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Trade liberalisation between the EU and the Mercosur countries: An economic assessment for the case of beef

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Franziska Julia Junker

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Referent: Prof. Dr. Thomas Heckelei
Korreferent: Prof. Dr. Monika Hartmann
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Abstract

Trade liberalisation between the EU and the Mercosur countries: An economic assessment for the case of beef

Franziska Julia Junker

The Mercosur countries (Argentina, Brazil, Uruguay, Paraguay and Venezuela) are the most important source of beef imports for the European Union (EU).

Despite the reductions of tariffs in the multilateral context, the EU´s tariff on beef is especially high. Argentina, Brazil, Uruguay and Paraguay however enjoy preferential access to the European beef market through multilateral and bilateral tariff rate quotas (TRQs). These TRQs are overfilled, giving rise to quota rents whose distribution is *a priori* unknown.

In the year 2005, the EU and the Mercosur countries exchanged their respective negotiation proposals. The Mercosur countries requested a significantly increased access to the beef markets of the EU. The EU responded with a less ambitious proposal. Both proposals have in common that expansion of the existing bilateral TRQs is envisaged. In addition, reductions of the in-quota tariffs are stipulated. The two proposals differ in the extent of both the TRQ expansions as well as the tariff reductions.

For almost any policy change, there are winners as well as losers.

The objective of this study is to provide an economic assessment of different options of beef trade liberalisation between the EU and the Mercosur countries.

Three problems of analysis arise in this context. One is the low level of product aggregation on which the TRQs are defined. The second difficulty is the distribution of the quota rents both on international as well as on national level, which can have important consequences for the distribution of welfare. The third inconvenience is related to the non-continuous reaction of the domestic price to imports that needs to be included in any model that seeks to represent TRQs as accurately as possible.

To provide an answer to the abovementioned research question, a partial equilibrium model operating at a very low degree of product aggregation was set up. Technically, the model is formulated as a mixed complementarity problem (MCP), which has the advantage of endogenously representing the quota rent.

From a consultation of experts from the beef producing and exporting industry, insight into the market structure, the administration of the TRQs and the implications for the allocation of the rents was gained.

It was found that the rents arising from the bilateral TRQs remain fully in the exporting country, whereas those from the multilateral schemes are captured by importers in the EU. The impact on trade is limited in the scenario based on the

proposal made by the EU, and more pronounced in the one made by the Mercosur countries. The latter leads to *de facto* free trade for Argentina and Uruguay. It was found that the quota rents and their distribution are decisive for the welfare effect in some countries and for some economic agents, i.e. an alternative distribution of the quota rents would lead to a different welfare effect.

Kurzfassung
Handelsliberalisierung zwischen der EU und den Staaten des Mercosur: Eine ökonomische Bewertung für den Fall von Rindfleisch

Franziska Julia Junker

Die Staaten des Mercosur (Argentinien, Brasilien, Uruguay, Paraguay und Venezuela) sind die wichtigste Quelle für Rindfleischeinfuhren in die Europäische Union (EU).

Die Zölle, die die EU auf Einfuhren von Rindfleisch erhebt, sind trotz des Abbaus von Handelsschranken im multilateralen Kontext noch immer hoch. Argentinien, Brasilien, Uruguay und Paraguay verfügen über präferenziellen Marktzugang im Rahmen von bilateralen und multilateralen Zollquoten (TRQs). Die TRQs sind überliefert und Quotenrenten entstehen, deren Verteilung zunächst unbekannt ist.

Im Jahr 2005 haben die beiden Staatengruppen Verhandlungsvorschläge präsentiert. Die Mercosur Staaten forderten deutlich verbesserten Zugang zu den Rindfleischmärkten der EU, der Vorschlag der EU war weniger weitreichend. Beiden Vorschlägen ist gemein, dass sie eine Ausdehnung der bestehenden TRQs zusammen mit einer Senkung des präferenziellen Zollsatzes vorsehen. Sie unterscheiden sich im Ausmaß der vorgeschlagenen Quotenausdehnung und Zollsenkung.

Bei wohl fast jeder Politikänderung gibt es Gewinner und Verlierer. Das Ziel dieser Arbeit ist eine ökonomische Analyse verschiedener Optionen für die Liberalisierung des Rindfleischhandels zwischen der EU und den Staaten des Mercosur.

Drei Herausforderungen stellen sich in diesem Zusammenhang. Eine besteht in der sehr spezifischen Definition der Produkte, die unter den Quoten importiert werden können. Die zweite ist die zunächst unbekannte Verteilung der Quotenrenten, die die Wohlfahrtswirkung aber entscheidend mit beeinflussen kann. Das dritte Problem ist die Darstellung der stellenweise nicht stetigen Reaktion des Preises eines importierten Guts auf die Menge.

Um dem ersten Problem zu begegnen, wurde ein partielles Gleichgewichtsmodell entwickelt, dessen Produktdeckung speziell auf die oben genannte Forschungsfrage angepasst ist. Die TRQs wurden über einen Mixed Complementarity Problem (MCP) – Ansatz dargestellt. Dieser erlaubt die endogene Abbildung der Quotenrenten. Zusätzlich wurde eine Befragung von Experten aus dem landwirtschaftlichen Sektor und der verarbeitenden Industrie durchgeführt, aus der Informationen über die Administration der Quoten, die herrschenden Marktstrukturen sowie der daraus resultierenden Verteilung der Quotenrenten gewonnen wurden.

Es hat sich gezeigt, dass die Quotenrenten, die mit den bilateralen Quoten in Zusammenhang stehen, vollständig im exportierenden Land verbleiben. Die, die im Rahmen der multilateralen Zollquoten entstehen, fallen dagegen vollständig den Importeuren in der EU zu. Die Simulationsergebnisse legen nahe, dass die Auswirkungen des EU Vorschlags auf die Handelsströme nur gering sind. Würde eine Einigung dagegen auf Basis des Mercosur Vorschlags erzielt, ist mit einem deutlich stärkeren Anstieg der Importe zu rechnen. Es zeigt sich, dass die Quotenrenten und ihre Verteilung für manche Länder und für manche ökonomischen Agenten entscheidend für die Gesamtwohlfahrtseffekte sind, d.h. eine alternative Verteilung der Renten würde zu anderen Wohlfahrtseffekten führen.Es hat sich gezeigt, dass die Quotenrenten, die mit den bilateralen Quoten in Zusammenhang stehen, vollständig im exportierenden Land verbleiben. Die, die im Rahmen der multilateralen Zollquoten entstehen, fallen dagegen vollständig den Importeuren in der EU zu. Die Simulationsergebnisse legen nah, dass die Auswirkungen des EU Vorschlags auf die Handelsströme nur gering sind. Würde eine Einigung dagegen auf Basis des Mercosur Vorschlags erzielt, ist mit einem deutlich stärkeren Anstieg der Importe zu rechnen. Es zeigt sich, dass die Quotenrenten und ihre Verteilung für manche Länder und für manche ökonomischen Agenten entscheidend für die Gesamtwohlfahrtseffekte sind, d.h. eine alternative Verteilung der Renten würde zu anderen Wohlfahrtseffekten führen.

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ABBREVIATIONS AND ACRONYMS

ABC	Argentine Beef Consortium
AoA	Agreement on Agriculture
AVE	Ad-valorem Equivalent
CGE	Computable General Equilibrium
CN	Combined Nomenclature
CW	Carcass Weight
DIPOA	Departamento Nacional de Inspecçao de Productos de Origem Animal
ESTJ	Enke-Samuelson-Takayama-Jugdge
EU	European Union
EUR	Euro
FAO	Food and Agricultural Organisation
FMD	Foot and Mouth Disease
FOB	Free on Board
GSP	Generalised System of Preferences
GTAP	Global Trade Analysis Project
INAC	Instituto Nacional de Carnes
MFN	Most Favoured Nation
MIO	Million
OECD	Organisation for Economic Cooperation and Development
ONCCA	Oficina Nacional de Control Comercial Agroalimentario
SENASA	Servicio Nacional de Sanidad y Calidad Agroalimentaria
SIF	Serviço de Inspeção Federal
SISBOV	Serviço Brasileiro de Rastreabilidade da Cadeia Productiva de Bovinos e Bubalinos
SPE	Spatial Price Equilibrium
TRQ	Tariff Rate Quota
UN	United Nations
URAA	Uruguay Agreement on Agriculture
w.r.t.	with respect to

WATSIM	World Agricultural Trade Simulation Model
WFM	World Food Model
WTO	World Trade Organisation

SYMBOLS USED IN FIGURES

ED	Excess Demand
ES^{lc}	Excess Demand of a large country
ES^{sc}	Excess Demand of a small country
M^{*lc}	Equilibrium import quantity of a large country
M^{*max}	Maximum import quantity
M^{*min}	Minimum import quantity
M^{*sc}	Equilibrium import quantity of a small country
M_{t1}	Import quantity unter t_1
p^{*lc}	Equilibrium price for a large country
p^{*sc}	Equilbrium price for a small country
P_d	Domestic price
P_{imp}	Import price
P_{max}	Maximum price
P_{min}	Minimum price
P_{q0}	Price corresponding to import quantity q_0^{trq}
q_0^{trq}	Initial quota quantity
q_1^{trq}	Quota quantity 1
q_2^{trq}	Quota quantity 2
q_{trq}	Quota quantity
t_1	First-tier tariff
t_2	Second-tier tariff
t_e	Tariff equivalent

1 Introduction

1.1 Motivation

The *Mercado Commún del Sur* (Mercosur), the common market of the south, was created in 1991 with the treaty of Assunción between Argentina, Brazil, Uruguay and Paraguay, Venezuela joined the group at a later point in time. Shortly after the creation of the Mercosur, the European Union (EU) and the South American country group intensified the political dialogue. One of the goals of the intensified political cooperation is the creation of a free trade area between the two country groups.

