000, a new ban on imports of livestock from the Horn of Africa was imposed by Saudi Arabia, Yemen and the UAE following an unprecedented outbreak of Rift Valley Fever (RVF) in Saudi Arabia and Yemen that killed over 100 people. Although some of the importers in the Arabian Peninsula partially lifted the ban in 2001, the ban was still in place in 2003.

What are the implications of the ban for the Ethiopian economy? Looking at the official trade statistics, the magnitude of trade in livestock products is surprisingly low given the importance of the livestock sector in the economy suggesting that efforts invested in solving this problem would not be justified. Table 1 presents the composition of Ethiopian exports showing that exports of meat and live animals represent only a small fraction of total exports. Exports of live animals are also insignificant in total value: sheep exports in the peak year of 1997 before the imposition of the ban amounted to a total of approximately 1.6 million dollars. However, the official statistics on livestock trade are misleading. The bulk of livestock exports from Ethiopia occur as illegal trade and come from the eastern and southeastern lowlands, mainly from the Somali region, a vast and underdeveloped region with ethnic and economic links with neighboring Somalia (see Appendix A for a map of Ethiopian regions).

Livestock exports played a central role in the transformation of the Somali pastoralist society from a subsistence to a livestock oriented market economy where the marketing of livestock allowed both cash earnings and the inflow of food- and non-food consumer goods from far away. With a predominantly nomadic population of nearly 3.5 million, only 15 per cent live in so called urban centers and an estimated 90 per cent derive their livelihood from pastoralism and animal related activities (Ahrens, 1998), Somali Region is the Ethiopia region with the largest stock of sheep and goats.

Most livestock exports from the Somali Region pass through ports in Somaliland and Somalia. FEWS report (1998) divides the Somali Region into a set of livestock market sheds, defined in terms of the destination markets through which exports occur (figure 1). The main port of livestock exports for the Northwestern part of Ethiopia's Somali Region is Berbera in Somaliland with Hargeisa being the main transit center. Other ports in the region are Bosasso in the northeast and Kismayo in the south.

[1] World Organization for Animal Health (OIE) classification of diseases, List A: Transmissible diseases that have the potential for very serious and rapid spread, irrespective of national borders, that are of serious socio-economic or public health consequence and that are of major importance in the international trade of animals and animal products.

Figure 2 compares official data on exports with estimates of exports of live animals from the Somali ports of Berbera and Bosasso between 1993 and 1997. Exports increased from 650 thousand animals in 1993 to 1.4 million animals in 1997. However, the estimates of the number of animals exported vary considerably. While FEWS (1998) estimates total animal exports through Berbera in 1996 at about 1.3 million animals (figure 2), Ahrens (1998) refers to a "Somaliland Two Year Development Plan" which lists for the same year and the same port 2,480,090 animals (2,372,656 sheep and goats; 64,606 cattle; 42,828 camels) at a total export value of US$155.6 million. Ahrens' report for the UN refers also to livestock-traders in the small town of Hartishek, a major hub for trade in the region, estimating the number of animals exported through Berbera port to be "two to three million in a normal year". For the year 1997 the "Development Plan" referred above by Ahrens, extrapolates to a total of 2,857,468 animals. The same UN report also refers to other sources establishing that Somaliland's total turnover for the year 1996, including also minor ports was 3.6 million heads and in 1997 more than 2.7 million heads were exported to Saudi Arabia and the Emirates. Somaliland's annual earnings from livestock are estimated over $ 200 million every year (more than Ethiopian coffee exports in 2001).

According to Ahrens (1998), of the livestock exported annually through Berbera port, between 60 per cent (according to "Somaliland" sources) and 80 per cent (Ethiopian sources) are of Ethiopian origin. Berbera is Somali Region's main outlet for livestock exports, which is one day's sail closer to Saudi Arabia than the alternative port, Bosasso. Prices paid for animals in the latter port are also lower than in Berbera due to the greater distance from importing markets. Livestock from the south of the Somali Region headed historically to Mogadishu but during the civil war they were diverted to Bosasso. Livestock from Moyale are mainly delivered to slaughterhouses in Nairobi (FEWS, 1998). The majority of animals sold for export, mainly to Saudi Arabia, are males of the "Somali black head" or "fat-tailed sheep", followed by male goats, male cattle and young male camels, which are imported mainly for meat (Ahrens, 1998).

The links between the informal economy of the Somali Region and other regions in Ethiopia are tenuous. We identified three major areas of exchange between Somali Region and other Ethiopian Regions: trade of chat, coffee and grain coming from the highlands into Somali; bullocks, draught animals and contraband consumption goods (electronics and others) from Somali to the Highlands; and potentially, livestock moved from other regions to Somali to be exported. There is no information on trade flows of these commodities however, there is evidence showing that purchases from the region are mainly from abroad (with the exception of chat that comes from Ethiopian highlands).

Measuring the cost of the ban on livestock exports from this region is the first step to find if there is justification to comply with the costs of developing an animal health program that would allow a regular export flow between the Somali region and the Gulf countries. If this is the case, there could be opportunities to "formalize" this informal economy, contributing to its integration with the rest of the country. It could also give an opportunity to the Central Government of Ethiopia to play a central part in the

development and the stabilization of an insecure region while sharing the benefits of growing exports of live animals and livestock products.

The rest of the article is organized as follows. First, information used to build a Social Accounting Matrix that determines the main economic relationships within the region is presented. Next, the structure of the CGE model used and results from simulations are presented. Based on the estimated costs of the ban using the CGE simulation, incremental costs and benefits associated with a proposed health program to reduce the damage of future bans are analyzed and different alternatives for its implementation are evaluated. The last section summarizes findings and concludes.

Data: A social Accounting Matrix for the Somali Region of Ethiopia

Measuring the impact of the ban on imports from Ethiopian Somali Region is a difficult task given the informal nature of the region's economy and the absence of official records. On the other hand, the fact that the Somali Region is a very simple agricultural economy allows us to model its core structure and approximate estimates of the cost of the ban on exports. We do this using information from reports and studies conducted in the region mainly by Save the Children Fund (SCF-UK)[2] and UN missions, information from the Regional Office of Population of the Somali Regional State (SNRS), the Central Statistical Authority of Ethiopia (CSA) and data from a survey conducted in Somali as part of this study. Figure 3 presents a simplified diagram of the economic model developed in this study, highlighting the main agents and economic flows in the model. We use this diagram to present the main characteristics of the Somali economy and the information used to define the different components of the model. We end this section formalizing the model in figure 3 in the form of a Social Accounting Matrix for the Somali Region of Ethiopia.

Looking at the diagram in figure 3, we start describing the activities or the entities that carry out production in this economy. The agricultural activities defined in our model are: pastoralists, agro-pastoralists and sedentary farmers, each of these divided into "poor", "middle" and "better-off" making a total of 9 agricultural activities. Trading and services are the non-agricultural activities. Livestock, livestock products (milk) and grain are the commodities produced by the agricultural activities. The non-agricultural activities produce a trade and a service commodity. Activities use inputs, labor and capital to produce commodities (output). These commodities have two main destinations: they can be consumed directly by households or they can be sold in the market. The destination of these commodities is final consumption by households, intermediate use by activities as inputs (not shown in the diagram), or the rest of the world" (ROW) as exports. At different levels of the marketing process, the agents pay taxes that are collected by the Government.

[2] We use the reference SCF-UK along this paper to refer to several reports undertaken by Save the Children Fund (UK) as part of a Household Food Economy Analysis in the Somali region. See Reference section for more details.

To determine production and sales in agricultural activities we use two sources of information. Total animal stock is obtained from SNRS (2003). Using information from SCF-UK, we are able to allocate animal stock, between households. The same SCF-UK reports allow us to determine animal sales by species and consumption of animal products, by different households. According to SNRS the total population of livestock in the region is 8,467,000 LU, which include 3,746,000 cattle, 9,053,000 sheep, 8,547,000 goats, 213,000 donkeys and 2,032,000 camels. Cattle and camel are mainly kept to provide milk for family consumption while small ruminants are mainly kept as a source of cash and capital deposit.

To estimate animal holdings per type of activity we use information from SCF-UK on average stock composition, annual sales of different species and quality of different animals sold by each household type. A poor pastoralist owns 42 shoats, 5 cattle and 3 camels, and sells 6 shoats and eventually one cattle every two years and one camel every 10 years. A rich pastoralist on the other hand, owns on average 168 shoats, 29 cattle and 28 camels and sells more than 20 shoats and 0.8 camels per year, but would also sell one head of cattle every two years. Better-off pastoralists sell a greater proportion of quality animals than poor pastoralists. These are estimated average numbers for Somali region, with the composition of species varying between zones depending on agro-ecological conditions.

According to our estimates, approximately 2.4 million shoats, 0.17 million cattle and 0.04 million camels are sold each year by local producers in Somali region. This numbers represent 14 percent of total stock of shoats, and 4 percent and 2 percent of cattle and camel inventory respectively. The total number of export quality shoats estimated in this way is below 1.5 million. Total exports to Arab countries resulting from our estimates account for 1.3 million shoats 37 thousand cattle and 12 thousand camels, which represent 46 percent of total animal sales in value terms. The value of total animal sales amounts to $92 million in a normal year. Of this total amount, $22 million are sold domestically and $70 million are exported to other regions and countries. The total value of exports to Arab countries is $42 million, 46 percent of total value of animal sales or 60 percent of total value of exports, with exports including sales to Ethiopian Highlands. It also represents 10 percent of total household income in the region.

Households are the consumption units in this economy, they are the owners of capital and labor and they earn factor incomes, which they receive from the activities. The activity captures the production component of this unit, while the household models the consumption component receiving income from the activity. Activities provide households with commodities that are not transacted in the market (home consumption of produced goods by the household). They also receive transfers from the Government and remittances from the rest of the World. Households use this income to purchase commodities, make transfers to other households or to the rest of the World or to save (not represented in the diagram). Total demand is satisfied by domestic production from the activities and by imports. Grain, other food and non-food commodities are main imports in the Somali region. While grain is also produced in the region, the other two

groups of commodities are not and so Somali region depends totally on imports to satisfy domestic demand.

Rural households in our model correspond directly to an activity. So for instance, we define a “poor pastoralist” activity and a “poor pastoralist household”. The model includes a total of 12 households: pastoralists, agropastoralists, sedentary farmers and urban households each divided in three wealth categories. Wealth categories among pastoralists are determined by livestock ownership. The main determinants of wealth for sedentary farmers are oxen, labor and area of land cultivated. Information to classify urban households in wealth categories is obtained from the Report on the 1999/2000 Household, Income, Consumption and Expenditure Survey of the Central Statistical Authority of Ethiopia, which contains information on expenditure and income sources by expenditure group.

Average income per capita varies for different households from less than $60 per year for the poor rural households to 160 in the case of better-off pastoralists. Urban incomes are higher on average than rural incomes in all categories. Rural households consume their own production, mainly milk and ghee in the case of pastoralists, milk, ghee and grain in the case of agro-pastoralists and sedentary farmers. The importance of own livestock products (milk, ghee and meat) as a source of food increases with wealth. Milk is the main product produced and consumed by pastoralists while meat consumption usually takes place on special occasions and holidays. All wealth groups purchase food to make up the majority of their food needs but purchase requirements tend to decrease as wealth increases, with the ‘better off’ relying least on the market for food (SCF-UK, 2003). All pastoralists and poor agro-pastoralists and sedentary farmers purchase grain as staple food. This is complemented by purchases of other food, mainly sugar, oil, and tea. Purchases of grain and sugar take more than 50 percent of total purchases by poor pastoralists, while better off households spend from one quarter to a third of their income on these staple goods. Non-food items normally include clothes and other essential goods for the family. Urban households staple food are grain and livestock products as is the case for rural households. The middle and the better-off urban households have access to more diversified food and non-food items.

Livestock sales are the most important income source for all wealth rural groups. Sales of livestock products also appear as important sources of income for the ‘poor’ and ‘middle’ pastoralists and also for agro-pastoralists and sedentary farmers. In general, the poorer groups need to diversify their sources of income so they engage in more income-generating activities than the ‘middle’ and ‘better off’ groups, such us petty trade (sales of bush products like firewood and charcoal), and labor exchange like assisting caravans transporting contraband goods, leading pack camels to neighboring countries, self employment like renting an own pack camel to transfer goods, etc. Remittances are also received from relatives working outside the region (SCF-UK). In some regions, better-off households take children from poor households to do herding and other types of work. Gifts in kind from better-off households are another source of income for poor households in the region. Better-off households can obtain rents from property in towns.

Finally, households receive transfer from the Government and transfers and gifts from other households.

ROW in our analysis is defined as the “rest of the World” and the “rest of the country,” mainly Ethiopian Highlands, Somalia, Djibouti, Kenya and the Arab countries. Imports to Somali region are defined as the difference between demand and supply of the different commodities. A total of 223 thousand tons of imported grain are needed to complement the 386 thousand tons produced in the region in order to satisfy domestic demand. Other food and non-food goods are not produced in the region so total demand for these goods is satisfied with imports from neighboring countries and the Highlands. The total value of imports is $67 and $127 million in the case of other food and non-food products respectively. The difference is balanced by Central Government transfers, paying for local Government deficits and resulting in an inflow of money from outside the region.

We relate trade flows with trade and transportation costs (transaction costs). Domestic transaction costs represent the costs of moving the commodity from the producer to the domestic demander. For imports it represents the cost of moving the commodity from the border t the domestic demander, while for exports, it is the cost of moving the commodity from the producer to the border. In the case of livestock exports transaction costs include costs of trekking, feed and water, and vaccination and trucking in the case of animals going to Arab countries. Domestic movement of animals is estimated including only trekking and lower costs of feed and water assuming movements over shorter distances. Commodities other than livestock are charged with a marketing margin calculated as proportion of the total value of the commodity traded. A trade commodity is defined in our model with total value equal to the sum of all transaction costs. Thus, the sum of transaction costs equals total output of the trade and transport sector.