The EU and the Mercosur countries are both important players on international markets. In 2007, the EU exported a total of 1,239.8 billion Euros, of which 5.9 percent are attributable to agricultural trade (COMMISSION OF THE EUROPEAN COMMUNITIES, 2006). The Mercosur´s export value in 2007 was with 231.7 billion Euro significantly lower than the EU´s, but the share covered by exports of agricultural goods is with over 25 percent more important than in the case of the EU (FAO (n.d.), UNITED NATIONS (n.d.)).

Both country blocks are important trading partners for each other. In 2007, the EU imported a total of 48 billion Euros of goods from the Mercosur countries, of which over 40 percent originate from trade with agricultural products. Agricultural imports from the Mercosur countries account for over 20 percent of the total import value of agricultural products of the EU (COMMISSION OF THE EUROPEAN COMMUNITIES, 2008). In value terms, soybeans are the most important product, dominated by exports from Brazil. Soybeans are followed by beef[1], with the largest share again originating from Brazil. Fruits, nearly entirely from Argentina and Brazil, are another product that generated significant benefits for the Mercosur countries. In quantitative terms, the EU is an important export destination of cereals and here predominantly corn from the Mercosur countries (EUROSTAT, n.d.a).

There is considerable imbalance in the trade balances between the two country blocks: The value of merchandise exports from the EU to the Mercosur countries was only 32.1 billion Euros in 2007, so the trade balance is clearly negative. Of the total value of the EU´s exports to the Mercosur countries in 2007, less than 1.3 billion Euros or 4 percent were agricultural exports. Within the agricultural exports, by far the most important commodity in value terms are dairy products, followed by sugar and meat. An important sector to the EU in terms of exports is services, with an export value of almost 8 billion Euros in 2006 (COMMISSION OF

[1] "Beef" includes fresh, chilled or frozen meat of bovine animals (code 020110, 020120, 020130, 020210, 020220, 020230 of the *combined nomenclature*).

THE EUROPEAN COMMUNITIES, 2008). Though in bilateral trade, exports of manufactured goods and services from the EU to the Mercosur countries are more important than agricultural goods, in the export package of the EU to the world, exports to the Mercosur account with 3 percent only for a relatively small share.

These figures indicate that there is strong demand for agricultural products from the Mercosur countries in the EU, while the Mercosur countries play only a minor role as an export market for agricultural products from the EU. Hence, for agricultural goods, this study will be focused on trade flows from the South American country group to the EU.

In 2005, the EU and the Mercosur presented their respective proposals for reducing trade barriers. For some agricultural commodities, creation or expansion of existing tariff rate quotas (TRQs) and tariff reductions were put forward. For other agricultural goods, the reduction or abolition of import duties were proposed.

Soybeans, the most important commodity in the EU´s imports from the Mercosur, face zero tariff from the European Union (WTO, n.d.a), and trade liberalisation will therefore only have an indirect effect on trade flows of soybeans. For this reason, soybeans will not be considered in more detail.

Beef is the second most important commodity in the EU´s import package from the Mercosur countries, and the Mercosur countries are among the most important beef exporters in the world. For most Mercosur countries, part of this trade takes place under preferential schemes that the EU granted mostly in response to the conclusion of the Uruguay Round Agreement on Agriculture (URAA). Most Mercosur countries fully use these trade preferences. Furthermore, beef production in the EU still enjoys a relatively high degree of protection and public support. An expected pronounced negative effect on the beef sector in the EU is likely to act as an impediment to an understanding between the trade partners. This makes it an interesting and relevant case for applied agricultural trade policy analysis.

Fruits, that range third in the list of agricultural goods imported by the EU from the South American country group, are excluded from further analysis because of their minor importance to the agricultural markets of the EU as a whole. Imports of cereals are not further considered because they consist almost exclusively of imports of corn, and the existing trade preferences where not fully utilised in the past, indicating limited importance of further trade liberalisation.

For these reasons, this study is focused on beef. Non-agricultural goods and services are not further considered as their inclusion would go beyond the scope of this study.

As for almost any political change, there will be groups experiencing economic losses, whereas others can be expected to benefit from the new political environment. The aim of this study is to assess the economic consequences of a

potential agreement between the EU and the Mercosur countries for the beef sector in a quantitative manner.

As indicated above, beef imports of the EU from the Mercosur countries take place mainly under preferential trading schemes, and the EU grants these preferences through TRQs. Three main problems of TRQs in quantitative policy analysis can be identified. The first one is related to limited availability of information or the limited ability to fully exploit it. It is often the case that only very narrowly defined commodities benefit from the preferential tariff. In the worst case, the definition of the product is so specific that it can not be differentiated from other products in the available trade statistics. It may also be the case that the necessary information is available, but the model is designed at a higher product aggregation level. If this is the case, in many applications the trade preference is given to the aggregate commodity (see for example DROGUÉ et al. (2005), WEISSLEDER et al. (2008)), thereby systematically over- or underestimating the impact of trade liberalisation.

The second difficulty results from the quota rent that arises when imports are at the quota level or exceed it. Its amount and its distribution are factors that can crucially influence the impact of the policy change on both trade flows and on the welfare effects. It will be seen that in some cases, the distribution of the rent can actually determine whether a country benefits or not from a free trade agreement including TRQ expansion. Once the amount and the allocation between countries are determined, another question that arises is which actor inside the country benefits. TRQs are sometimes seen as a development instrument (see for example MATTHEWS et al. (2002)), and the allocation of the quota rent within the country may give insight on the effectiveness of TRQs as a development instrument. The questions of rent allocation between countries and inside the chain are closely related to the administration of the licences to import or to export and therefore have to be analysed on a case-to-case basis. This is probably one of the reasons why theses questions have been widely ignored in both large and small scale quantitative works.

The third inconvenience is related to the behaviour of the tariff and modelling techniques. Problems arise from the non-continuous reaction of domestic prices to imports that needs to be included into any model that seeks to represent TRQs as accurately as possible.

The study presented hereinafter adds to the existing research in the following ways:

- First, it provides a detailed assessment of possible trade liberalisation scenarios for the case of beef, employing a simulation model working at low level of product aggregation.

- Second, it gives insight into the distribution of the quota rents on international level as well as inside the production chain for the case of beef trade between the EU and the Mercosur countries.

- Thirdly, on the methodological side, it illustrates how bilateral trade can be represented through a Takayama-Judge model operating at a low level of product aggregation.

1.2 Methodological approach

To address the research question outlined above, a dual approach was taken. On the one hand, a partial equilibrium model was set up to assess different options for trade liberalisation in a quantitative manner. On the other hand, a consultation of experts was carried out to shed more light on the issue of the distribution of quota rents.

To best represent the trade relations between the EU and the Mercosur countries, this study employs a bilateral trade model. This class of models supplies information on not only both imports and exports of a region, but also on source and direction of the shipment, that is the trade flows between each possible pair of countries and thus goes further than the net-trade models that are based on the orthodox trade theories founded on the Ricardo-model and the Hecker-Ohlin-model (for an overview of international trade theories see GANDOLFO (1998)).

There are two main approaches for modelling bilateral trade flows: So-called Takayama-Judge models, which will here be more correctly referred to as Enke-Samuelson-Takayama-Judge (ESTJ)-models, and Armington models.

ESTJ-models were developed by ENKE (1951), SAMUELSON (1952) and TAKAYAMA et al. (1964), and render the equilibrium prices and trade flows of spatially separated markets, including the possibility of arbitraging behaviour (ANANIA et al., 1991).

Armington models are the main competitor of the ESTJ-models. Paul S. Armington developed an approach for modelling bilateral trade flows based on a theory of demand that distinguishes products by origin, that is, products are no longer homogenous (ARMINGTON, 1969). The Armington-Approach is underpinned by the theory of consumer's preference of differentiated goods, either in terms of varying over time, exhibiting "love of variety" or having a "most preferred good". Consumers show a different willingness to pay for the same commodity depending on its place of production, hence prices do not necessarily equalise across countries.

There are several deficiencies of the Armington approach in applied agricultural trade modelling. One is the fact that changes induced through shocks will always take place only in relation to the existing market share, hence a country

with a small share in an import market can not significantly expand its exports unless the elasticities of substitution are arbitrarily set to high values. Another weakness is the fact that a zero trade flow can not become non-zero in the simulation. This can be overcome by setting trade flows in the initial situation to an arbitrary small value, but this is fairly unattractive as the value chosen lacks empirical validation and at the same time influences the modelling results considerably. Unpublished work carried at the Institute for Food and Resource Economics of the University of Bonn suggests overcoming this problem by introducing a commitment parameter into the CES utility function (see WITZKE et al. (2005)).

However, as in the context of this study, a low level of product aggregation was required anyhow, the Armington approach was ruled out, and the model specified as a Takayama-Judge model at a low level of product aggregation.

1.3 Structure of the study

As mentioned, beef trade between the two country groups in the focus of this study takes predominantly place under TRQs. In order to set the ground for the further analysis, the study starts off with a thorough discussion of the economic theory of TRQs, their administration and related aspects of rent distribution.

In the following, a detailed description of the trade policies and patterns of beef trade between the EU and the Mercosur countries is given. This comprises imports of the EU from the Mercosur countries, as well as an analysis of the utilisation of the existing trade preferences granted by the EU to the South American states.

Chapter 4 relates these theoretical aspects to the reality of TRQ administration and rent distribution for imports of beef under the different preferential schemes of the EU from the Mercosur countries.

After that, the design of the model developed for this specific research question is described. The description includes basic features like the covered country and commodity space, but also comprises more detailed information on model specification and data issues.

Against this background, results of the quantitative scenario analysis are presented. These include the development of trade flows along with a welfare assessment for the different groups involved. In the latter, special attention is paid to the role and the distribution of the arising quota rents. The deterministic simulations are complemented with an analysis of the sensitivity of the model outcomes to the parameter values.

The final chapter provides a summary and discusses the limitations of the work. Finally, conclusions from the analysis are drawn.

2 Economics of Tariff Rate Quotas

TRQs are a policy instrument which has attracted a lot of attention from researchers in agricultural economics in recent years. In the Uruguay Agreement on Agriculture (URAA) it was agreed to transform all non-tariff barriers into tariffs. This partially resulted in prohibitive tariffs, which stood in contrast to the commitment to maintain all market access existing prior to the URAA, a clause called "current access" (IATRC, 2001). In detail, members were required to preserve the market access opportunities in place in the period from 1986 to 1988. In cases where this was challenged by the high tariffs resulting from the tarification process, TRQs were used to assure that the historic levels of trade were conserved (WTO, n.d.b).

If the market access in the base period had been less than 5 percent of domestic consumption of the respective product, a second provision denominated "minimum access" gave further rise to the use of TRQs. It implied that all member countries of the World Trade Organisation were to open a minimum market access of 5 percent of domestic consumption on a most-favoured-nation (MFN) basis. As in the case of the current access opportunities, TRQs have been used to reach the minimum access opportunities (WTO, n.d.b).

This boost in the use of TRQs has called upon many researchers to dedicate themselves to the analysis of economic aspects of TRQs. The aim of this chapter is to give an overview of the existing economic theory underlying TRQs.

2.1 Definition

As its name says, a tariff rate quota consists of both tariffs and quotas. An import level q^{trq} is fixed up to which a relatively low first-tier tariff t_1 is charged on all products for which the quota is defined. Once imports exceed this fixed level, the second-tier tariff $t_2 > t_1$ is charged. Unless the second-tier tariff is prohibitive, TRQs differ from a regular import quota as imports can occur at a level higher than the quota by paying the higher second-tier tariff t_2 (BOUGHNER et al., 2000). There can be more than two tiers in the tariffs and quota levels. However, to the author's knowledge this is neither foreseen in the WTO rules, nor are there any examples for this known from agricultural trade between non-WTO member countries. The irrelevance and probable non-existence of TRQs with more than two tariffs is further supported by the fact that economic literature on the economics of TRQs is limited to two-tier tariff rate quotas, typically consisting of two tariffs and consequently one quota level.

Apart from the general definition of TRQs given above, there are different specifications of TRQs. A TRQ can be open to all exporting countries or import

quantities can be reserved for a specific country or a limited group of exporting countries. In the first case, each country has the same right to export under the first-tier tariff until the quota level is reached. In the second case, a specific country or country group has exclusive access to the importing country's market at the low tariff. This criteria is referred to as "bilateral" versus "multilateral", "allocated" versus "non-allocated", "country specific" versus "non country specific", or "preferential" TRQ. Another distinction refers to legal aspects of the TRQ. Some TRQs are notified to the WTO, but importing countries can, in addition to their minimum requirements in terms of minimum access or current access, open autonomous, i.e. un-notified import quotas. These can be preferential or multilateral (WTO, n.d.b).

The term TRQ will here be used to denominate a two-tier tariff-rate quota. The term quota will be used synonymously. The case of more than two tiers is empirically not relevant and therefore omitted.

2.2 Basic Economics of TRQs

As already mentioned, TRQs are composed of three elements:

- A low first-tier tariff,
- the import quota which determines the import level from which on the second-tier tariff will be charged,
- the higher second-tier tariff.

For any quota, only one of the three elements will directly determine quantities and prices and thereby the market equilibrium (MÖNNICH, 2003a). This characteristic will be illustrated in this section.

In the academic literature, two different ways of depicting the economic effects of TRQs can be found: Some authors represent it by a kinked excess demand curve (see, for example, BOUGHNER et al. (2000), DE GORTER et al. (1999)), while others prefer to depict it by a kinked excess supply curve (see SKULLY (2001), MÖNNICH (2003b)). Here, the basic mechanism and the three possible regimes of a tariff-rate import quota will be explained with the effect of the policy measure incorporated into the excess supply curve.

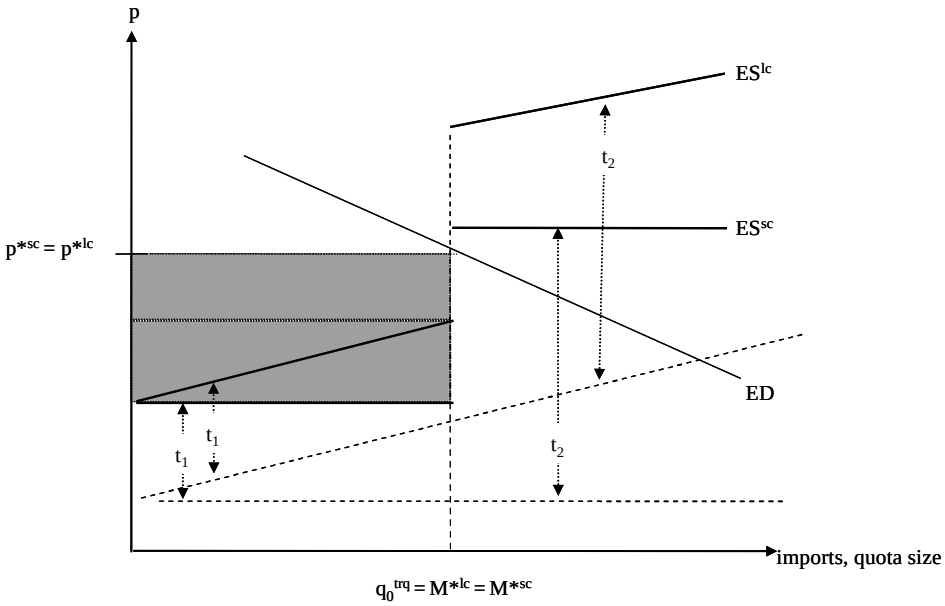
Binding Quota

The case of a binding quota, i.e. when the quota itself is the element determining the market equilibrium, is illustrated in Figure 1 for the import market of both a small importing country and a large importing country. The excess supply curve *ES* has a positive slope in the case of a large importing country indicated by su-

perscript *lc*, and is totally elastic for a small importing country, indicated by the superscript *sc*.

The respective excess supply curve is shifted upwards by the amount of the tariff[2]. It becomes clear from Figure 1 that for an import quantity smaller q_0^{trq} the supply curve is shifted upward by the lower in-quota tariff t_1. Once imports exceed q_0^{trq}, the higher second-tier tariff is applied, causing a more pronounced upward shift of the supply function and introducing a totally inelastic section of $(t_2\text{-}t_1)$ at q_0^{trq} into the excess supply function. The effective excess supply curves including the tariff are depicted by the bold solid lines.

Figure 1 Binding quota



Source: Own representation

The question which element is effective for the respective tariff-rate import quota depends on where the excess demand curve *ED* intersects *ES*. In Figure 1, *ED* intersects the *ES* curve in its inelastic section, this being true for both assumptions on the size of the importing country. The equilibrium level of imports for the large country M^{*lc} as well as for the small country M^{*sc} is exactly at the quota level, that is q_0^{trq}. The resulting market prices p^{*sc} and p^{*lc} are identical for both countries.

[2] For easier understandability, a specific tariff is assumed, which results merely in a parallel upward shift of the respective supply function. An ad-valorem tariff would result in a pivot of the respective supply function.

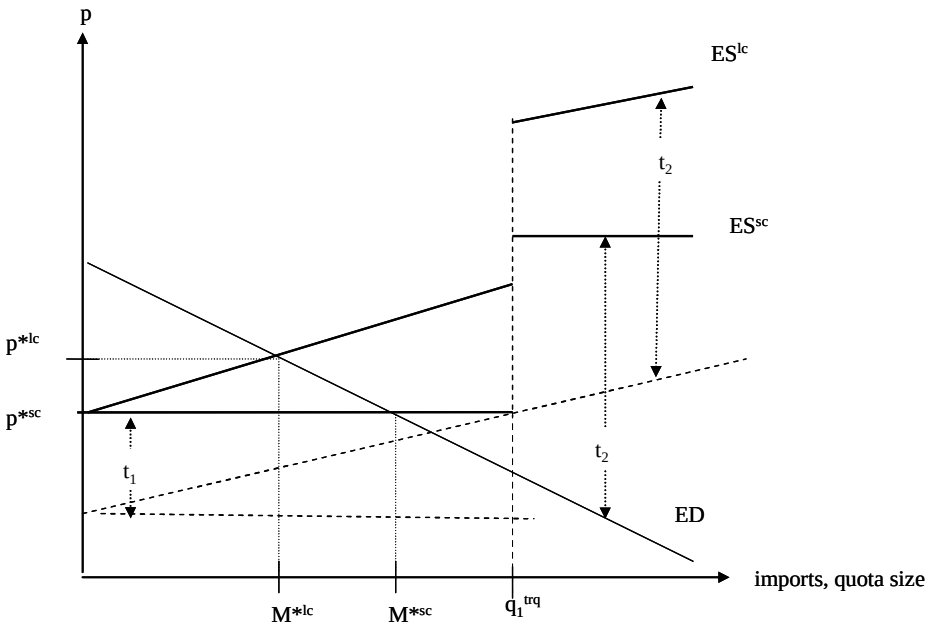
In this situation, the domestic price in the importing country is higher than the import price plus the first-tier tariff. This is so because of the quantitative restrictions placed on imports. The difference between the import price and the domestic price multiplied with the imported quantity is an economic benefit called the quota rent. In Figure 1 it is represented by the two shaded rectangular areas, the upper part for the case of the large importing country, both shaded areas for the illustrated small importing country.