The Government in our model pays transfers to households, collect taxes and purchase goods. Purchases of services by the Government are defined to balance the service sector, which together with the trade sector is the main source of income for the urban households. There is no official information available on tax collection in Somali region. According to the UN report (1998) the regional government collects taxes on livestock sales in local municipal markets. There is an export tax collected only by "Somaliland". According to information gathered by the UN (1998) from Ethiopian-Somali livestock traders and brokers, export fees in Berbera are, per head of sheep and goats US$3.50, cattle US$18 and per camel US$35. We assume that the Central Government covers the local Government deficits by transfers from outside the region.

The final output is a Social Accounting Matrix (SAM) for the Somali region. A SAM is a comprehensive economy wide data framework representing the economy (see Reinert and Roland-Holst, 1997; Lögfren, Harris and Robinson, 2001, and Robinson, Cattaneo, and El-Said, 1998 as part of an extensive literature). Technically, a SAM is a square matrix in which each account is represented by a row and a column. The incomes of an account appear along its row, its expenditures along its column. Each cell shows the

payment from the account of its column to the account of its row. The underlying principle of double-entry accounting requires that, for each account in the SAM, total revenue equals total expenditure (row total equals column total). The information collected from different sources does not comply with the SAM requirement of balanced rows and columns. We balanced the SAM using non-linear programming developed by Zenios, Drud and Mulvey (1986).

The main characteristics of the Somali region economy are summarized in a macroeconomic SAM (table 3). This macro SAM has nine accounting categories: Activities, Commodities, Taxes, Factors, Households, Government, Rest of the World and Savings-Investment. Activities sell commodities in the market for a value of $345 million and transfer commodities to the household for direct home consumption for a value of $103 million. Adding up these two values (row total) we obtain the value of all commodities produced ($478 million), which should be equal to the value of output (column total). Marketed commodities are purchased by activities as inputs ($82 million), by commodities that purchase a transport commodity that reflects transaction costs ($45 million), by households as final consumption ($287 million), by the Government ($112 million) and by the ROW (exports for $97 million). Total commodity value adds to $634 million. This should be equal to the column total which includes the value of commodities produced by activities (at producer price), plus transaction costs of selling those commodities, plus commodity taxes ($8 million), plus the value of imported commodities ($236 million). The row Taxes captures tax payments for commodity sales and the Tax column pays the total amount of taxes collected to the Government. Activities pay to the Factor's account for the use of capital and labor (Value Added, $366 million) and Factors transferred this amount to households. Government receives payments from the Tax account and transfers from ROW, and purchases commodities and pays transfers to households. ROW sells commodities to Somali region (imports), purchases commodities from Somali region (exports) and pays transfers to Households and Government. Finally, the Savings-Investment account receives payments from Households (savings) and pays to commodities (investments).

The macroeconomic SAM summarizes the microeconomic SAM developed for this study (table B.17 in Appendix B). The complete SAM has 40 accounts: 11 activities, 7 commodities, 3 transaction costs accounts, 2 factor accounts (labor and capital), 12 households, 2 tax accounts, Government, ROW and Savings-Investments accounts. This SAM provides the database for the empirical implementation of a general equilibrium model to analyze the impact of the ban on exports from the Somali region of Ethiopia.

Model structure

The trade implications of a ban on exports including the implications for different types of producers and households and the wider macroeconomic effects suggest the use of a general equilibrium approach (see McDonald and Roberts, 1998; Hubbard and Philippidis, 2001, Perry et al., 2003 (Chapter 5), and Hertel, 1990). Limitations in data availability also make a CGE approach convenient. Because of the lack of centralized

information from government agencies or other sources, we need to rely on information from diverse sources, which collect data for varied purposes. Social accounting matrices used by CGE models for their empirical structure can be used as the guideline to organize this information in a way compatible with the basic accounting identities of the economy. The need for all households to be in their budget; the fact that all firms exhaust their revenues on factor payments, taxes and transfers to households and that markets are in equilibrium provide a powerful check on the consistency of the data collected.

The SAM presented in the previous section is linked to the CGE model developed by Lögfren, Harris and Robinson (2001). The model follows the neoclassical-structuralist modeling tradition in Dervis, de Mello and Robinson (1982) and includes household consumption of non-marketed commodities, transaction costs for commodities that enter the market, and separation between producing activities and commodities that permits any activity to produce multiple commodities and any commodity to be produced by multiple activities. The model is fully developed and explained in the referred paper by Lögfren, Harris and Robinson. We describe here some of the features of the model that are relevant to our analysis.

In its mathematical form, the model is a system of simultaneous, non-linear equations, with the number of equations equal to the number of variables. Endogenous variables are most prices with the exception of export and import prices, quantities of commodities demanded and supplied including exported and imported commodities. Parameters of the model are defined using the specific information from the specific SAM and are used to benchmark the model to this original information.

The CGE model assumes that each producer (activity) maximizes profits subject to a production function that utilizes a Leontief function to determine the combination of inputs and value added. The latter is itself a CES function of primary factors whereas the aggregate intermediate inputs are assumed to have a Leontief relationship. The user can choose between alternative mechanisms for equilibrating supplies and demands in factor markets. The default closure assumes fixed factors, but factors can move between activities. Economy wide factor prices are free to vary to equilibrate factors demand and supply. Alternatively, it is possible to assume fixed factor prices and factor unemployment. With fixed factor prices, factor supply is endogenous and activities are free to hire any desired quantity. A third closure simulates segmented factor markets where factors are assumed to be activity-specific. With this closure, ach activity is forced to hire the observed, base-year factor quantity.

For a marketed output, the first stage in the model is to generate a domestic aggregate output from the output of different activities, assuming that commodities produced by different activities are imperfect substitutes. At the next stage aggregated domestic output is allocated between exports and domestic sales assuming imperfect transformability between exports and domestic sales. In the international markets, export demands are infinitely elastic at given world prices. If the commodity is not exported, total output is passed to the domestic market.

Domestic demand is made up of the sum of demands for household consumption, government consumption, investment, intermediate inputs and transaction inputs. When a commodity is imported and produced domestically (grain in our data), all domestic market demands are for a composite commodity made of imports and domestic output (Armington structure). Household consumption of both market and home commodities is allocated across different commodities according to Linear Expenditure System (LES) demand functions.

The model allows several rules for clearing the macroeconomic balances or how equilibrium is achieved in the balances for the government, the rest of the world and the savings investment account. In our analysis, we use a closure that combines fixed foreign savings, fixed real investment and fixed real government consumption. This closure avoids misleading welfare results that occur in a single-period-model when increases in foreign savings, decreases in investment and changes in government consumption could increase welfare, not capturing welfare losses in later periods. The model determines relative prices and the numeraire used is an aggregated consumer price.

Having described the main characteristics of the model, in the next section we present the different scenarios used to analyze the impact of the ban on livestock exports from Somali region.

Simulations and Results

Two scenarios are developed to capture different types of adjustment to the export ban. The first scenario is a short-run scenario where it is assumed that capital and labor are not mobile between activities, so the quantity of factors employed by each activity is fixed. The second scenario represents the medium-run where labor and capital are mobile but total supply of each factor is fixed. These different scenarios are determined by defining the closure that equilibrates factor markets, as explained in the previous section. In both scenarios, livestock export prices are shocked to cause exports of live animals to fall to the desired level.

To define the level of export reduction we go to table 4 where livestock sales are allocated between different destinations. The share of animal exports to Arab countries in total exports is 60 percent, and so, a shock reducing exports of live animals by 60 percent would be required. However, there is evidence that during the ban, animal exports from Somalia are not necessarily down to zero. The ban could be partially lifted, or lifted by some countries and not others. Sources in the region mention that even during the ban, animals were still exported from Somalia to Arab countries. Table 5 compares estimated Ethiopian shoats exports from the port of Berbera for the period 1995-1998. While in normal years the number of animals exported varies between 1.2 and 1.4 million heads, during the ban it drops to around 0.34 million or close to 30 percent of exports in a normal year. Taking this information into consideration, we allow exports during the ban period up to 30 percent of their level in a normal year. Applied to animal exports in table

4 this means a 42 percent reduction on total animal exports from Somali region in a normal year.

To measure the total cost of the ban we assume duration of the ban of 16 months, which is within the range of duration of bans in the past. In order to simulate the expected behavior of producers and households after the imposition of the ban we assume that the shock reducing exports from Somali region occurs in two stages. In the first stage total exports of live animals are reduced 15 percent (first 4 months of the ban) and producers cannot reallocate factors of production between activities. During this first period factors in each activity are fixed (short-run). In the second stage (medium-run), total livestock exports are reduced by 42 percent (last 12 months of the ban) but at this point producers react to the changes allocating resources according to the new situation. Movements of capital and labor between activities are allowed. The experiments are conducted independently, so possible interactions between both scenarios are neglected. The total impact of a 16-month ban results from adding up the effects of these two scenarios. The relative importance of the short-run and medium-run scenarios within the period of duration of the ban is defined ad hoc.

Macroeconomic impacts

Table 6 shows the impact of the ban on different macroeconomic variables. As expected, the ban has a devastating effect on Somali's economy. GDP is reduced by $135 million in nominal terms, which represents a 36 percent reduction compared to a normal year. Absorption is also significantly affected, reducing its value by $101 million. Private consumption falls by almost $60 million. Almost in all cases, losses in the short run amount to similar values than losses in the medium run, even though the short run extends for only four months compared to 12 months for the impact of the ban in the medium run.

Comparing nominal and real values for the different variables, we verify the extent to which the ban affects prices in the region. Real GDP, or equivalently the difference in total real absorption between the base and the ban cases[3] falls by $1.5 million in the short-run. Losses increase to $10.1 million in the medium-run to give a total of approximately $12 million for the 16-month period of the ban. This means that the ban reduces output in the Somali region by approximately 3 percent.

The use of macro indicators to measure the economic impact of the ban is useful as a general indication of the aggregate effects in the economy of the region, but at the same time, it does not allow to capture the differential effects of the ban on producers and households, a key aspect when defining policies to tackle the problem. We now proceed to analyze the impact of the ban at the microeconomic level, focusing on producers and households in the Somali region.

[3] Government consumption and investment are kept constant by the macro closure used in the model.

Activities

At the micro level, we measure the impact of the ban on different types of producers and consumers. Table 7 shows changes in output, input and value added prices and total impact of the ban on producers in the short-run measured as the difference in total factor income between the base and the ban scenarios[4]. Pastoralists and traders are the most affected by the ban, with reductions in factor income that go from 50 percent of income obtained in a normal year in the case of poor pastoralists to 122 percent for traders. Activities in services experience factor income losses of 19 percent. Agro-pastoralists are relatively less affected by the ban with modest reductions in factor income going from –17 percent to –8 percent. Sedentary farmers are not affected or only experience small losses. Given that in the short-run factors of production are not mobile, these results are explained by price changes. Activity prices for pastoralists, the activity most dependent on livestock sales, are reduced almost by half. The ratio aggregate input price/activity price increases for all pastoralists from 1 in a normal year to more than 1.7. The results for other activities are less dramatic, with reduction in per unit activity revenue of less than 20 percent and reduction of the input/output price ratio in most cases. The results for traders are explained by a sharp reduction in per unit activity revenue.

The medium-run impact of the ban for agricultural producers and services in the Somali Region is shown in table 8. Pastoralists and traders reduce losses compared with the short-run results but they still suffer sharp reductions in their revenues. The increased grain supply impacts negatively on sedentary farmers increasing Value Added losses from 8 to 23 percent in better-off farmers and from 1 to 11 percent in middle farmers. Although poor producers are relatively less affected by the ban, the consequences of the ban on poverty and on the livelihoods of poor producers are very significant with a 39 and a 50 percent reduction in value added in the case of poor and middle pastoralists respectively, a significant part of total population in the region. The increase in value added generated by agro-pastoralists reflects the fact that in the medium-run, pastoralists reallocate their factors of production increasing grain production and reducing the production of live animals for sale as a strategy to cope with the relative increase in the price of grain.

To understand aggregate changes in activity level and economic impacts of the ban on the different activities we need to look at supply and price changes in the individual commodities (figure 4). In the short-run after the imposition of the ban, livestock prices plunge to 57 percent of their level in a normal year (figure 4a). In order to cope with a shrinking income, households substitute away non-basic imported goods, now more expensive as a consequence of the deterioration of the region's terms of trade with the rest of the World and increase their demand for staple food (grain and milk). As a consequence of this, milk and grain prices increase significantly relative to livestock prices in the short-run and producers react to this shock by shifting their fixed factors to the production of milk and grain.

[4] Given the family nature of almost all producers in the region we use total factor income including income to family labor, capital and land as a measure of total income to the family from the specific activity.

In the medium-run, producers react reallocating resources between activities, reducing supply of livestock and transport services and further increasing supply of milk and grain (figure 4b). This results in partial recovery of livestock and transport prices compared to the effect of the initial shock and pushes grain and milk prices down, negatively impacting sedentary farmers and agro-pastoralists that were less affected by the ban in the short-run. In this way, through reallocation of factors of production, pastoralists and traders, the most affected by the short-run effects of the ban, are able to buffer these effects, shifting part of those costs to other agents through markets and prices.

A summary of the impacts of a 16-month ban on exports from the Somali Region on Somali producers is presented in table 9. The total loss in value added for the region is $195 million or almost the total value added produced in a normal year. Approximately 10 percent of this loss is explained by losses suffered by poor producers, 23 percent by middle producers, 18 percent by better-off producers and the remaining 49 percent of the total loss corresponds to the share of non-agricultural activities including trade, retail and other services. The impact of the ban on different types of producers is similar with total loss in value added of around 50 percent of their respective levels in a normal year.

Households

The ban affects households through changes in their income and through changes in prices of consumption goods. One of the possible strategies to cope with these changes is to modify consumption patterns, adjusting consumption to price changes.

Table 10 shows the general pattern of changes in the consumption of different goods in the short and medium-run after the ban is imposed. According to the data, the strategy followed by households in Somali region to deal with the impacts of the ban is to increase consumption of domestically produced goods and purchases of staple food, reducing consumption of non-essentials. Consumption of non-food and other foods is reduced on average 5.5 and 6.1 percent respectively. Poor producers reduce consumption of non-essentials between 8 and 13 percent in most cases. Consumption of grain reduces 1 percent on average in the short-run but stays stable in the medium-run, while milk purchases increase.