This case, in which the quota itself is the instrument determining the amount of imports and the domestic price is referred to as "(import) quota regime" (BOUGHNER et al., 2000), (IATRC, 2001), or "binding quota" (MÖNNICH, 2003a) in the academic literature.

Quota under-fill

A different situation arises when the quota level is extended as it is shown in Figure 2. Now, *ED* intersects *ES* to the left of the new quota level q_1^{trq} under both assumptions on the size of the country.

Figure 2 Quota under-fill



Source: Own representation

For the large importing country the equilibrium amount of imports is M^{*lc} at the price p^{*lc}, for the small importing country market equilibrium is reached at M^{*sc} and p^{*sc}. Evidently, this is a situation in which the quota itself has no influence on the market equilibrium: The policy instrument determining import quanti-

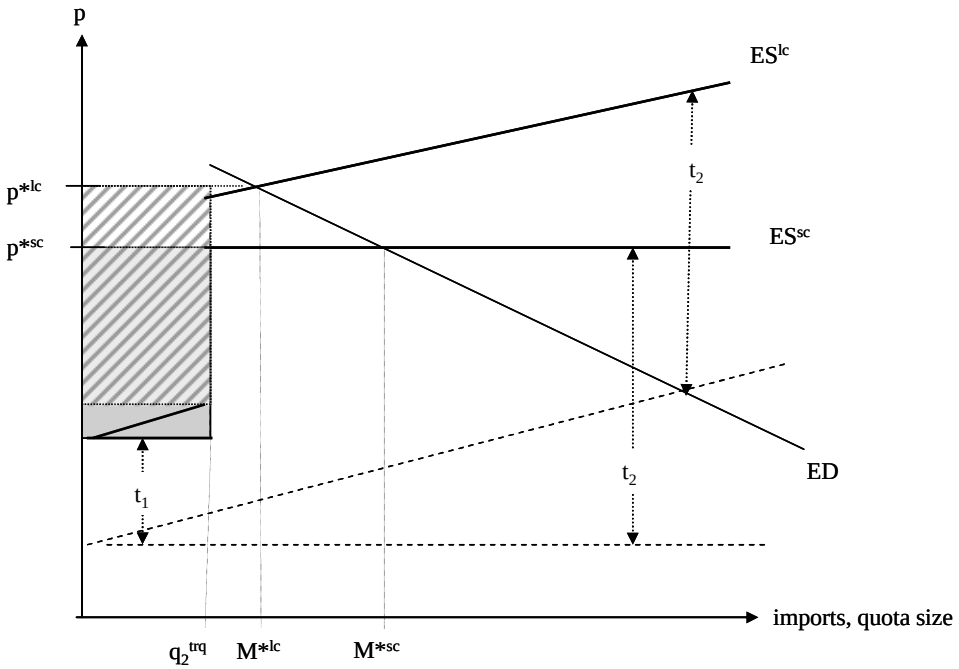
ties and prices is first-tier tariff alone, a setting in which the second-tier tariff and the quota are redundant. No quota rents arise. This situation is referred to as "binding in-quota tariff" (MÖNNICH, 2003a), "in-quota tariff-regime" (IATRC, 2001), "t_1 regime" (DE GORTER et al., 1999) or "quota under-fill".

Quota overfill

Of the three policy instruments representing the tariff rate quota, not only the first-tier tariff or the quota itself can be effective, but also t_2, given that it is not prohibitively high. This case is illustrated in Figure 3, in which the quota level q_2^{trq} is reduced such that the *ES* curve intersects *ED* to the right of q_2^{trq}. The equilibrium for the large country is M^{*lc}, the corresponding market clearing price is p^{*lc}. For the small country, imports are at M^{*sc} and the domestic market price is p^{*sc}. Clearly, this is a situation in which the level of imports exceeds the quota and t_2 is the instrument defining prices and quantities. In this case as opposed to quota-under fill, quota rents can be observed even though the quota is not binding. This is due to the fact that all imports up to the quota level are only charged t_1, but are sold at the higher price including the second-tier tariff. In Figure 3, the quota rents for the small country case are depicted by the shaded area, the quota rents in the large country case by the hatched area.

In the academic literature, this situation is referred to as "second-tier tariff regime" (BOUGHNER et al., 2000), "out-of-quota tariff regime", "binding out-of-quota tariff" (MÖNNICH, 2003a) or "quota overfill".

Figure 3 Quota overfill

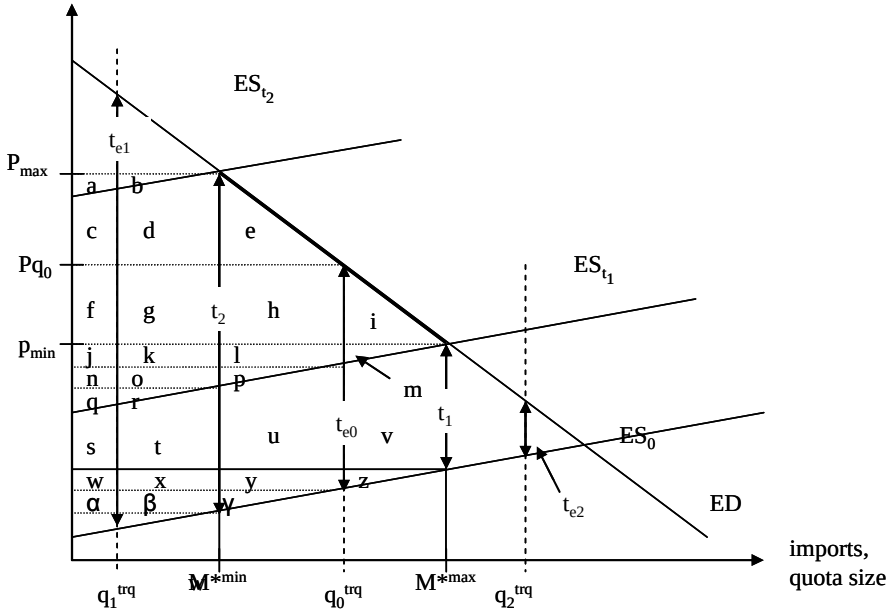


Source: Own representation

The conditions for the three tariff rate quota regimes to be effective are summarized in Figure 4[3]. It can be seen that if there was only the in-quota tariff t_1, the importing country would purchase the commodity in question up to an amount of M^{*max}. If on the other hand, only the second-tier tariff t_2 was in place, the equilibrium amount of imports would be M^{*min}. Consequently, if the quota lies to the right of M^{*max} like q_2^{trq}, quota under-fill will occur since the equilibrium is to the left of the quota. If on the other hand the quota lies to the left of M^{*min} as for example q_1^{trq}, an amount greater than the quota will be imported, because even including the second-tier tariff, the equilibrium amount of imports lies to the right of the quota level q_1^{trq}. In other words, the quota itself will only then be the binding instrument, when it lies between M^{*min} and M^{*max} as for example q_0^{trq}.

[3] For the ease of representation, only the case of a large importing country and, again, a specific tariff is represented.

Figure 4 TRQ regimes



Source: Own representation, based on IATRC (2001)

It should be mentioned that the quota size is not the only variable determining which of the three policy parameters of the TRQ is effective. Situations in which the excess supply or excess demand curves shift such that a different TRQ regime as in the initial situation is in place can be imagined easily.

The reasoning described in this section can be attributed to several authors, e.g. SKULLY (1999), BOUGHNER et al. (2000) and MÖNNICH (2003b).

The Concept of the Tariff Equivalent

For further analysis of the economic effects of TRQs, the concept of the tariff equivalent t_e of a quota shall be introduced here. If the quota is the binding instrument, the tariff equivalent is the absolute or percentage difference between the domestic price and the import price. The tariff equivalent can then be calculated according to the two formulas below.

$$(1)\quad t_e = (p_d - p_{imp}) / p_{imp}$$

for an ad-valorem tariff, and

$$(2)\quad t_e = (p_d - p_{imp})$$

for specific tariffs (DE GORTER et al., 1999). In case of first- or second-tier tariff regimes, the tariff equivalent of the (non-binding) quota is the vertical difference between the excess supply curve without tariff ES_0 and the excess demand curve at the quota level. This can be seen in Figure 4, where t_{e0}, t_{e1} and t_{e2} are shown for the three different quota sizes. It can be seen that an expansion or a cut of the quota level changes its tariff equivalent, an expansion leading to a reduction of t_e, a cut in the quota level to an increase of t_e.

Depending on which parameter of the TRQ is binding, the following can be stated on the relation between t_e, t_1 and t_2 along the lines of DE GORTER et al. (1999):

Table 1 Tariff equivalent and TRQ regime

imports and quota quantity	tariff equivalent	effective element
$q_{trq} \leq M^{*min}$	$t_e \geq t_2$	t_2
$M^{*min} \leq q_{trq} \leq M^{*max}$	$t_1 < t_e < t_2$	q_{trq}
$q_{trq} \geq M^{*max}$	$t_e \leq t_1$	t_1

Source: Own representation, based on DE GORTER et al. (1999)

2.3 Welfare and distributional effects of liberalising TRQs

The question which of the three parameters constituting a TRQ should be liberalised in order to provide more traded quantity and maximum overall welfare gains is easy to answer: The one that is effective. But the overall welfare gains are usually not the prime interest of the negotiating parties and stakeholders, they are rather interested in maximizing welfare gains for themselves.

To see who loses and who benefits from liberalisation of elements of TRQs, the distribution of the welfare gains and losses between the trading partners is treated here. It is assumed that the exporting country is a net-exporting country, and that the importing country is a net-importing country. This is not a serious constraint in this context, as the EU has become a net-importer of beef in 2004 (OECD, n.d.a), and the Mercosur countries treated here are net-exporters of this commodity. This assumption implies that the increase in producer surplus will always exceed the losses of consumer surplus in the exporting country. For the importing country, the opposite is true: Gains of consumer surplus will always outweigh the losses incurred by the producing sector.

Quota expansion

Expansion of a non-binding quota. In cases in which the quota is not binding, either t_1 or t_2 must be effective. If t_1 is binding, a quota increase will bring no

change at all, the market equilibrium as well as the distribution of welfare remain identical.

On the other hand, if t_2 is binding, quota expansion will not affect prices or traded quantity, but it will reduce the tariff revenue from the second-tier tariff and increase the quota rent. Going back to Figure 4, and assuming that the quota level is q_1^{trq} in the initial situation and it is expanded to M^{*min}, which is the maximum quota size with a still binding t_2. Then the state incurs a loss of tariff-revenue by *(-b-d-g-k-o)*. This income is transformed into quota rent, increasing it from *(a+c+f+j+n)* before the quota expansion by *(b+d+g+k+o)*. Thus, enlarging a quota when t_2 is binding represents a mere redistribution of income from the state to the owner of the quota. Whereas the exporting country will never incur any loss but might even benefit if the rent accrues to it, the effect for the importing country is neutral if it gains the rent, but potentially negative if it is not able to capture the rent.

Expansion of a binding quota. The maximum welfare effect from expanding a binding quota *($t_e<t_2$)* can be gained by expanding it to a point from which on it is not binding anymore, that is, when $t_e<t_1$ or, equivalently, the quota level lies to the right of M^{*max}.

In Figure 4, the maximum welfare effects for expanding a binding quota can be shown by shifting the quota level from q_0^{trq} to M^{*max}, causing domestic prices to fall and import prices to rise. The importing country has a net benefit of consumer and producer surplus to the extent of area *(+f+g+h+i)*, the exporting country to the extent of area *(w+x+y+z)*. The state budget of the importing country will benefit from the quota expansion, its income from t_1 rises by the tariff times additional imports, that is area *(+m+v)*[4]. As already described, consumers in the exporting country and producers in the importing country experience losses, but these losses are always offset by the welfare increase of consumers in the net-importing country and producers in the net-exporting countries.

This case is somewhat more complex for the quota rent. The expansion from q_0^{trq} to M^{*max} (or to its right) represents a case where the quota rent, which was area *(f+g+h+j+k+l)* before the policy change, vanishes, clearly harming the owner of the quota. But if the quota level was for example at (or very close to) M^{*min} to start with and is then expanded to q_o^{trq}, it is undetermined whether the owner of the quota gains or looses from the quota expansion: While area *(-a-c-b-d-n-o)* is a loss of quota rent, *(+h+l)* are gained. Whether quota expansion is favourable for the owner of the quota is contingent on the extent of the quota expansion and the price elasticity of the excess demand curve. All that can be said is that if the quota rent decreases and the importing country was the owner of the

[4] Actually, the effect on the state budget is *+(j+k+l+m+v) +(-w-x-y)*, but area *(-w-x-y)* has the same value as *(j+k+l)*, the two cancel each other out and merely *(m+v)* are left.

rent, this loss has to be compensated by increases of consumer surplus and state revenue, whereas an increase of the quota rent would contribute to the compensation of losses of producer surplus. If on the other hand the exporting country was the owner of the quota rent and it decreases, it is no longer certain that the exporting country would benefit from quota expansion. In contrast, an increase of the quota rent would underline the exporting countries interest in a quota expansion.

Second-tier tariff reduction

Non-binding second-tier tariff reduction. If the first-tier tariff or the quota is binding, a reduction of the second-tier tariff will not trigger any changes neither to the market equilibrium nor to the welfare distribution.

Binding second-tier tariff reduction. The case of a binding t_2 can be seen in Figure 4, e.g. for q_1^{trq}. The most extreme case for a second-tier tariff reduction would be to reduce it to the level of t_1. Not surprisingly the overall welfare effect of the t_2 reduction is positive as imports increase from M^{*min} to M^{*max}, import prices increase and domestic prices decrease from p^{max} to p^{min}. The importing country has a net gain of area $(a+b+c+d+e+f+g+h+i)$ resulting from changes in consumer and producer surplus, exporters benefit from increased export quantities and prices by area $(w+x+y+z+\alpha+\beta+\gamma)$. The importing country incurs a loss of tariff revenue from t_2 by area $(-b-d-g-w-x-\alpha-\beta)$, but at the same time gains tariff revenue from t_1 by area $(n+j)+(l+m+p+u+v)$. The quota rent, which was $(a+c+f+j+n)$ in the initial situation, is reduced to zero, part of it being transformed into consumer surplus $(a+c+f)$.

For the importing country, it is undetermined whether it will gain or loose from the policy change. It depends on whether the losses of tariff revenue from the abolition of t_2 will be outweighed by the gains from t_1 times the additional imported quantity. If the importing country was the owner of the rent in the initial circumstances, its loss has to be compensated as well by gains in consumer surplus in order to have a net welfare gain.

The situation is clear for the exporting country if it was *not* the owner of the quota rent prior to the policy change: It will obviously benefit from the second-tier tariff reduction. If the quota rent was accruing to the exporting country, the gain of producer surplus must outweigh the loss of the quota rent and consumer surplus in order to ensure a beneficial effect on the exporting country.

First-tier tariff reduction

Non-binding first-tier tariff reduction. In a situation in which the quota or t_2 is binding, reducing the first-tier tariff will not change the market equilibrium. What will in fact be altered is the distribution of welfare. In both cases, reducing t_1 will

reduce the tariff revenue generated to the importing country and increase the quota rent by the same amount (not shown in Figure 4).

As for the expansion of a non-binding quota, this policy change would imply a shift of income from the state to the owner of the quota rent. The importing country might loose if it is not able to capture the increased rent, whereas the exporting country will either benefit if the rent accrues to it or remain unaffected.

Binding first-tier tariff reduction. If on the other hand the first-tier tariff is in fact the binding instrument, its complete abolition will always bring welfare gains to both trading partners. The amount and distribution of the welfare gains are equal to the ones of every simple tariff reduction and are therefore not described here.

2.4 Quota administration methods

With the agreements of URAA and TRQs coming into force, countries also had to find answers to the question how to allot the rights to trade under the preferential duty among importers. Seven categories of principal administration methods can be distinguished as shown in Box 1.

Box 1 Quota administration methods and additional conditions

Quota administration methods

Applied tariffs: The quota part of the TRQ is not applied; the products concerned enter the territory at the in-quota tariff rate in unlimited quantities.
First-Come, First-served: Shares are not allocated; imports are allowed to enter at the in-quota tariff until the quota quantity is reached. Then, the second-tier tariff applies to any further shipment.
Licence on demand: Licences are issued as a function of quantities demanded. When the licence requests exceed the available quantity, they are often reduced *pro rata*.
Auctioning: Licences are sold through a competitive bid system.
Historical allocation: The licences are distributed in relation to historic transactions.
State trading entities: The rights to trade under the preferential levy are transferred to state trading entities.
Producer groups or associations: Producer groups or associations are granted the right to control for imports under the preferential tariff rate.

Additional conditions

Domestic purchase requirement: To import under the TRQ and to obtain the lower duty rate, purchase of domestic production of the product to be imported is required.
Limits on shares per allocation: A condition limiting the quantity of the share of the TRQ that can be assigned to each importer or shipment
Export certificates: This condition requires that an export certificate, a certificate of origin or authenticity is issued by the exporting country.
Past trading performance: Similar to the allocation based on historic imports, this additional condition limits eligibility to established importers. This requirement can be combined with any of the administration methods outlined above.

Source: De Gorter et al. (2004), p. 99.

An importing country can require that the import licences, distributed to importers through any administration method, need to be matched with an export certificate handed out by the exporting countries´ authorities. Export certificates are particularly interesting for the exporting countries: They provide economic

agents in the exporting country with information on the duty that is going to be charged on their product.

For a thorough discussion of the economics of TRQ administration methods see SKULLY (1999) and IATRC (2001).