The impact of the ban on household income is presented in table 11. All households are affected by the ban, experiencing a substantial reduction in their income. In the short-run this reduction is in all cases close to 30 percent of the level of income in a normal year. In the medium-run households are able to reduce their losses but the ban implies a significant reduction of income of more than 20 percent in most cases, even after households adjust to the shock.

The trends in consumer price changes follow those of producer price changes already discussed (figure 5). In the short-run, prices of livestock are reduced to 56 percent of normal year levels. Prices of services and trade are also reduced significantly. Imported goods like non-food goods and other food become more expensive as a consequence of the deterioration in the terms of trade of the region with the rest of the

World. Milk and grain prices decrease in the short-run following an increase in domestic supply because producers move a way from livestock production and increase grain and milk production. In the medium-run, prices of grain and milk decrease further while prices of imported non-essentials increase above their initial level in the short-run. The reduced supply of animals for sale in the medium-run increases consumer price of livestock in the domestic market.

We combine income and consumption effects to look at the consequences of the ban on the welfare of different types of households. Values of Equivalent Variation calculated for different household types are presented in table 12. Results in the short-run can be explained by the sharp reduction of livestock and livestock product prices. In this context, large pastoralists can increase home consumption of their own production and/or increase sales of livestock products compensating their income losses. Poor pastoralists, on the other hand, depend on purchases of food because of their limited production capacity. Even if they can increase home consumption, this increase is not enough to compensate for the income losses and so the overall effect is reduced consumption and welfare.

In the medium-run, pastoralists (including better-off households) and urban households appear to loose welfare while sedentary farmers and most agro-pastoralists increase welfare. This means that when the economy is allowed to adjust, reduced livestock supply and reduced income in pastoralist activity is higher than in the short-run and household consumption strategies are not sufficient to avoid welfare losses even for better-off pastoralists. The overall effect in this case is reduced consumption and welfare loss. On the other hand, households earning their income from grain production and eventually livestock products experience income losses that are compensated by favorable changes in consumption prices

Case study of the impacts of the ban on producers and market agents

Results of this study using the CGE model are in the line of impacts reported from the region. According to Ahrens (1998), the imposition of the ban made prices shrink to levels between 55 (sheep) and 65 (cattle) percent of prices in a normal year, which compares to our short-run result of 57 percent of price level in a normal year. Our simulation also shows the negative impact of the ban on trade and retail in the region. In the short-run, traders and retailers obtain negative returns to capital and labor while in the medium-run the loss in value added represents 35 percent of its level in the base scenario. The short-run result in our simulation could reflect the situation shown by the UN report of 1998. According to this report, the cessation of livestock exports has had a serious impact on the economy of the Somali Region: “cash income from livestock exports, on which prior to the ban the large majority of the population depended, has stopped. No more goods are coming across the border. Goods available in local shops represent old stocks and by the time of the mission’s visit had started to become more expensive. Terms of trade are deteriorating with animal prices going down and grain prices increasing. Due to the people’s significantly reduced purchasing power, the general trade

business in the towns visited has already suffered drastic cuts. According to local informants, in Harshin about 25 per cent of the shops are closed, in Camoboker about 30 per cent and in Rabasso and Daror up 50 per cent."

Simulated impacts of the ban on households in the region are also consistent with those directly verified by the Household Food Economy Analysis conducted by Save the Children Fund (see King et al., 1998). SCF-UK reports that middle and better-off households are generally more affected because they rely more heavily on livestock sales in a normal year. According to SCF-UK "In order to counter the initial deficit in the current year, households will employ a variety of strategies, the first of which will be to reduce spending on non-essentials in order to increase food purchases from available income. The better off the household, the greater the capacity it has to switch expenditure." This means that the behavior of consumers simulated by the CGE model tallies the behavior of the economic agents verified in the field.

The survey conducted in the region as part of this study is another means for verifying the CGE simulation results. Agents in the livestock production-marketing chain (pastoralists and agropastoralists, exporters, transportists, retailers, and households) were interviewed during a survey conducted between June and July 2003 in the northern part of Somali region, from where the largest number of Ethiopian animals is exported to the Middle East,

Results of the survey show that livelihoods of pastoralists have been severely affected by the ban, deteriorating their terms of trade and forcing them to sell livestock for very low prices and in larger numbers. To compensate for the income losses, pastoralists develop different strategies, like taking the animals to better grazing areas and highlands to gain more weight, and traveling to different local markets in their zone as well as across the Somalia border in search of alternatives for better prices. Grain and cash crop cultivation is also one of the strategies pastoralists used to cope with stress created by the ban and the drought. The situation also forced them to look for alternative incomes, like sending some of their children to be herdsmen for the rich or working in acacia tree bush clearing for charcoal making and wood sale.

Significant changes occurred in livestock herd composition. Mostly goats and camel species increased while cattle and sheep population decreased, although this cannot be fully attributed to the ban given that change in herd structure could also relate to drought. Majority of the pastoralists were obliged to keep fewer animals in their herds in the last three years and they also agreed on the fact that the age groups of the animals they rear has changed, with an increase in the share of young and female stock.

Consumption patterns were also affected. The drought problem and strict contraband control, coupled with the RVF ban effects, have forced pastoralists to spend less on food (sugar, oil, and salt) and non-food items. Most pastoralists still purchase grains, but it is not adequate to sustain all the household members. Consumption of milk also decreased since they use it as an alternative to generate income. They have also

decreased meat consumption, partly because they produce grains and partly because they have access to contraband pasta and rice and food aid.

With respect to traders, the survey shows that almost all traders suffered and endured the effects of the ban, which resulted in decline in their income due to fewer transactions of animals because of drought and the ban. About 75 percent of the traders feel they changed the nature of their trade by relying more on local livestock trade, shifting to other non-livestock goods (contraband and chat sale), or still trading livestock but diversifying to more species of animals.

Other agents were also affected by the ban. Most brokers experienced a reduction of the livestock market operation and two-thirds of them reported a decline in their income by about 80 percent, while one-third said there was no change in income due to diversification of business. Almost all transporters were transporting less than half the number of livestock now compared to three years ago. Market administrators report that the ban has decreased government's revenue from tax collection. Butchers in part benefited from the ban because of the low price of livestock, increasing their purchasing power although they report that their income has decreased by 15-60 percent in the past three years due to lower volume of business. Results for grain retailers were mixed and clothes retailers reported that they experienced a decline in their income due to a 57-95 percent decline in the quantities of goods exchanged because of the weakening of the purchasing power of their various customers.

An Export Certification Scheme to Comply with OIE Regulations

The certification of exported live animals from a RVF non free zone, as is the case of the Somali region in Ethiopia is evaluated as one possible option to handle the problem by matching international and OIE sanitary regulations. The alternatives discussed here refer to a certification scheme with testing of animals and with or without vaccination. Additionally, the zoonotic aspect of the diseases and its consequence for human health are not considered into cost and benefit calculation. The study provides cost and benefit measurements and evaluates the advantage of the proposed program of live animal certification using cost-benefit analysis. Benefits and costs of three policy alternatives for implementing the program are also evaluated. The benefits used in the analysis are derived from the CGE simulation discussed above. Future outbreaks of the disease are simulated using a Monte Carlo approach.

Treatments and control scenarios

OIE regulations refer to two types of country status with regard to RVF: free and non-free countries. Given the present status and the animal health situation in Ethiopia, the possibility of Ethiopia being declared free from RVF is considered a major effort not attainable in the near future. Therefore, we assume that the country has a non-free status and that animal exports are allowed only with an OIE like certification scheme with or without vaccination. This is not a medical program to cure the disease but to alleviate its impact based on opportunities opened by sanitary OIE regulations. The application of

such program would result in export salvaged as compared with the current situation.

OIE admits two status with regards to RVF for animals exported from non-free countries: vaccinated or non vaccinated. In the case of non-vaccinated animals, the treatment implies keeping the animals in collection ground for 30 days and first sampling and testing of 1 to 5 percent of animals to be exported. During this period, feeding and watering in collection ground is required. After this period, the animals enter quarantine for 30 days, where feeding and watering are also required and a second sampling and testing of animals to be exported is conducted.

During quarantine and transportation animals should be protected from vectors by using fenced and roof covered buildings and covered trucks or railway wagons. This is a compulsory measure if OIE regulations are not adjusted for non-at risk areas for vector bites (which is suggested to be the case in arid zones of the Horn of Africa). If not modified, this aspect definitely hampers the formal possibility to handle walking convoys of animals from quarantine to transiting or embarkation destination. Otherwise, it would imply that similar certification should be carried out in the transiting country. In our study this aspect is incorporated into building calculations only, and no cost associated with insecticides or chemical prophylactics is considered.

For the treatment using a vaccine certified by OIE, animals must spend 30 days in collection ground where they are fed and watered and all animals are vaccinated. After this, the animals enter quarantine for 30 days, where feeding and watering are required but no testing is needed. Vaccination with certified vaccine should occur within the period of 21 days at least and no more than 90 days before shipment (day of official certification and truck loading in Ethiopia).

The two alternatives considered here, certification scheme for vaccinated or non-vaccinated animals, require the same investments and costs, except for the use of a vaccine or animal testing in the case of vaccinated and non-vaccinated animals respectively. Given that costs and procedures are similar and that we assume that the benefits of both treatments are the same, we focus on the non-vaccinated animals treatment, which has costs 6 percent lower than the vaccinated-animals treatment when one percent of exported animals is sampled and tested. If we increase the number of tested animals to 5 percent, then the costs of both alternatives are almost the same. The general conclusions of our analysis do not change using the vaccination scheme or the 5 percent testing in the non-vaccination treatment. The alternative to the treatment is the status quo scenario, where the present situation is projected into the future with no actions taken to tackle outbreaks of the disease.

Benefit-Cost Analysis

The Benefit-Cost ratio is a discounted measure of project worth calculated by dividing the present value of the benefit stream by the present value of the cost stream. When analyzing the convenience of investing in a certain project the selection criterion is to accept projects with a benefit-cost ratio of 1 or greater when discounted at a suitable

discount rate (Gittinger, 1982). Formally, the mathematical statement of the benefit-cost ratio is given below.

(1) $$B/C = \frac{\sum_{t=0}^{n}\left(B_t/(1+i)^t\right)}{\sum_{t=0}^{n}\left(C_t/(1+i)^t\right)}$$

This ratio is applied to measure the costs and benefits that producers in Somali region would face if an animal health program as the one proposed in the previous section were implemented. The benefit-cost ratio in this particular case is an indicator of the benefits that producers in Somali region could expect from the implementation of the plan.

Alternatively, we also consider the Net Present Value (NPV) as a measure of the results producers would obtain from the application of the certification program to complement the information given by the benefit-cost ratio. This measure can be interpreted as the present value of the income stream generated by the investment and it can be computed by finding the difference between the present value of the benefit stream less the present value of the cost stream.

The absolute value of the benefit-cost ratio (and the NPV) will vary with the discount rate ***i*** chosen. For financial analysis, the discount or cut-off rate is usually the rate at which the enterprise is able to borrow money. It is not possible to determine this rate for producers in the Somali region with the available information. We assume a discount rate of 10 percent presuming a higher interest rate than the official real interest rate in Ethiopia for the past 10 years, which varied around 8 percent according to information from the World Bank, but we were not able to determine the actual cost of money in the Somali region.

The benefit-cost ratio approach has been extensively applied to disease control analysis (see Perry et al. 2003 for a review of previous studies). According to Perry et al. (2003) there is a wide variability in how this analysis is conducted particularly with respect to predicting the interaction between control efforts and disease outbreaks over time and the degree to which indirect impacts of the disease are effectively incorporated into the analysis. In what follows we explain how these elements are treated in this study to define costs and benefits before proceeding to the analysis of the results.

Costs of the treatments proposed

The costs and investments required to implement the health certification program for non-vaccinated animals during a 20-year period are presented in table 13. The investments needed amount to a total of $1 million, with more than 80 percent of this amount required before starting the project. Main investments necessary are in buildings (collecting ground facilities, clinics and laboratories) and vehicles. These investments are low compared to the operative costs of the project, which on average sum to $4 million per year. These costs include fuel and vehicle maintenance, paperwork, feeding costs, tagging animals, salaries of technicians and personnel in collecting grounds and lab tests.

The present value of the 20-year cost flow and investments sums to a total of US$55 million.

The most important cost component of both alternative treatments proposed is the feed cost with a share of 85 percent of total annual operating costs. According to OIE regulations no free grazing is allowed, and during the 60-day period of control and quarantine required by the treatment, the animals should be fed and watered in the holding grounds. We estimate feeding costs per animal head and per day at $0.05 with maize and sorghum fodder and water delivered on ground. This information is from Shank (1997) who estimates the cost of feeding animals by trucking maize and sorghum fodder when the animals are being held at the port of Berbera. When envisaging feeding cost per month and per animal head we get a figure of $1.48 for shoats and we estimate total feed cost by converting exported cattle and camels in shoat equivalents. We assume that these are maintenance diets. Shank does not offer detailed information on the specific components of the cost of feeding animals, like distance that feed is transported, labor and transport costs. The estimated cost of water is from SCF-UK, who provides information of better-off pastoralists owning water reservoirs and selling water as part of their income. We estimate the cost of water per animal and per month to be $0.20

Expected benefits of the proposed treatments

The expected benefits of the treatments proposed during the 20-year projected period are the avoided costs of future bans imposed on Somali exports because of disease outbreaks. We take 16 months as ban duration without treatments. If treatment is applied and there is an outbreak of the disease, the effect of the certification system will be to reduce the ban to the duration of an RVF outbreak event, which we assume to be 6 months. The incremental benefit resulting from the treatment is to avoid 10 months costs of possible future bans on exports each time that an outbreak of the disease occurs in the next 20 years.