2.5 Who captures the rent? Factors affecting rent distribution and dissipation

In the discussion of welfare effects of liberalisation of elements of TRQs in section 2.3, the final distribution of welfare could not always be determined in a precise way because a general statement on which of the trading partners gains the rent could not be made. On top, the circumstances can be such that the rent is not generated at all. To gain further insight into these issues, the determinants of the rent distribution will be briefly discussed in the following, along with possible factors contributing to its dissipation.

Rent distribution

The distribution of rents can be considered basically at two levels: First, at the international level, that is between countries, or second at national level, that is between the different groups of economic agents. At any level, the distribution of rents depends on to whom of the trading partners import or export rights are assigned to. This is because, as BOUGHNER et al. (2000) point out, holding the rights to trade is a necessary, though not sufficient condition for holding the right to the rent. Market and bargaining power are factors that are likely to be critical for the rent distribution and go beyond the allocation of formal rights to trade. BOUGHNER et al. (2000) distinguish three scenarios with different outcomes for the distribution of the rents:

In the first case, only rights to import are issued (no rights to export are assigned), and actors on the exporting side are perfectly competitive and have no market power. In these conditions, the rents accrue to the importing side.

The authors analyse a second setting in which no right to import is allocated to perfectly competitive economic actors on the importing side, and export licences are issued and/or agents on the exporting side have market power. According to the authors, these are circumstances that lead the appropriation of the rent by the exporting side, which can be explained by the fact that importers have no negotiation power over the importing side.

In the third case, the authors assume that rights to import are allocated on the importing side, and that export licences are issued on the exporting side. In these circumstances the importing and the exporting side have equal formal rights. The authors point out that this does not imply an equal distribution of the rent, as the economic agents in the importing and/or exporting country may have market

power and may be able to negotiate over the available rents (BOUGHNER et al., 2000). In the extreme, this could lead to full appropriation of the rent on only one side.

It should be born in mind that this discussion is based on the idea that importing and exporting companies are domestic to their respective country. One could think of an exporting company to open branches in the importing country and conduct both import and export, preventing domestic firms in the importing countries from participation in the business or vice-versa, changing the distribution of the rent on international level.

Parallel to the international level, holding the right to trade does not mean that the economic rent is not further distributed within the country. One could think of constellations that force the entities that receive the rights to export or to import to share the quota rents with other economic actors that are not directly involved into international trade. If for example the commodity in question was scarce, the producers of this commodity, provided they had the knowledge that their produce is intended for exportation under a preferential tariff, could bargain for part of the quota rent when selling their product to the entities engaged in trade. Similarly, vertical integration could lead to sharing of the rent between actors directly involved in trade and others.

Rent dissipation

In the comparative-static analysis carried out earlier in this chapter, it has been implicitly assumed that markets are perfectly competitive on the supply as well as on the demand side and that there are no transaction costs. Only under these circumstances, one can assume that rents are created[5] to the full extent. In the following, various factors will be considered that contribute to the partial or complete dissipation of rents.

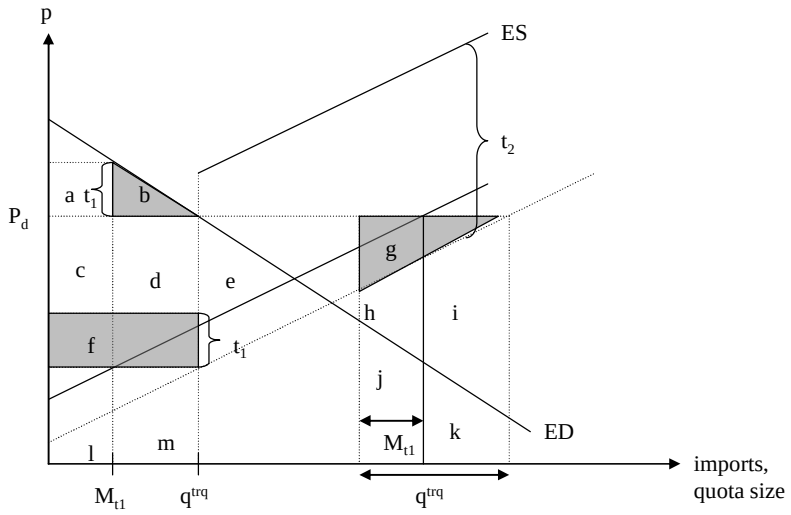
Rent dissipation due to inefficient quota allocation. Relaxing the assumption on competitive markets, parts or the entire rent can be dissipated due to inefficient resource allocation. Two mechanisms can be distinguished through which a TRQ can affect market efficiency in a negative way. The first stage is the one at which the rights to export or import are assigned. This can be illustrated by means of Figure 5. When the quota rights[6] are assigned to the lowest cost producer, the domestic price would be at p_d with import occurring up to q_{trq}, a quota rent of area *(c+d)* and tariff-revenue from t_1 of the shaded area *f*. If in turn the quota rights are

[5] Rent creation is here understood as the emergence of the economic rent due to the quantitative restriction, not as process of the political economy where stakeholders lobby for policy measures that provide them with an economic rent (FLOWERS, 1987).

[6] It is assumed that the economic setting is such that the quota is binding.

assigned to the highest cost producer, importers have no other choice than to purchase from him paying price p_d. The rent is completely dissipated (BOUGHNER et al., 2000)[7]. The result is complete dissipation of the rent, quota under fill and additional deadweight losses (see BOUGHNER et al. (2000)). All quota administration methods that discriminate against certain suppliers like the one based on historical shares or state trading entities are prone to this effect (IATRC, 2001).

Figure 5 Losses of efficiency in the presence of TRQs



Source: Author, based on BOUGHNER et al. (2002)

Even if no export rights are allocated and exporters compete against each others, inefficiencies can arise. In cases in which a binding quota is in place, the higher domestic price enables higher cost producers that would otherwise have shut down to stay in business and crowd low-cost suppliers out. Obviously, the higher the potential rent is, the higher the risk of inefficient producers entering the market (SKULLY, 1999).

Rent dissipation due to rent seeking activities. Other than through inefficient allocation of quota rights, the quota rent may be dissipated due to rent seeking activities. CHAU et al. (2003) distinguish two strands of economic literature in this context. One is the rent-seeking literature focused on the economic agents´ activities to obtain a share or the entire rent, leading to inefficient resource allocation and investment. The second one relates to what the authors reference as the waiting in

[7] There is an additional deadweight loss due to the inefficient resource allocation as the high cost suppliers have a cost of production of area *(h+i+j+k)* compared to *(l+m)* for the low cost producers. Additionally, t_1 will be charged on all imports, reducing the imported quantity to Mt_1 creating an even more inefficient market outcome (BOUGHNER ET AL., 2000).

line literature, where rents are dissipated through waiting costs as a consequence of the rush to the border under a first-come-first-serve quota allocation mechanism. Other authors associate increased storage cost with this quota administration mechanism, as traders may want to minimise the risk of arriving late and paying the full duty. Also, if the quota shares are allocated based on historic performance, resources may be wasted by trying to increase market shares for strategic reasons (IATRC, 2001). FLOWERS (1987) challenges this hypothesis of economic waste through rent seeking activities and describes a number of settings and examples under which dissipation of the rent may not occur or only to a limited extent. However, they relate mainly to non-trade and non-agricultural issues, so this discussion shall not be further developed here.

2.6 Conclusions of the chapter

TRQs are constituted through three elements: An in-quota tariff, the quota quantity, and an over-quota tariff.

Only one element can be effective at a time. Which element of the three is effective depends on the level of imports. When imports are at or over the quota level, a quota rent arises.

Liberalizing different elements of the TRQ has different trade and welfare implications, hinging on the level of imports in relation to the quota quantity before and after the policy change.

In some cases, the welfare impact for the involved regions can not be determined without knowledge of the distribution of the quota rent. This distribution is *a priori* unknown.

TRQs can be administrated through different mechanisms. Holding the right to trade (through import or export licences) does not automatically imply capturing the rent when unequally distributed market power exists. Specific constellations on the domestic market can also contribute to reallocation of the rent beyond the formal distribution of rights.

The presence of TRQs can also influence the market outcome indirectly and further add to the inefficiencies arising from the quantitative restrictions. Depending on the administration methods, the degree of competitiveness of the agent provided the rights to trade may lead to dissipation of the rents. Rent seeking activities or waiting costs can underline this undesired effect.

In the next chapter, a detailed description of the different TRQs for beef as well as their utilisation is given.

3 Beef trade and trade policies between the EU and the Mercosur Countries – the current situation

The EU grants trade preferences to third countries within different agreements. One of them is the Generalised System of Preferences (GSP), which grants tariff reductions to developing countries. All Mercosur countries are beneficiaries of the GSP, but for beef they have been graduated from the preferences.

Another framework under which the EU has bound tariff reductions is the WTO Agreement on Agriculture (AoA). Within this framework, the Mercosur countries benefit from bilateral trade preferences for beef in the form of TRQs. These preferences are not granted to the Mercosur countries as a group, but to the individual member states. In addition to the bilaterally agreed market access for beef, there are multilateral TRQs, from which the Mercosur countries benefit as well. In the following, a description of the bilateral trade preferences between the EU and the Mercosur countries for beef will be given. The analysis will be expanded to the multilateral TRQs. Furthermore, an assessment of the utilisation of the TRQs will be presented.