In order to define the benefits from the proposed treatments we need to represent the incidence of RVF in the 20-year period defined for the study. In order to do this, an estimate of the probability of an outbreak of the disease is needed. Davies and Nunn (1998) reported epidemics in Eastern and Southern Africa at irregular intervals of about 5–25 years whereas EMPRES/FAO (1998) reports that epidemics occur in 5 to 20 year cycles, but in the dry semi-arid zones of eastern Africa the cycle could vary between 15 to 30 years (Tibbo, 2001). The last observation in the Horn of Africa suggests that RVF was present (clinical cases) in 1997-98 but with low evidence in 2000. We will take one reference scenario where the probability of occurrence of RVF in one particular year is 1/20, once within the next 20 years. Having defined this probability, we use a Poisson distribution to model the occurrence of an outbreak of the disease.

The Poisson distribution is used here as an approximation to the distribution of the number of outbreaks of the disease to occur in the next 20 years, assuming that the occurrence of these events are independent. The variable to be modeled is X = Number of RFV outbreaks in 20 years, where X = [0, 1, 2, …, 20]. The mean or expected value of this distribution is $\mu = 1$, meaning that the expected number of RVF outbreaks in 20 years

is 1. Using the Poisson distribution assuming $\mu = 1$ we estimate the probability of 0, 1, 2 and up to 20 RVF outbreaks in 20 years. The results are presented in figure 6. The probability of no outbreak of the disease in 20 years is 0.37 leaving a probability of at least one outbreak in 20 years of 0.63. The probability of only 1 outbreak in 20 years is 0.37, of 2 outbreaks 0.18, 3 outbreaks, 0.06, 4 outbreaks 0.02. Probabilities of 5 to 20 outbreaks are very low.

With these probabilities and using a Monte Carlo approach we simulate the occurrence of outbreaks over the next 20 years repeating the simulation 5000 times. Each of these 5000 simulations obtained is one possible event in terms of number of RFV outbreaks in the next 20 years. After obtaining the number of outbreaks, the next step is to allocate those outbreaks between the 20 years of the period considered in the analysis. This allocation is important because as we are working with present values of incomes in the future, assuming that the outbreak occurs in year 20 or in year 1 will have obvious implications in the results of the BC analysis. We assume that once the number of outbreaks is defined, the specific year of occurrence of this outbreak within the 20-year period is random with probability of occurring in a particular year equal to 1/20. In this way we generate 5000 simulated 20-year periods, each of them with a particular number of RVF outbreaks and with a particular distribution of those outbreaks between years. Assuming that there is a gain from the application of the treatments each time an outbreak occurs, this simulated outbreaks are used as a distribution of the expected benefits of the treatments in the future. The probability of higher incidences than 1/20 is not examined but net gain under higher probability of occurrence could make a strong justification for the public investment.

The actual value of total costs avoided because of the treatment is derived from the CGE simulation of this study (see tables 7 and 8). The total cost of the ban derived from the simulation with the CGE model is divided in short-run and medium-run impacts. We assume that the short-ran costs in our base scenario are the costs of an RVF outbreak that cannot be avoided with our treatment. The actual gains from the treatment are to avoid what we estimated as the medium-run costs. We use this value with the distribution of outbreaks in the Monte Carlo simulation to obtain a distribution of future income (avoided costs) resulting from our treatment. Figure 7 shows the main characteristics of this distribution. If no RVF outbreak occurs (with probability = 0.37), and there is no ban or restriction on trade flows, then there is a loss of US$55 million that corresponds with the costs and investments of the treatment proposed. If outbreaks of the disease occur, then income is positive and its total amount depends on the number of outbreaks in a 20-year period. The expected income if an outbreak occurs is US$134 million and the overall expected income, including the negative income resulting when no outbreak occurs is US$64.4 million, greater than the US$55 million that the treatment costs.

Results: The Benefit-Cost indicator

Having defined costs and benefits of the treatment we present the results of the Benefit-Cost analysis in figure 8. The probability of having a benefit-cost ratio greater than 1 is 0.5 and the overall expected value of the Benefit-Cost ratio is 1.50.

For the cases where a Benefit-Cost ratio greater than one occurs, the expected NPV resulting from subtracting costs to expected benefits is US$97 million. On the other hand, when a benefit-cost ratio taking values less than 1 occurs (with probability 0.5) the NPV is -US$45 million, which result from combining the losses that occur if there is no RVF outbreak and the losses that result when RVF outbreaks do occur but the benefit-cost ratio is less than 1. The NPV for a 20-year period is US$14 million resulting from adding expected gains and losses weighted by their respective probabilities.

Three main considerations about these results must be made. First, the fact that we are considering only static economic gains, assuming that income losses avoided are those of the base year, must be emphasized. Doing so we are underestimating the gains from the program given that we should expect benefits coming from increased economic growth in a more stable region, with increased exports and investments (e.g., slaughterhouses). Given the structure of the stream of benefits and costs (low investments relative to high operating costs), the results are not sensible to changes in the discount rate. Finally, the most important factor affecting the results is the cost of feeding animals during quarantine and testing. This is an OIE requirement difficult to implement in the Somali region, given its resources and production system. The possibility of implementing a program like the one proposed here would depend on the development of an efficient system of producing and delivering fodder to the collect grounds.

Taking these elements into consideration, and given the expected results of the benefit-cost ratio and the NPV, we conclude that the possibility of implementing an animal health program in the Somali region is feasible and would benefit producers. The resulting costs and the risks of the program are manageable and within the range of expected income. In the next section we discuss how different policy options to implement the plan and recover its costs could affect the region and the different producers and households.

Implementation of the program and policy implications

The health certification scheme proposed, benefits livestock producers in Somali region, as shown in the previous section. However, simulation using benefit-cost analysis, simply assumes that investments and costs of the certification program do not result in distortions to the economy, not affecting competitiveness, not making other considerations about how this plan is going to be implemented and how producers will pay for the service. In this section we discuss some simple policy alternatives to implement the health certification scheme proposed, evaluating the implications that these different options have for producers and consumers in terms of income and welfare.

The present value of all costs and investments needed to comply with OIE's standards as a RVF non-free country, as shown in the previous section, sums to a total of US$55 million. If we transform this total amount in a constant annual payment using financial equivalences with a 10 percent discount rate, the value of this annual payment equals US$6.5 million. This means that US$55 million today is equivalent to an annual payment of US$6.5 during 20 years assuming a 10 percent discount rate. We assume then that US$6.5 is the annual cost for the Somali economy to comply with OIE's health

standards. Assuming that producers can pay this annual cost as shown by the benefit-cost analysis in the previous section, we discuss different alternatives to make these payments:

- Scenario 1. The government implements the animal health plan and puts in place an export tax to collect an amount equal to the cost of the plan.
- Scenario 2. The government implements the animal health plan and puts in place a tax on livestock sales to collect an amount equal to the cost of the plan.
- Scenario 3. There is no government intervention and no tax increase. The plan is implemented by the private sector charging a fee to the user of the service. This results in an increase of the marketing margins of livestock sales for exports. The costs to move animals from the market to the port (border) are increased by the amount of the cost of the plan.

These options use instruments already in place in the region. Exporters pay export taxes to Somaliland's government and the first scenario proposes to charge a similar tax that would be collected by the regional government in Somali. Scenario 2 implies an increase of the existing tax on livestock sales. Local municipal markets collect fees on every animal brought for sale. At Jijiga livestock market, for example, the fees are 1 Birr per shoat, 2.50 Birr per cattle and 5 Birr per camel. Reportedly, none of these municipality revenues are shared with the regional fiscal system and no national export taxation system is in place (Ahrens, 1998). Taxes should be increased to cover the total cost of the plan (US$6.5 million per year). We assume that no extra costs are required to improve the tax collecting procedure or to put in place the program. The last scenario does not involve the government. Transaction costs incurred to export animals from the region are increased by US$6.5 million to include the cost of the health plan.

Table 14 shows the total amount collected as export tax for livestock exports, livestock sales tax and total transaction costs of livestock exports. Increasing export taxes to cover the amount of the program implies doubling the export tax already charged by the neighboring Somaliland government to animals exported from the port of Berbera, although the Somali regional government would collect this new tax. Total export taxes would rise from US$5 per animal to almost US$10 per animal (see discussion below on the plausibility of this tax). In the case of domestic sales, the initial amount collected is assumed to be very low because only a small proportion of animals are taxed. In this case, a tax of around US$2.5 per animal marketed in the region would be enough to cover the cost of the program assuming that all transactions are taxed. Finally, if the cost of the health program is passed as increased export transaction costs, the cost per animal grows from US$6 to US$11.

In sum, targeting the export sector results in an increase of export costs of around US$10 per exported animal with any of the two options considered. Increasing US$10 per animal could still be feasible given that sheep could be sold for US$50 in Saudi Arabia and up to US$65 during the Haj and that the margins for traders are high (Shank, 1997), but there is not much margin left to further increase export taxes. The alternative of charging sales taxes on all livestock transactions will distribute the costs of the health

program among other agents not directly involved with livestock exports, not having major effects on export costs and competitiveness.

The impact of these different alternatives on the economic result of producers and on consumer's welfare is analyzed using the SAM of the Somali region developed for this study linked to the CGE model developed by Lögfren, Harris and Robinson (2001). Table 15 shows the impact of the different policies on households. Scenario 3 in which transaction costs are increased show the worse results in terms of welfare for the households who face losses of US$4.6 million for this scenario followed by Scenario 1, where export taxes are increased (losses of US$0.9 million). An increase in sales taxes results in modest losses of US$0.13 million. Losses by households are small if compared with initial income. In the worse case scenario, these losses would be of approximately one percent of their initial income. As expected, pastoralists and urban households lose with scenarios 1 and 3 where export competitiveness are affected. These two groups would pay the cost of the policy plus a welfare increase for agro-pastoralists and sedentary farmers who will gain with the imposition of an export tax (scenario 1). Pastoralists would benefit and sedentary farmers would pay some cost for the implementation of a sales tax (scenario 2), however the losses are a lesser amount of those in other scenarios. The increase in transaction costs is the worse option for all households. Finally, looking at the benefits and costs of the different policies by wealth category, the most negative effect for the poor households results from an increase in marketing costs and loss of competitiveness. The sales tax scenario on the other hand, results in welfare gains for the poor. In all cases, middle households are the most affected, although the negative impact of scenario 2 is small compared with the other two scenarios

Producers on the other hand (table 16), view Scenario 1 as the worse option where the total loss in value added sums to US$22 million. Losses in scenarios 2 and 3 are US$8 and US$11 million respectively. In other words, the annual cost of the program of US$6.5 million could be increased to US$8, US$11 or US$22 million as a result of distortions to the economy depending on the instrument used to charge producers for the cost of the program. With expected gains from the program of US$64.4 million for 20 years, equivalent to an annual income of approximately US$7.6 million, we can still expect welfare gains from the implementation of the program under any of these different policy options. However, the impact on producers differs substantially under different options and losses could be significant, reaching 13 to 16 percent of value added in the case of middle and better-off pastoralists and traders when export taxes are increased.

Table 17 separates the results in table 16 by production specialization and wealth category. Pastoralists and non-agricultural activities would be the most affected by an export tax, losing 12 and 6 percent of value added respectively. In general, pastoralists would pay for the policies targeting exports while implementing a tax on livestock sales results in lower costs for the economy and evenly shared by all groups. The better-off and middle producers are in general more affected than poor producers by the three policy scenarios. Better-off producers would loose 7 percent of value added with the imposition of an export tax, while poor producers will loose 3 percent. The sales tax scenario results

in gains (4 percent of value added) for poor producers and lower losses for other activities if compared with the scenarios targeting exports.

Assuming that the costs resulting from the different scenarios are the annual costs paid by the different producers for the implementation of the animal health program, we calculate the present value of the total cost for the 20-year period and for each wealth group. We then combine the costs of the different scenarios with the distribution of future income for each wealth group to calculate benefit-cost ratios and NPV for each wealth type. Figure 9 summarizes these results showing the probability of occurrence of a benefit-cost ratio greater than one for each type of producer under different scenarios. Tables 18 associates an expected NPV to the probability of a benefit-cost ratio greater or less than 1 for different types of producers and by wealth category. In the case of poor producers for example, the probability of getting a benefit-cost ratio greater than 1 in scenario 1 is 0.28 (figure 9 and second column in table 19). If this is the case, the expected NPV for this group under scenario 1 is US$7839 thousand.

From the analysis of figure 9 and table 18 we reckon that poor producers and traders are expected to gain in the process while middle and better-off producers might lose. All expected NPV values for middle and better-off producers in table 19 are negative, while expected values for the poor and traders are positive with only one exception (scenario 1 for traders). However, the expected losses for middle and better-off producers are low. The worse possible case for better-off producers is a 4 percent decrease in value added in scenario 1 (table 19).

We conclude that even when considering only part of the possible benefits that producers would achieve from complying with OIE sanitary rules, poor producers and the trading and service sector are expected not to lose from the implementation of an animal health program with the characteristics proposed here. Middle and better-off agricultural producers are expected to lose on average but the losses are only a small fraction of their total value added, and it is very likely that these losses would be compensated by benefits from growth resulting from the program given that certification could result in better prices for Somali exports, among other benefits not considered in this analysis.

Increasing taxes on livestock sales offers the best prospect as the way to implement the health certification plan in the Somali region. This option has the less negative impact on exports, and welfare; it also has the higher benefit for the poor given that it implies a transfer from middle and better-off producers to poor producers. The sales tax policy would benefit pastoralists and traders and will affect sedentary farmers and agro-pastoralists negatively although the total amount of the losses expected is small.

Summary and Conclusions

The ban on livestock exports from the Horn of Africa has had a major impact on the livestock dependent economy of Somali Region in Ethiopia; however, no attempt was made to quantify the actual cost of the ban to the region. In order to analyze the

economy-wide effects of the ban, build a Social Accounting Matrix of the Somali economy and used this SAM to simulate the impact of the ban using a CGE model

The results of the simulation show that the ban has a devastating effect on Somali's economy. GDP is reduced by $135 million in nominal terms, which represents a 36 percent reduction compared to a normal year. Evaluating the effects of the ban at the microeconomic level, we find that in the short-run, the ban causes a sharp reduction of livestock prices directly affecting the activities most dependent on livestock sales, deteriorating their input/output price ratio. The total loss in value added generated in the region is $195 million or almost the total value added produced in a normal year. The impact of the ban is similar on different types of producers with total loss in value added of around 50 percent of their respective levels in a normal year.

The analysis of the impacts of the ban on the Somali region using a CGE analysis was complemented by an analysis of the links between agents in the livestock production-marketing chain and the distribution of costs of the ban among these agents based on case studies. These agents were interviewed during a survey conducted in the northern part of Somali region between June and July 2003. Results of the survey show that livelihoods of pastoralists have been severely affected by the ban, deteriorating their income, changing the composition and reducing the number of animals in the herd, and changing consumption patterns decreasing purchases of food and grain. Marketing agents like traders; brokers, transportists and retailers also experienced negative effects in income and in the volume of business.

Having evaluated the extent of the negative impact of the ban on exports on Somali region's economy, the next step is to evaluate the certification of exported live animals from a RVF non free zone, as is the case of Ethiopia, as one possibility to handle the problem and matching international and OIE sanitary regulations. Costs and benefit measurements are provided and an evaluation of the proposed program of live animal certification using cot-benefit analysis is conducted.

The Benefit-Cost analysis shows that the implementation of an animal health program in the Somali region is feasible and would benefit producers. Different alternatives (export tax, sales tax and increased transaction costs) to charge producers for the equivalent amount of the cost of the program are analyzed. Increasing taxes on livestock sales offers the best prospect as the way to implement the health certification plan in the Somali region. This option has the less negative impact on exports, and welfare; it also has the higher benefit for the poor given that it implies a transfer from middle and better-off producers to poor producers. The sales tax policy would benefit pastoralists and traders and will affect sedentary farmers and agro-pastoralists negatively although the total amount of the losses expected is small.

In conclusion, by showing the consequences for a poor economy of losing access to markets, this study illustrates how agricultural producers in poor countries benefit from markets, increasing their income, gaining access to cash and consumption goods and increasing their assets by keeping larger number of animals in their herds. The case of the

Somali region of Ethiopia is a clear example of the cost that poor countries pay for lack of investment in animal health programs. The results of this study also show that there are options to explore that could be adapted to the resources and possibilities of poor countries, allowing increased and more stable trade flows and contributing to a much needed diversification of exports.

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Table 1. Composition of Ethiopian exports (percentage)

Period	Coffee	Hides & skins	Chat	Meat	Live animals	Others	Total
1990	44.7	20.8	3.0	0.1	1.6	30.2	100
1991	61.6	13.3	2.0	0.1	0.4	22.5	100
1992	58.9	19.0	6.9	0.0	0.0	15.1	100
1993	63.6	16.3	9.4	0.0	0.5	10.1	100
1994	65.2	14.4	6.2	0.1	0.5	13.6	100
1995	65.3	13.7	6.6	0.3	0.2	13.9	100
1996	64.8	11.6	6.6	0.6	0.0	16.3	100
1997	65.1	10.1	6.9	0.7	0.4	16.7	100
1998	68.2	7.3	9.0	0.9	0.1	14.4	100
1999	57.4	6.5	14.0	0.8	0.2	16.2	100
2000	52.6	9.8	14.2	0.5	0.3	16.2	100
2001	31.7	16.8	12.5	0.3	0.1	31.2	100
Average	58.3	13.3	8.1	0.4	0.4	18.0	

Source: National Bank of Ethiopia (the NBE obtained the data from the Ethiopian Customs Authority

Table 2. Number and Percentage Distribution of Livestock in Ethiopia (in 1000 heads)

	Cattle	%	Sheep	%	Goats	%
Tigray	2304	6.0	941	4.5	1454	8.2
Afar	618	1.6	387	1.8	616	3.5
Amhara	8931	23.3	4079	19.4	2771	15.6
Oromia	15421	40.2	4665	22.2	2724	15.4
Somali(*)	3746	9.8	9053	43.0	8547	48.2
Benshangule-Gumuz	308	0.8	59	0.3	163	0.9
S.N.N.P.R.	6925	18.0	1822	8.7	1368	7.7
Gambela	16	0.0	8	0.0	7	0.0
Harar	29	0.1	4	0.0	17	0.1
Addis Ababa	26	0.1	8	0.0	4	0.0
Dire Dawa	51	0.1	23	0.1	72	0.4
Total	38375	100	21049	100	17743	100

(*) Note: Data for the Somali Region are from Somali Regional State (2003).
Source: Source: Central Statistical Authority and the Regional Office of Population of the Somali Regional State (SNRS) (2003)

Table 3. Macroeconomic SAM for the Somali region (1000 US$)

	Activities	Commodities	Sales tax	Export tax	Factors	Households	Government	ROW	S-I	Total
Activities		344850				102887				447737
Commodities	81856	45339				286864	111909	97419	11005	634392
Sales tax		349								349
Export tax		7435								7435
Factors	365881									365881
Households					365881	798	16297	18578		401554
Government			349	7435				120422		128206
Rest of the World		236419								236419
Savings-Investment						11005				11005
Total	447737	634392	349	7435	365881	401554	128206	236419	11005	

Source: elaborated by authors

Table 4. Exports from Somali region by destination in normal and ban year and percentage of exports reduction (1000 US$)

		Ban year		Ban year	
	Normal year	Medium-run	% change	Short-run	% change
Arab countries	43733	13120	-70	33529	-23
Kenya	9517	9517	0	9517	0
Highlands	19068	19068	0	19068	0
Total	72317	41704	-42	62113	-14

Source: elaborated by authors

Table 5. Estimated exports of sheep and goats from Ethiopian Somali region through the port of Berbera in Somaliland (number of heads)

	1995	1996	1997	1998	1999
January	140600	103819	164309	169394	57521
February	125773	90707	104405	54302	110392
March	139203	111315	243663	21771	58196
April	205648	142545	109925	20793	16436
May	55787	27087	72879	19778	17429
June	98109	83036	75557	9758	88544
July	100642	7790	124324	22209	100311
August	118580	99637	78788	32551	96850
September	111112	117973	81490	14870	70767
October	92353	106511	55410	24819	109893
November	105277	108576	128963	29552	124004
December	53176	119125	167531	58811	173720
Total	1346260	1118121	1407244	478608	1024063

Source: elaborated by authors

Table 6. Impact of the ban on livestock exports: changes in macroeconomic variables (1000 US$)

		Short-run		Medium-run		Total impact of the ban
	BASE	Ban	Difference	Ban	Difference	Difference
NOMINAL						
Private consumption	389752	359781	-29971	360559	-29193	-59164
Investment	11005	7820	-3185	12066	1061	-2124
Government consumption	111909	98626	-13283	85282	-26627	-39910
Exports	97419	97864	445	77741	-19678	-19233
Imports	-236419	-255445	-19025	-232088	4331	-14694
Absorption	512665	466227	-46438	457907	-54759	-101197
GDP	373665	308647	-65018	303560	-70106	-135124
REAL						
Private consumption	389752	388242	-1509	379678	-10074	-11583
Investment	11005	11005	0	11005	0	0
Government consumption	111909	111909	0	111909	0	0
Exports	97419	86325	-11094	70011	-27408	-38501
Imports	-236419	-225326	11094	-209011	27408	38501
Absorption	512665	511156	-1509	502592	-10074	-11583
GDP	373665	372156	-1509	363591	-10074	-11583

Source: authors from model simulation

Table 7. Short-run changes in activity prices and value added of different activities as a consequence of the ban on livestock exports

	Gross revenue Per activity Unit	Factor income Per activity Unit	Aggregate intermediate Input price	Input-output Price ratio	Base Value Added (1000 US$)	Ban Value Added (1000 US$)	Difference Ban – Base (1000 US$)	Value Added per Househld (US$)	Loss Per Househld (US$)..	% Change Value Added
Pastoralist										
Poor	0.56	0.50	1.03	1.83	24661	12288	-12373	274	-137	-50
Middle	0.57	0.42	0.96	1.68	36217	15212	-21005	503	-292	-58
Better-off	0.58	0.23	0.98	1.70	15457	3625	-11832	665	-509	-77
Agro-pastoralist										
Poor	0.83	0.83	1.09	1.31	9316	7741	-1575	347	-59	-17
Middle	0.83	0.87	0.71	0.86	23232	20109	-3123	519	-70	-13
Better-off	0.84	0.92	0.72	0.86	14336	13183	-1153	800	-64	-8
Sedentary										
Poor	1.00	1.00	1.09	1.09	6976	6944	-32	236	-1	0
Middle	0.96	1.01	0.77	0.80	32939	33433	494	477	7	1
Better-off	0.88	0.92	0.78	0.88	36182	33333	-2848	1048	-82	-8
Other activities										
Services	0.81	0.81	0.83	1.03	144839	116685	-28154	-	-	-19
Traders	0.13	-0.22	0.56	4.12	21726	-4813	-26539	-	-	-122

Source: authors from model simulation

Table 8. Medium-run changes in activity prices and value added of different activities as a consequence of the ban on livestock exports

	Gross revenue Per activity Unit	Factor income Per activity Unit	Aggregate intermediate Input price	Input-output Price ratio	Base Value Added (1000 US$)	Ban Value Added (1000 US$)	Difference Ban – Base (1000 US$)	Value Added per Household (US$)	Loss Per Household (US$)	% Change Value Added
Pastoralist										
Poor	0.80	0.76	1.08	1.36	24661	15042	-9619	274	-107	-39
Middle	0.86	0.76	1.14	1.33	36217	17981	-18236	503	-253	-50
Better-off	0.91	0.76	1.12	1.23	15457	6948	-8509	665	-366	-55
Agropastoralist										
Poor	0.76	0.76	1.04	1.37	9316	13004	3688	347	137	40
Middle	0.80	0.76	1.33	1.65	23232	23614	382	519	9	2
Better-off	0.84	0.76	1.33	1.58	14336	11922	-2414	800	-135	-17
Sedentary										
Poor	0.76	0.76	1.04	1.36	6976	6947	-29	236	-1	0
Middle	0.80	0.76	1.29	1.60	32939	29167	-3772	477	-55	-11
Better-off	0.80	0.76	1.28	1.60	36182	28023	-8158	1048	-236	-23
Other activities										
Services	0.77	0.76	0.96	1.25	144839	110213	-34626	-	-	-24
Traders	0.85	0.76	0.98	1.15	21726	7115	-5167	-	-	-35

Source: authors from model simulation

Table 9. Impact of the ban on exports on producers in the Somali region measured in terms of Value Added (1000 US$)

	Poor	Middle	Better-off	Non-agriculture	Total
Value added base year	40953	92388	65975	166565	199316
Change in value added	-19940	-45260	-34915	-94486	-194602
Percentage of loss in total VA	10	23	18	49	100
Loss in VA with respect to normal year	-49	-49	-53	-57	-98

Source: Authors from model simulation

Table 10. Change in consumption patterns of different types of households as a result of the ban on livestock exports (Percentage)

	Pastoralists			Agro-pastoralists			Sedentary farmers			Urban			
	Poor	Middle	Better-off	Poor	Middle	Better-off	Poor	Middle	Better-off	Poor	Middle	Better-off	Average
Short-run													
Home consumption	13.3	4.0	4.1	8.1	-7.0	24.0	-9.3	16.9	4.8				
Livestock products	-0.6			1.2						-1.8	-2.2	0.3	-0.6
Grain	-2.6	-0.7	1.4	-0.3	-1.3	-0.8	-3.7	-3.3	-0.2	-1.5	-1.7	-0.8	-1.3
Other food	-8.7	-3.4	2.0	-2.4	-4.9	-3.4	-11.2	-10.1	-2.1	-7.9	-8.8	-4.9	-5.5
Non-food	-10.2	-3.8	2.9	-2.5	-5.7	-3.8	-13.4	-12.1	-2.2	-8.3	-9.3	-5.0	-6.1
Services	-2.6	0.9	5.1	1.9	-0.6	0.5	-5.5	-4.8	1.6	-3.1	-3.6	-0.5	-0.9
Medium-run													
Home consumption	0.4	0.7	1.4	1.5	0.9	0.0	1.3	0.0	0.7				
Livestock products	2.9			6.6						1.5	3.1	4.9	3.8
Grain	-1.9	-2.1	-1.3	1.9	-0.4	-0.3	1.3	0.1	2.1	-1.8	-1.5	-0.9	-0.4
Other food	-9.3	-8.9	-6.7	0.4	-4.7	-4.2	-0.6	-3.3	1.6	-10.6	-9.8	-7.1	-5.3
Non-food	-11.3	-10.8	-8.2	0.6	-5.7	-5.1	-0.6	-4.0	2.1	-11.5	-10.6	-7.7	-6.1
Services	1.4	0.1	1.7	9.6	3.7	3.7	8.0	4.9	9.5	-2.2	-0.8	1.3	3.4

Source: authors from model simulation

Table 11. Impact of the ban on livestock exports on household's income (1000 US dollars)

	Base	Short-run	Change	%	Long-run	Change	%	Total change %
Pastoralists								
Poor	40760	29601	-11159	-27.4	31503	-9257	-22.7	-50.1
Middle	75532	54332	-21200	-28.1	58110	-17422	-23.1	-51.1
Better-off	42512	31505	-11007	-25.9	33470	-9042	-21.3	-47.2
Agro-pastoralists								
Poor	9312	6987	-2325	-25.0	7402	-1910	-20.5	-45.5
Middle	26645	19444	-7201	-27.0	20738	-5907	-22.2	-49.2
Better-off	13958	10014	-3944	-28.3	10725	-3233	-23.2	-51.4
Sedentary farmers								
Poor	8160	5927	-2233	-27.4	6303	-1857	-22.8	-50.1
Middle	34563	24841	-9722	-28.1	26590	-7973	-23.1	-51.2
Better-off	28225	20891	-7334	-26.0	22223	-6002	-21.3	-47.2
Urban								
Poor	4935	3767	-1168	-23.7	3962	-973	-19.7	-43.4
Middle	50007	37503	-12504	-25.0	39795	-10212	-20.4	-45.4
Better-off	67911	51931	-15980	-23.5	54708	-13203	-19.4	-43.0