3.1 Current trade preferences for beef

The EU opened a bilateral TRQ for fresh or chilled high-quality beef, the so-called "Hilton" quota of 58,100 tonnes, to which ten meat exporting countries have access. From the Mercosur countries, Argentina benefits from 28,000 tonnes, Brazil from 5,000 tonnes, Uruguay from 6,300 tonnes and Paraguay from 1,000 tonnes[8]. This TRQ is not only defined on 8-digit level of the European *Combined Nomenclature* (CN), but additional requirements need to be fulfilled in order to qualify for imports under this trade regime. These requirements vary from country to country, but they have in common that the meat imported must be high quality beef, the latter referring to the production techniques as well as to characteristics of the slaughtered animal:

[8] The quantity for Paraguay is not granted in the AoA, but was introduced in 2002/2003 as an autonomous quota. For the other Mercosur countries, the quantities mentioned here are those laid down in the commitments of the URAA. In certain years, the individual quantities had been increased as for example the quota for Argentina, that in 2002/2003 was increased by 10,000 tonnes (COMMISSION OF THE EUROPEAN COMMUNITIES, 2002).

- The slaughter animals must be exclusively pasture-grazed.
- The live weight of the slaughter animals must not exceed a certain threshold[9]

and/or

- the age of the slaughter animals must be within a certain range[10].

A detailed description is laid down in COMMISSION OF THE EUROPEAN COMMUNITIES (1997).

Several tariff lines can potentially qualify for the quota, hence no single out-of-quota rate can be identified. But as shown in Table 2, they vary only slightly in the specific part of the composed tariff that is either 3,034 or 3,041 Euro per tonne. The AVE of the over-quota tariff lies between approximately 68 and 86 percent, depending on the exporting country. The preferential rate lies with 20 percent significantly below the AVE, revealing a notable preferential margin.

[9] For Argentina and Uruguay, this threshold is 460 kg live weight (COMMISSION OF THE EUROPEAN COMMUNITIES, 1997).

[10] For Argentina, the slaughter animals must be aged between 22 and 24 months, for Brazil between 20 and 24 months (COMMISSION OF THE EUROPEAN COMMUNITIES, 1997).

Table 2 Preferential trading schemes for beef

	quota quantities (tonnes)	MFN rate	AVE of MFN rate [1)]	preferential rate	AVE of preferential rate
High quality beef quota					
Argentina*	28,000	12.8% + 3,034-3,041 EUR/tonne	76%	20%	20%
Brazil**	5,000		86%		
Paraguay***	1,000		2)		
Uruguay**	6,300		68%		
GATT frozen beef quota					
World****	53,000	12.8% + 1,414-3,041 EUR/tonne	112%	20%	20%
Frozen beef for processing					
World*****	50,700	12.8% + 1,414-3,041 EUR/tonne	116%	20 % (A) 20 %+994.5-2,138.4 EUR/tonne (B)	20% (A) 90%(B)

* For 020130 and 02061095 of the *combined nomenclature*
** For 020130, 02023090, 02062991and 02061095 of the *combined nomenclature*
*** For 020130 and 02023090 of the *combined nomenclature*
**** For 020210 00, 02022010, 02022030, 02022050, 02022090, 02023010, 02023050, 020230 90 and 02062991 of the *combined nomenclature*
***** For 02022030, 02023010, 02023050, 02023090, 02062991 of the *combined nomenclature*
1) Calculated based on the average import unit values 2004-2006 and simple averages of the different tariffs. For high quality beef, only fresh beef was considered
2) No AVE was computed because in recent years no imports of fresh beef from Paraguay took place
(A) A-quota of TRQ for frozen beef for processing
(B) B-quota of TRQ for frozen beef for processing

Source: Own compilation based on COMMISSION OF THE EUROPEAN COMMUNITIE, (1997), COMMISSION OF THE EUROPEAN COMMUNITIES (2002), EUROPEAN COMMUNITIES (2004), EUROPEAN COMMUNITIES (2005), WTO, (n.d.a), EUROSTAT (n.d.a).

In addition to the bilateral access to European beef markets, the Mercosur countries benefit from the multilaterally improved market access.

First, there is the so called *"GATT frozen beef quota"*. This quota is also a result from the URAA, and is not allocated to specific exporting countries. Its total quantity is 53,000 tonnes. Products that qualify for this TRQ are frozen bovine meat[11] and thick or thin skirt[12] (COMMISSION OF THE EUROPEAN COMMUNITIES, 2005). The out-of-quota tariff naturally varies as several tariff lines are affected, having in common an ad-valorem rate of 12.8 percent. The specific component of the MFN tariff varies between 1,414 Euro per tonne and 3,041 Euro per tonne respectively (WTO, n.d.a). As Table 2 shows, this translates into an AVE of 112 percent. The preferential rate with 20% lies significantly lower.

[11] This corresponds to the tariff line 0202 of the *combined nomenclature.*

[12] This corresponds to the tariff line 02062991 of the *combined nomenclature*

There is a second multilateral TRQ for frozen beef that is intended for processing in the EU. The total quota quantity is of 50,700 tonnes of frozen beef[13]. In order to qualify for imports under this quota, the frozen beef must be intended for processing in the EU into certain products. These processed products are differentiated into so-called A- and B-products[14]. The total quota quantity is open to 40,000 tonnes of frozen beef intended for processing into A-products and 10,000 tonnes intended for processing to B-products (COMMISSION OF THE EUROPEAN COMMUNITIES, 2005a).

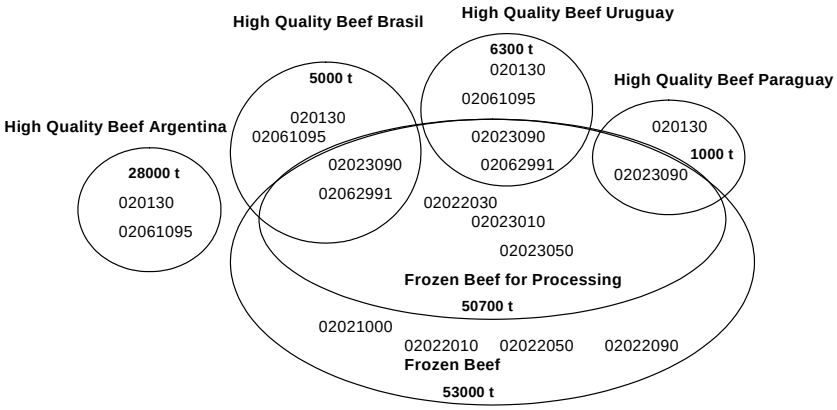
There is an ad-valorem rate of 20 percent for beef intended for processing into both product categories, and an additional specific duty of 994.5 to 2,138.4 Euro per tonne is charged on beef to be processed into B-products (COMMISSION OF THE EUROPEAN UNION, n.d.a). As shown in Table 2, the AVE of the composed tariff is 116%, and the preferential rate is 20 percent for meat that is intended for processing into A-products, and 90 percent for meat that is to be processed into B-products.

A summary of the different tariff lines and the different beef TRQs is given in Figure 6.

[13] corresponding to the tariff lines 02022030, 02023010, 02023050, 02023090 and 02062991 of the *combined nomenclature.*

[14] A-products are defined as products corresponding to the CN codes 160210, 16025031, 16025039, 16025080 ("other prepared or preserved meat, meat offal or blood") of the *combined nomenclature* with additional requirements as pure beef meat. B-products are other processed meat products (e.g. salted meat) laid down in COUNCIL OF THE EUROPEAN UNION (1999).

Figure 6 Tariff lines eligible for different TRQs



Source: Own representation

3.2 Utilisation of current preferences

As discussed above, trade preferences for the Mercosur countries are granted through TRQs. For an assessment of the effect of liberalisation of the different elements of TRQs it is crucial to know which regime is in force in the reference situation. Thus, the utilisation of different TRQs by the Mercosur countries is in the focus of interest in this section.

The quantities of imports under the preferential tariff allocated to the Mercosur countries differ from country to country and different tariff lines potentially qualify for imports under the quota. Hence, the fill rates have to be analyzed on a country by country base.

Several problems arise when the attempt is made to determine the fill rates of the TRQs for beef. One is the fact that some TRQs are defined on a more detailed level then the 8-digit level of the combined nomenclature, which is the most detailed level at which trade flows are available. The second problem is that, as can be seen in Figure 6, for most of the Mercosur countries, there is considerable overlap between the high quality beef quota and the two multilateral TRQs in the tariff lines concerned, so it is not possible to distinguish under which quota the imports enter the EU.