Source: authors from model simulation

Table 12. Welfare changes measured as EV for different household types as a result of the imposition of the ban on livestock exports

	Short-run (1000 US$)	Medium-run (1000 US$)	Total (1000 US$)	# Households.	# Household members	EV per Household. (US$)	EV per Person (US$)
Pastoralists							
Poor	-1358	-1743	-3101	90142	630227	-34	-5
Middle	1143	-3981	-2838	72053	615330	-39	-5
Better-off	3139	-1624	1515	23240	264702	65	6
Agro-pastoralists							
Poor	191	607	799	26869	161211	30	5
Middle	-332	-148	-480	44781	268686	-11	-2
Better-off	175	43	218	17912	107474	12	2
Sedentary farmers							
Poor	-719	502	-217	29603	207222	-7	-1
Middle	-2698	561	-2137	69074	414443	-31	-5
Better-off	495	2301	2797	34537	207222	81	13
Urban							
Poor	-322	-440	-762	10369	64286	-73	-12
Middle	-3222	-3605	-6827	56918	352891	-120	-19
Better-off	-1863	-3442	-5305	28415	176170	-187	-30
Total	-5369	-10969	-16338	503912	3469862	-32	-5

Source: authors from model simulation

Table 13. Investment and costs of the health certification program for non-vaccinated animals (1000 US$)

	Year0	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10
Investments											
Animal facilities	250										
Clinics	413										
Solar cold chain	3										
Computers	4					4					4
Vehicles	177										177
Costs											
Fuel		25	25	25	25	25	25	25	25	25	25
Paperwork		3	3	3	3	3	3	3	3	3	3
Feed		5948	5948	5948	5948	5948	5948	5948	5948	5948	5948
Tags		213	213	213	213	213	213	213	213	213	213
Tests		73	73	73	73	73	73	73	73	73	73
Salaries		97	97	97	97	97	97	97	97	97	97
Total	846	6359	6359	6359	6359	6362	6359	6359	6359	6359	6539

	Year11	Year12	Year13	Year14	Year15	Year16	Year17	Year18	Year19	Year20
Investments										
Animal facilities										
Clinics										
Solar cold chain										
Computers					4					
Vehicles										
Costs										
Fuel	25	25	25	25	25	25	25	25	25	25
Paperwork	3	3	3	3	3	3	3	3	3	3
Feed	5948	5948	5948	5948	5948	5948	5948	5948	5948	5948
Tags	213	213	213	213	213	213	213	213	213	213
Lab tests	73	73	73	73	73	73	73	73	73	73
Salaries	97	97	97	97	97	97	97	97	97	97
Total	6359	6359	6359	6359	6362	6359	6359	6359	6359	6359

Source: elaborated by the authors from several sources (appendix 1)

Table 14. Change in tax collection and transaction costs needed to cover the cost of the animal health certification program (1000 US$)

	Amount collected in a normal year	Annual cost of compliance	Amount to be collected to cover cost of compliance	Percentage increased required
Export tax	7435	6467	13902	87
Sales tax	349	6467	6816	1853
Transaction costs	9002	6467	15469	72

Table 15. Change in household Equivalent Variation as a result of different policies to charge for the animal health certification program

	Change (1000 US$)			Percentage change with respect to initial income		
	Export tax	Sales tax	Trans.cost	Export tax	Sales tax	Trans.cost
Pastoralists	-1032	97	-2107	-0.65	0.06	-1.33
Poor	-233	58	-548	-0.57	0.14	-1.34
Middle	-593	14	-1046	-0.78	0.02	-1.38
Better-off	-206	25	-514	-0.48	0.06	-1.21
Agro-pastoralists	1508	-188	-559	1.25	-0.16	-0.46
Poor	318	188	-17	1.82	1.08	-0.10
Middle	421	-131	-444	0.69	-0.21	-0.73
Better-off	769	-246	-99	1.82	-0.58	-0.23
Urban	-1408	-36	-1964	-1.15	-0.03	-1.60
Poor	-91	5	-99	-1.85	0.09	-2.00
Middle	-718	-93	-869	-1.44	-0.19	-1.74
Better-off	-599	52	-997	-0.88	0.08	-1.47
Total	-932	-127	-4630	-	-	-
By wealth category						
Poor	-6	251	-663	-0.01	0.40	-1.05
Middle	-890	-210	-2358	-0.48	-0.11	-1.26
Better-off	-36	-169	-1609	-0.02	-0.11	-1.05

Table 16. Changes in value added as a result of different policies to charge for the animal health certification program

	Pastoralists			Agro-pastoralists			Sedentary farmers			Other activities		
	Poor	Middle	Better-off	Poor	Middle	Better-off	Poor	Middle	Better-off	Trading	Services	Total
Value Added (volume)												
Base	24661	36217	15457	9316	23232	14336	6976	32939	36182	21726	144839	365881
Export tax	24167	33690	13794	10390	24666	14714	7354	34131	36796	21078	145102	365882
Sales tax	25973	35526	14906	10122	22910	13254	7406	32884	36035	21810	145052	365878
Trans.cost	24233	34430	14379	9763	23562	14213	7154	33247	36182	23854	144863	365880
Value Added Price												
Base	1	1	1	1	1	1	1	1	1	1	1	-
Export tax	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	-
Sales tax	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	-
Trans.cost	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	-
Value Added (1000 US$)												
Export tax	22714	31653	12960	9762	23175	13825	6912	32065	34567	19804	136365	343802
Sales tax	25440	34723	14568	9891	22393	12955	7255	32130	35199	21315	141990	357859
Trans.cost	23472	33345	13926	9455	22819	13765	6929	32198	35041	23103	140307	354360
Loss in Value Added (1000 US$)												
Export tax	-1947	-4564	-2497	446	-57	-511	-64	-874	-1615	-1922	-8474	-22079
Sales tax	779	-1494	-889	575	-839	-1381	279	-809	-983	-411	-2849	-8022
Trans.cost	-1189	-2872	-1531	139	-413	-571	-47	-741	-1141	1377	-4532	-11521
Percentage change in value added												
Export tax	-8	-13	-16	5	0	-4	-1	-3	-4	-13	-6	-
Sales tax	3	-4	-6	6	-4	-10	4	-2	-3	-8	-2	-
Trans.cost	-5	-8	-10	1	-2	-4	-1	-2	-3	3	-3	-

Note: Export tax, sales tax and transaction costs correspond to scenarios 1 to 3 respectively where taxes and costs are increased to cover the total cost of the certification program

Table 17. Changes in value added as a result of different policies to cover the costs of the animal health certification program by wealth category and production specialization

	Wealth category			Production specialization		
	Poor	Middle	Better-off	Pastoralists	Sedentary and agro-pastoralists	Non-agriculture
Value Added (volume)						
Base	40953	92388	65975	76336	122981	166565
Export tax	41911	92487	65303	71651	128050	166180
Sales tax	43501	91321	64195	76406	122611	166861
Trans.cost	41150	91238	64775	73043	124120	168718
Value Added (1000 US$)						
Export tax	39388	86893	61351	67327	120305	156168
Sales tax	42586	89246	62722	74732	119822	163305
Trans.cost	39856	88363	62732	70743	120208	163409
Percentage change						
Export tax	-3.8	-5.9	-7.0	-11.8	-2.2	-6.2
Sales tax	4.0	-3.4	-4.9	-2.1	-2.6	-2.0
Trans.cost	-2.7	-4.4	-4.9	-7.3	-2.3	-1.9

Table 18. Expected NPV by wealth category when benefit-cost ratio takes values less than one and greater than one respectively (1000 US$)

	Expected income					
	Scenario 1		Scenario 2		Scenario 3	
	Export tax	Probability	Sales tax	Probability	Trans.cost	Probability
Poor						
(1) If BC > 1	7839	0.72	22390	-	9364	0.63
(2) If BC < 1	-9789	0.28	-	-	-6974	0.37
Expected*	2893		22390		3244	
Middle						
(1) If BC > 1	16239	0.12	19192	0.31	18001	0.22
(2) If BC < 1	-33322	0.88	-19712	0.69	-24377	0.78
Expected*	-27524		-7488		-15012	
Better-off						
(1) If BC > 1	12070	0.09	13073	0.21	13165	0.21
(2) If BC < 1	-28250	0.91	-19888	0.79	-19796	0.79
Expected*	-24508		-12841		-12749	
Non-agriculture						
(1) If BC > 1	35936	0.14	48907	0.49	48397	0.50
(2) If BC < 1	-62410	0.86	-22095	0.51	-21824	0.50
Expected*	-48314		12455		13342	

* Note: The expected NPV is the average of NPV when BC>1 and NPV when BC<1 and is obtained by adding (1) and (2) weighted by their respective probabilities. For example, in the case of poor producers, they would gain US$7839 thousand on average when BC>1 in scenario 1, which occurs with probability 0.72. But they would lose US$9789 thousand if BC<1, which occurs with probability 0.28. The expected income is then 7893*0.72-9789*0.28 = 2893

Table 19. Expected NPV by wealth category when benefit-cost ratio takes values less than one and greater than one respectively (percentage of initial value added)

	Scenarios		
	Export tax	Sales tax	Transaction costs
Poor			
(1) If BC > 1	2.25	6.42	2.69
(2) If BC < 1	-2.81	-	-2.00
Expected*	0.83	6.42	0.93
Middle			
(1) If BC > 1	2.06	2.44	2.29
(2) If BC < 1	-4.24	-2.51	-3.10
Expected	-3.50	-0.95	-1.91
Better-off			
(1) If BC > 1	2.15	2.33	2.34
(2) If BC < 1	-5.03	-3.54	-3.52
Expected	-4.36	-2.29	-2.27
Non-agriculture			
(1) If BC > 1	2.53	3.45	3.41
(2) If BC < 1	-4.40	-1.56	-1.54
Expected	-3.41	0.88	0.94

*Note: see table 7

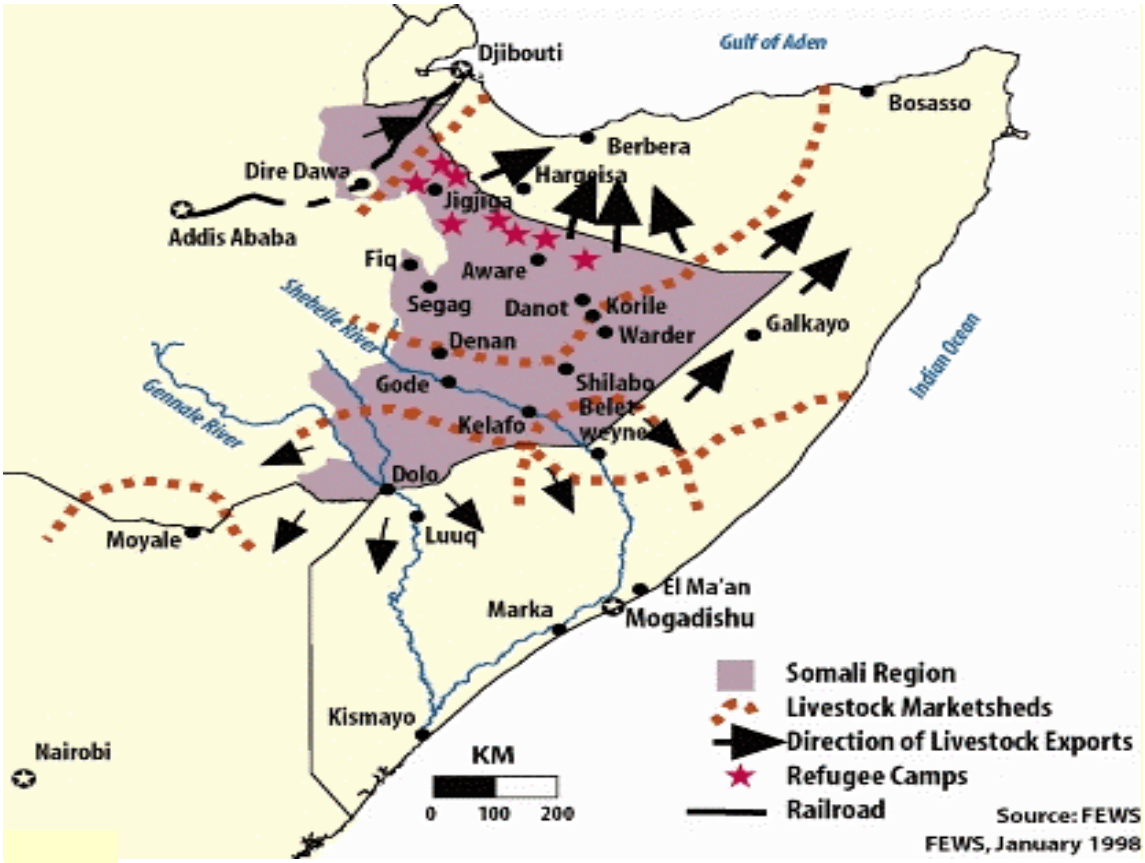


Figure 1. Livestock market sheds in the Horn of Africa

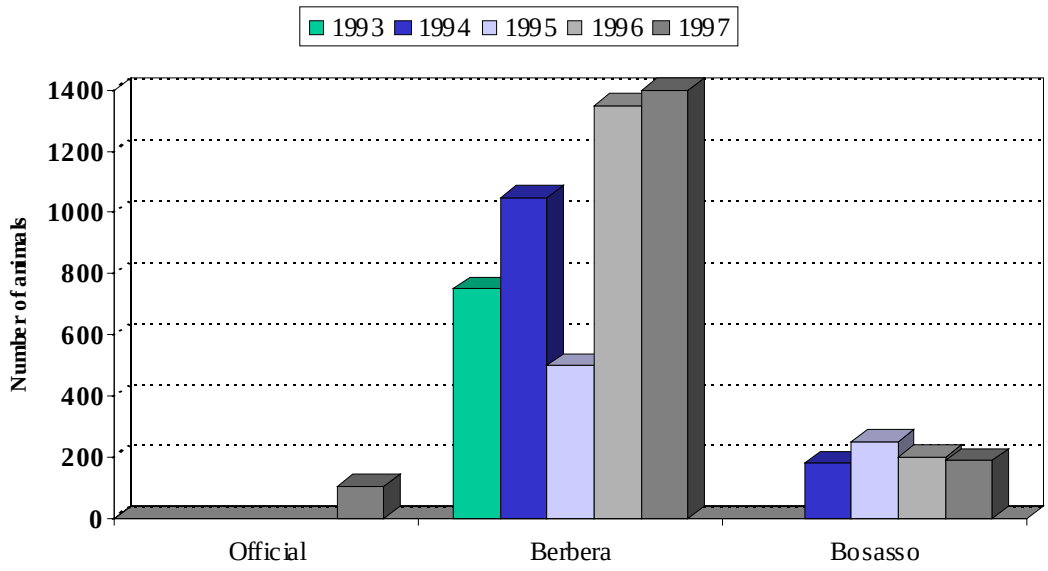


Figure 2. Official and informal exports of live sheep and goats from Ethiopia

Note: Informal exports from Somaliland ports of Berbera and Bosasso

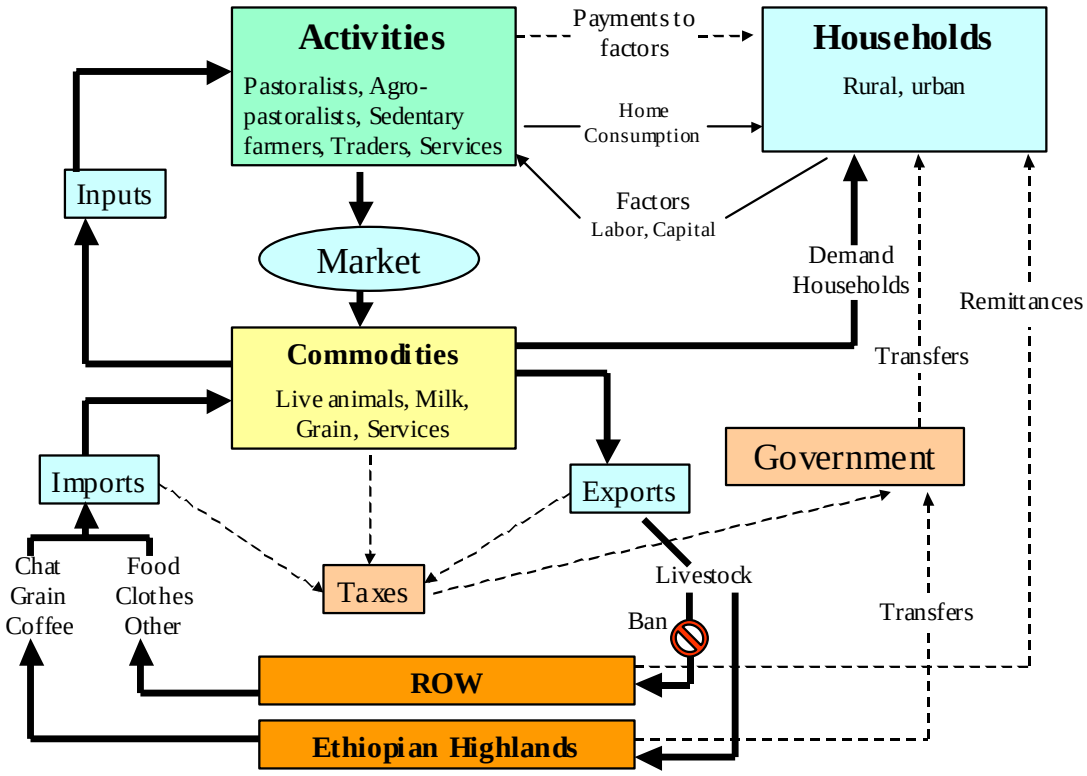


Figure 3. Diagram of an economic model representing main agents and economic flows in the Somali region

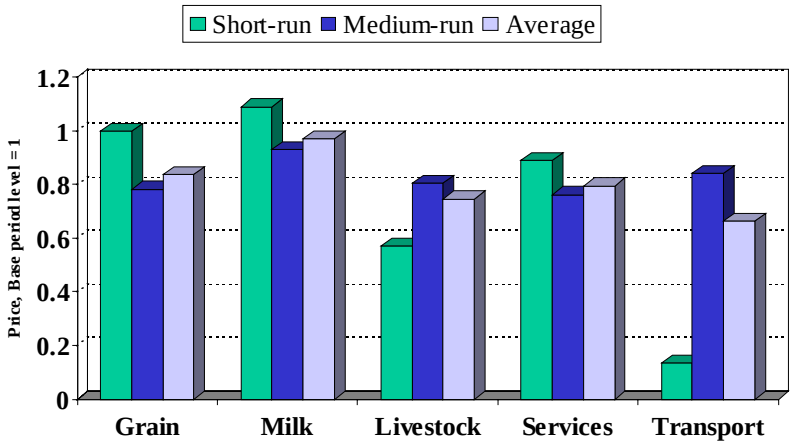
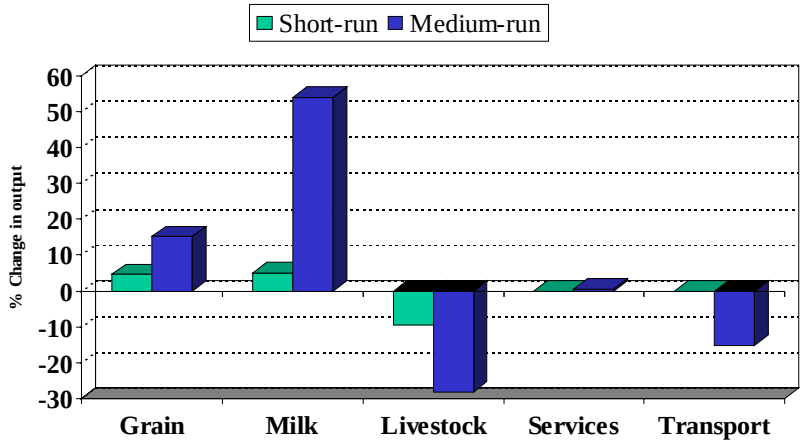


Figure 4.

a. Producer prices



b. Output

Figure 4. Commodity prices in the short and medium run and changes in output as a result of the ban on livestock exports

Note: prices in the base period = 1

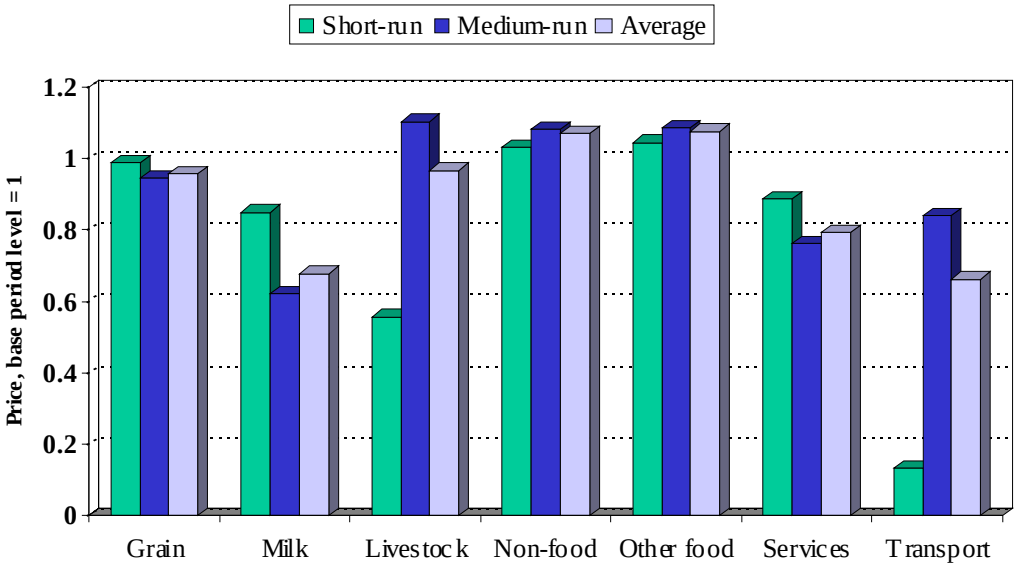


Figure 5. Change in consumer prices for different commodities in the short and medium run as a result of the ban on livestock exports

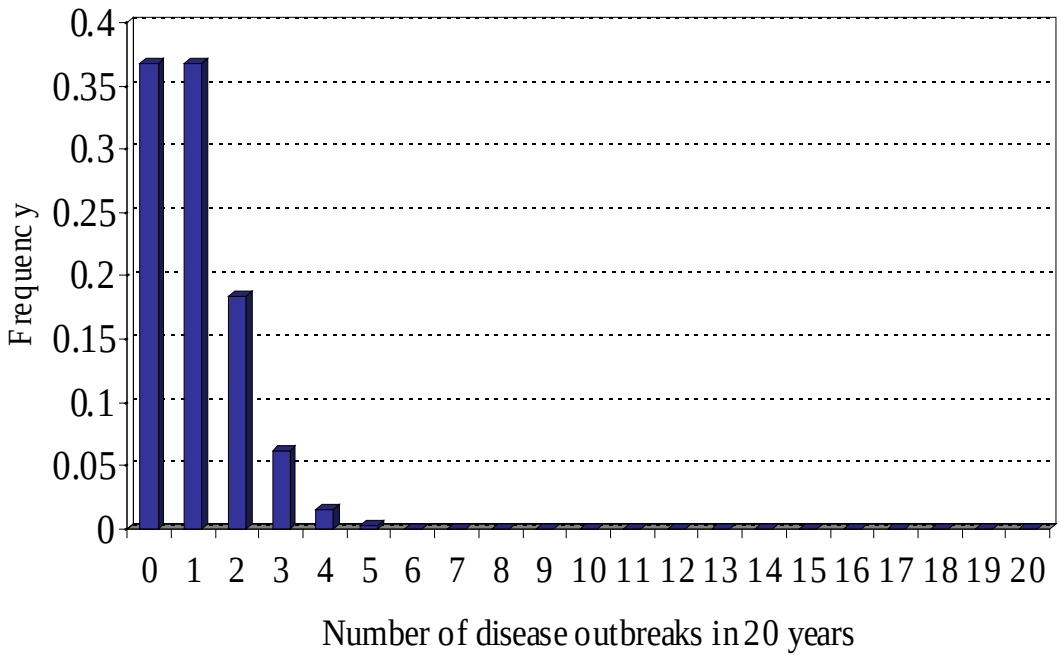


Figure 6. Poisson distribution for the number of outbreaks of Rift Valley Fever in 20 years

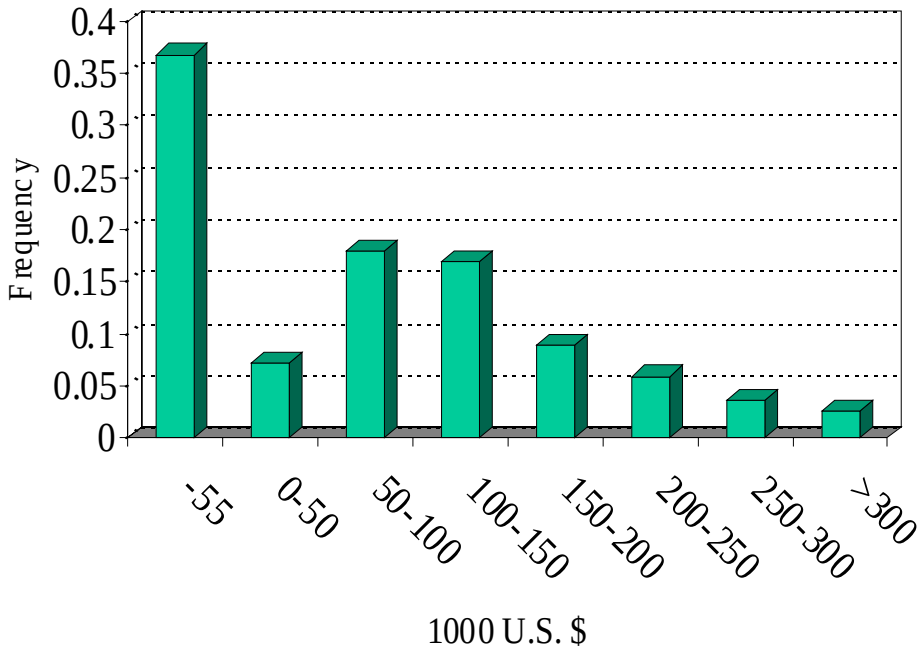


Figure 7. Distribution of present value of expected income for producers (value added) for a period of 20 years

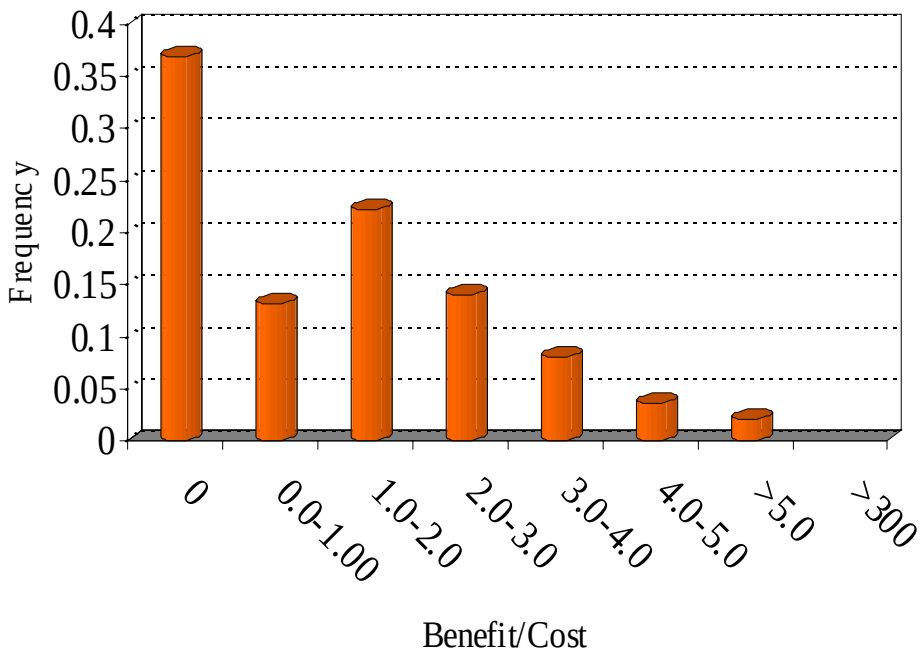


Figure 8. Distribution of the Benefit/Cost ratio for the animal health certification program

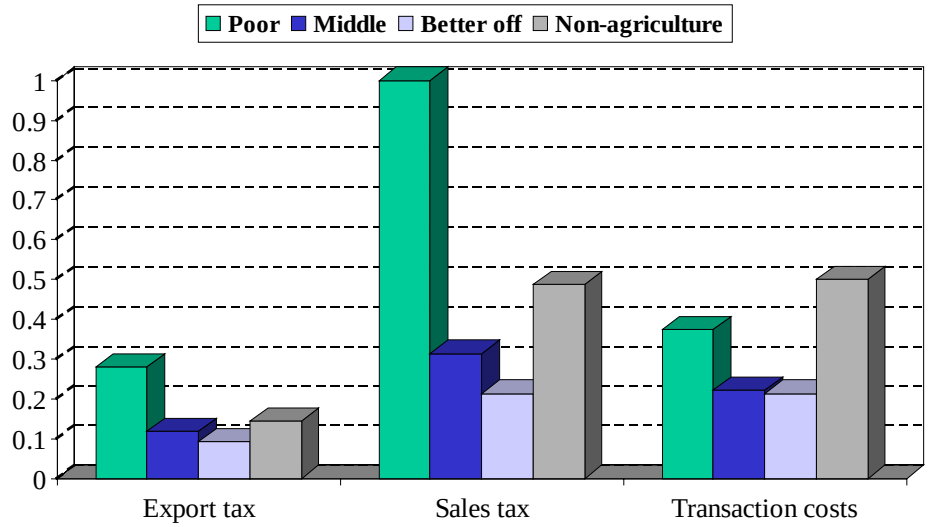
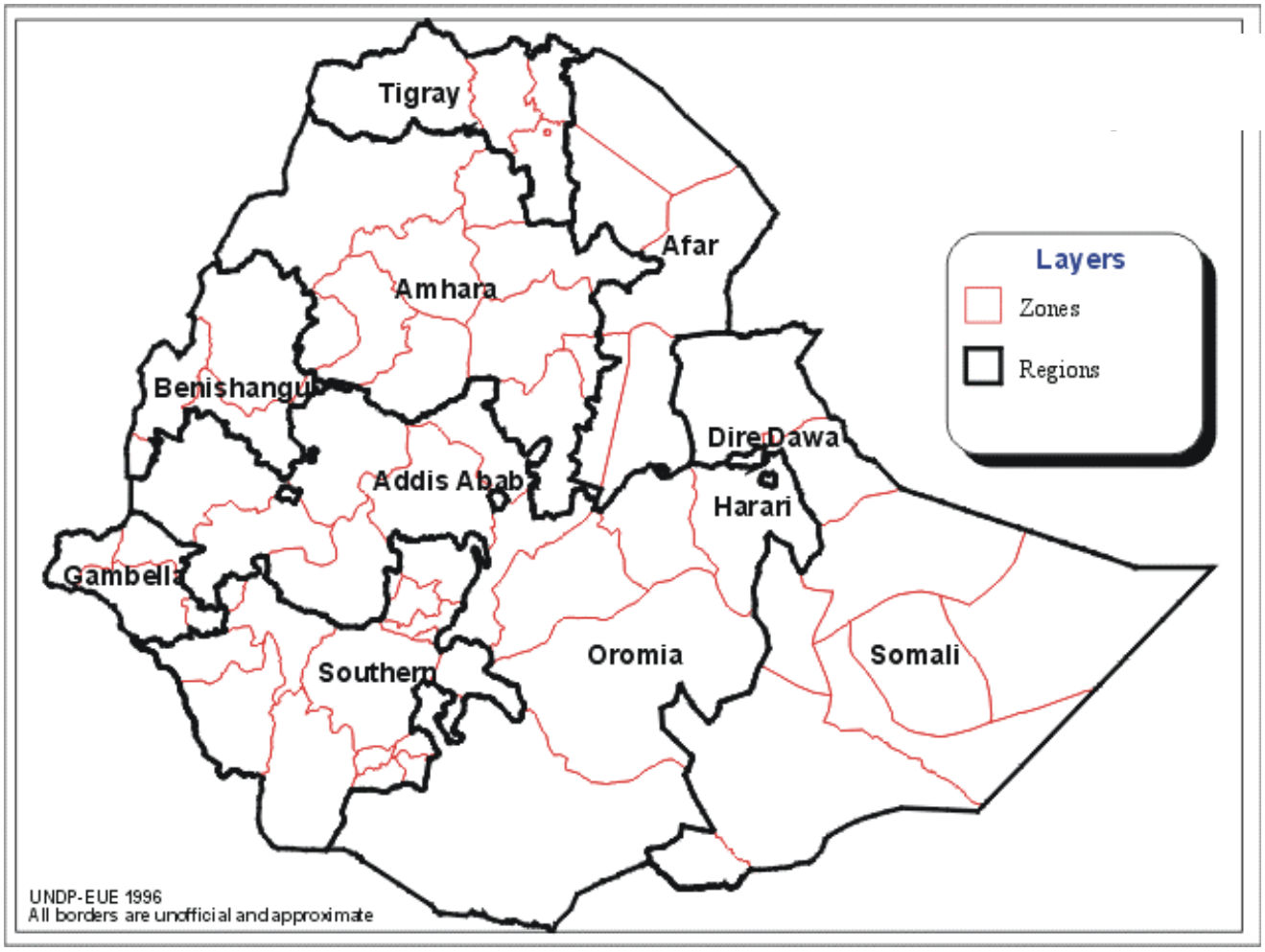


Figure 9. Probability of benefit-cost ratio being greater than 1 for different policy scenarios by wealth category

APPENDIX

Administrative regions and zones of Ethiopia



SAM for Somali region (Region 5, Ethiopia) in 1000 US dollars 1997												
		ACTIVITIES										
		1	2	3	4	5	6	7	8	9	10	11
1	Pasoralist-poor											
2	Pastoralist-middle											
3	Pastoralist-betteroff											
4	Agpastoralist-poor											
5	Agpastoralist-middle											
6	Agpastoralist-betteroff											
7	Sedentary-poor											
8	Sedentary-middle											
9	Sedentary-better off											
10	Trader											
11	Services											
12	Livestock		3926	2455		3577	4502		4684	4813	4264	
13	Milk											
14	Grain				17	257	359	230	1105	1291	551	
15	Otherfood											
16	Nonfood	3436	11796	11792	0	4	8	0	3	7	5566	4388
17	Transport										8800	1429
18	Services										644	1952
19	Trcosts-Exp											
20	Trcosts-Imp											
21	Trcosts-Dom											
22	Labor	18696	19295	8047	4765	12474	7733	5310	16339	16920	11216	100366
23	Capital	5965	16922	7410	4551	10758	6603	1666	16600	19262	10510	44474
24	Hhpast-poor											
25	Hhpast-middle											
26	Hhpast-betteroff											
27	Hhagrp-poor											
28	Hhagrp-middle											
29	Hhagrp-betteroff											
30	Hhsed-poor											
31	Hhsed-middle											
32	Hhsed-betteroff											
33	Hhurban-poor											
34	Hhurban-middle											
35	Hhurban-betteroff											
36	Salestax											
37	Exporttax											
38	Government											
39	ROW											
40	Savings-Invest.											
	Total	28097	51939	29704	9333	27070	19205	7206	38732	42292	41550	152608

SAM for Somali region (Region 5, Ethiopia) in 1000 US dollars 1997 (continued)

		COMMODITIES									
		12	13	14	15	16	17	18	19	20	21
1	Pasoralist-poor	22817									
2	Pastoralist-middle	34075									
3	Pastoralist-better off	17610									
4	Agpastoralist-poor	2596	2528								
5	Agpastoralist-middle	7834	6849	1111							
6	Agpastoralist-better off	4651	4087	1057							
7	Sedentary-poor		408	2382							
8	Sedentary-middle	2507	4347	13406							
9	Sedentary-better off	6513	684	15232							
10	Trader						41550				
11	Services						16342	136266			
12	Livestock										
13	Milk										
14	Grain										
15	Otherfood										
16	Nonfood										
17	Transport								9002	25080	11257
18	Services										
19	Trcosts-Exp	9002									
20	Trcosts-Imp			4138	6544	14399					
21	Trcosts-Dom	6214	1730	3313							
22	Labor										
23	Capital										
24	Hhpast-poor										
25	Hhpast-middle										
26	Hhpast-betteroff										
27	Hhagrp-poor										
28	Hhagrp-middle										
29	Hhagrp-betteroff										
30	Hhsed-poor										
31	Hhsed-middle										
32	Hhsed-betteroff										
33	Hhurban-poor										
34	Hhurban-middle										
35	Hhurban-betteroff										
36	Salestax	349									
37	Exporttax	7435									
38	Government										
39	ROW			42431	67150	126837					
40	Savings-Invest.										
	Total	121603	20632	83069	73694	141236	57893	136266	9002	25080	11257

SAM for Somali region (Region 5, Ethiopia) in 1000 US dollars 1997 (continued)

		FACTORS	
		22	23
1	Pasoralist-poor		
2	Pastoralist-middle		
3	Pastoralist-betteroff		
4	Agpastoralist-poor		
5	Agpastoralist-middle		
6	Agpastoralist-betteroff		
7	Sedentary-poor		
8	Sedentary-middle		
9	Sedentary-betteroff		
10	Trader		
11	Services		
12	Livestock		
13	Milk		
14	Grain		
15	Otherfood		
16	Nonfood		
17	Transport		
18	Services		
19	Trcosts-Exp		
20	Trcosts-Imp		
21	Trcosts-Dom		
22	Labor		
23	Capital		
24	Hhpast-poor	28124	10188
25	Hhpast-middle	43247	29382
26	Hhpast-betteroff	22869	15846
27	Hhagrp-poor	4672	3464
28	Hhagrp-middle	14136	10808
29	Hhagrp-betteroff	7435	6024
30	Hhsed-poor	5941	1745
31	Hhsed-middle	18651	14584
32	Hhsed-betteroff	13550	12148
33	Hhurban-poor	2910	1069
34	Hhurban-middle	20803	21755
35	Hhurban-betteroff	38821	17708
36	Salestax		
37	Exporttax		
38	Government		
39	ROW		
40	Savings-Invest.		
	Total	221160	144721

SAM for Somali region (Region 5, Ethiopia) in 1000 US dollars 1997 (continued)

		HOUSEHOLDS											
		24	25	26	27	28	29	30	31	32	33	34	35
1	Past-poor	5280											
2	Past-middle		17864										
3	Past-betteroff			12094									
4	Agpast-poor				4209								
5	Agpast-middle					11276							
6	Agpast-betteroff						9411						
7	Sed-poor							4416					
8	Sed-middle								18473				
9	Sed-betteroff									19863			
10	Trader												
11	Services												
12	Livestock												
13	Milk	1267			184						175	2841	4686
14	Grain	18731	19126	6860	2472	4745	467	1302	3830	1062	787	10589	9287
15	Otherfood	6454	12415	6386	879	3398	1552	447	2516	1750	2568	18153	17175
16	Nonfood	6914	17195	10013	1309	5712	1845	1246	6888	3379	1291	15647	29234
17	Transport										19	310	1079
18	Services	2114	5631	4001	259	850	242	748	2141	1335	95	1422	3839
19	Trcosts-Exp												
20	Trcosts-Imp												
21	Trcosts-Dom												
22	Labor												
23	Capital												
24	Hhpast-poor			964									
25	Hhpast-middle												
26	Hhpast-boff												
27	Hhagrp-poor						252						
28	Hhagrp-middle												
29	Hhagrp-boff												
30	Hhsed-poor									178			
31	Hhsed-middle												
32	Hhsed-boff												
33	Hhurban-poor												367
34	Hhurban-middle												
35	Hhurban-boff												
36	Salestax												
37	Exporttax												
38	Government												
39	ROW												
40	Savings-Invest.		3301	2194		664	189		715	656		1043	2244
	Total	40760	75532	42512	9312	26645	13958	8160	34563	28225	4935	50007	67911

SAM for Somali region (Region 5, Ethiopia) in 1000 US dollars 1997 (continued)

		OTHER INSTITUTIONS					
		36	37	38	39	40	Total
1	Pasoralist-poor						28097
2	Pastoralist-middle						51939
3	Pastoralist-betteroff						29704
4	Agpastoralist-poor						9333
5	Agpastoralist-middle						27070
6	Agpastoralist-betteroff						19205
7	Sedentary-poor						7206
8	Sedentary-middle						38732
9	Sedentary-betteroff						42292
10	Trader						41550
11	Services						152608
12	Livestock				85940	7442	121603
13	Milk				11479		20632
14	Grain						83069
15	Otherfood						73694
16	Nonfood					3563	141236
17	Transport			916			57893
18	Services			110993			136266
19	Trcosts-Exp						9002
20	Trcosts-Imp						25080
21	Trcosts-Dom						11257
22	Labor						221160
23	Capital						144721
24	Hhpast-poor			434	1049		40760
25	Hhpast-middle			826	2078		75532
26	Hhpast-betteroff			464	3332		42512
27	Hhagrp-poor			99	825		9312
28	Hhagrp-middle			288	1412		26645
29	Hhagrp-betteroff			151	348		13958
30	Hhsed-poor			87	210		8160
31	Hhsed-middle			375	953		34563
32	Hhsed-betteroff			305	2222		28225
33	Hhurban-poor			480	109		4935
34	Hhurban-middle			6229	1219		50007
35	Hhurban-betteroff			6560	4822		67911
36	Salestax						349
37	Exporttax						7435
38	Government	349	7435		120422		128206
39	ROW						236419
40	Savings-Invest.						11005
	Total	349	7435	128206	236419	11005	