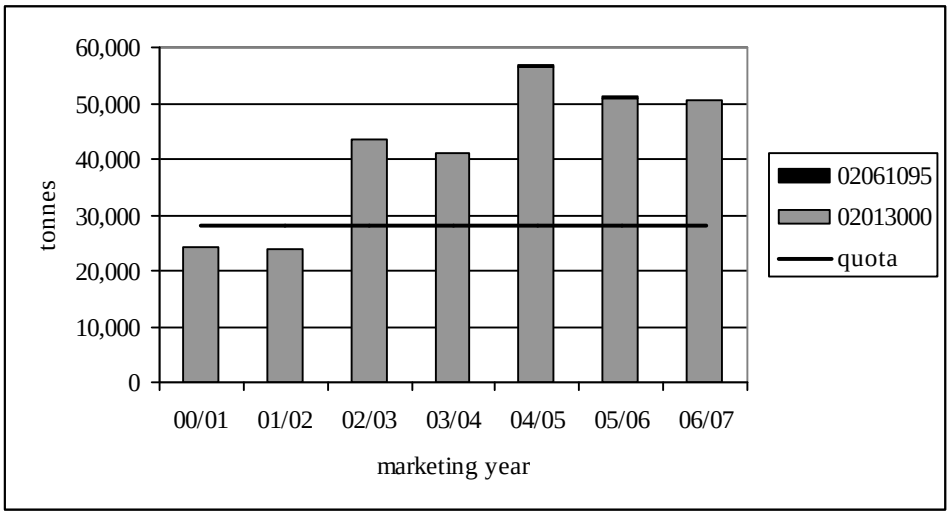
Bilateral quotas

As mentioned before, Argentina has a quota of 28,000 tonnes of high quality beef allocated[15]. Imports of beef that potentially qualifies for imports under the high

[15] The autonomous increase in 2002/2003 is not taken into account here.

quality beef TRQ are depicted in Figure 7. No unambiguous pattern can be identified regarding the fill rate of the quota. In most years, the imported quantities exceeded the quota by far. Only in the two marketing years in the beginning of the period considered here, shipments of beef eligible for the high quality beef TRQ from Argentina to the European Union stayed behind the conceded quantities. This is explained by the occurrence of Foot and Mouth Disease (FMD) in Argentina (OIE, n.d.), which triggered import bans by many trading partners. It is worth mentioning that even though imports of two tariff lines can potentially enter the EU under the preferential duty, only imports of one of them, that is fresh or chilled meat (corresponding to tariff line 02013000) took place in noteworthy scope. As no other quota is open to beef of these tariff lines, all imports can be assigned to be entering the EU under bilateral high quality beef quota allocated to Argentina or at full levy.

Figure 7 EU imports of beef eligible for the high quality beef TRQ from Argentina

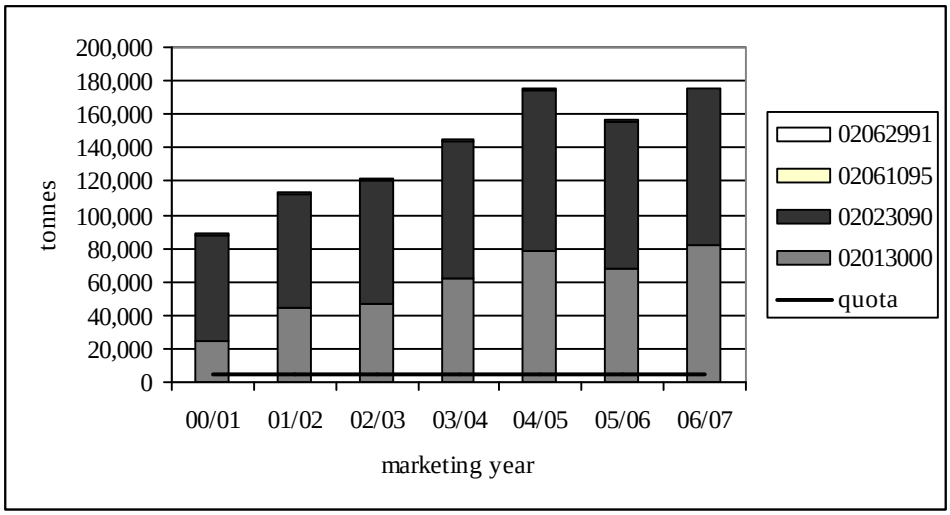


Source: Own compilation based on EUROSTAT (n.d.a)

For Brazil, the quota is open to 5,000 tonnes of high quality beef. Imports of the respective beef categories are shown in Figure 8. Here the data suggest that there is substantial quota overfill in all the marketing years included in the analysis, and that the over-quota imports increased over time. However it should be kept in mind that the distinction could be made only at 8-digit level, and therefore the overfill could be overestimated. A further complication in the case of Brazil is that some of the tariff lines that qualify for the bilateral high quality beef quota also qualify for one of the two multilateral beef TRQs. This is true for frozen beef and edible offal (these correspond to 02023090 and 02062991 of the *combined*

nomenclature). However, even if only the tariff lines that have exclusive access to the bilateral TRQ are taken into account, that is fresh and chilled bovine meat and fresh thick or thin skirt (these correspond to 020130000 and 02061095 of the *combined nomenclature)* the quota is clearly overfilled in the time period considered here.

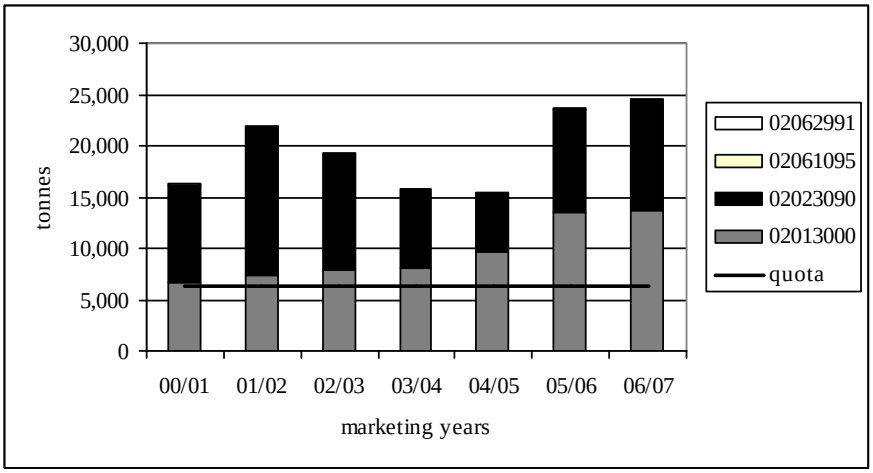
Figure 8 EU imports of beef eligible for the high quality beef TRQ from Brazil



Source: Own compilation based on EUROSTAT (n.d.a)

To Uruguay, a quota of 6,300 tonnes of high quality beef is allocated. In Figure 9, the imports of products qualifying for imports under the quota are presented. The same problem arises as in the case of Brazil: A considerable share of imports of beef meat corresponds to a tariff line that also qualifies for imports under a multilateral TRQ. This concerns mainly imports of frozen boneless beef (these correspond to 02023090 of the *combined nomenclature*), as imports other than fresh or frozen boneless meat (02062991 and 02061095 of the *combined nomenclature*) were virtually absent. Even under the assumption that all those imports that qualify for the multilateral regime do in fact enter the EU under that multilateral regime, Uruguay has increasingly exported beef to the EU at full levy. If alternatively one supposes that all imports that potentially qualify for both quotas do in fact enter under the bilateral quota and not under the multilateral one, the degree of over-fill is even more pronounced.

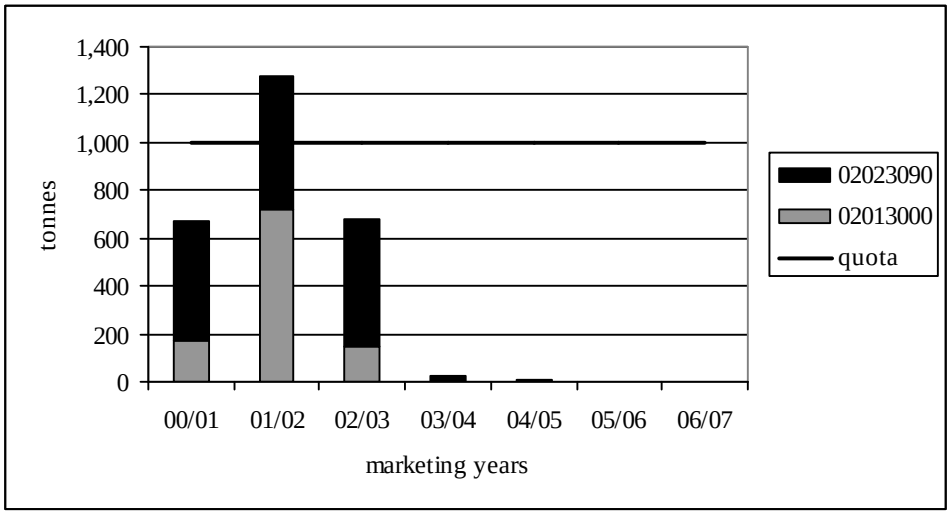
Figure 9 EU imports of beef eligible for the high quality beef TRQ from Uruguay



Source: Own compilation based on EUROSTAT (n.d.a)

The last Mercosur country, Paraguay, has no quota quantities allocated by the URAA schedule. However, from the marketing year 2002/2003 on, the European Commission opened an autonomous quota of 1,000 tonnes for fresh (02013000 of the *combined nomenclature*) and frozen beef (02023090 of the *combined nomenclature*) from Paraguay (COMMISSION OF THE EUROPEAN COMMUNITIES, 2002). In Figure 10, the imported quantities of beef potentially qualifying for this quota are shown. In most years, only very limited imports are observed, and the quota quantity is such that it was not filled in most of the years, even if the imports of frozen beef, that can also enter under the multilateral regimes, are counted in. If additionally it is assumed that the frozen beef is imported under the multilateral TRQ, the bilateral TRQ is always under-filled and the regime in place is that of a pure tariff.

Figure 10 EU imports of beef eligible for the high quality beef TRQ from Paraguay



Source: Own compilation based on EUROSTAT (n.d.a)

Multilateral Beef Quotas

As explained above, there is considerable overlap in the product coverage of the two multilateral tariff rate quotas and the bilateral high quality beef quotas: The quota for frozen beef *("GATT frozen beef quota")* includes all the tariff lines that qualify for import under the tariff rate quota for frozen beef intended for processing, and four additional tariff lines. Further complication is caused by the fact that some of the beef products that belong to the frozen beef quota can enter under the bilateral TRQs for high quality beef as well.

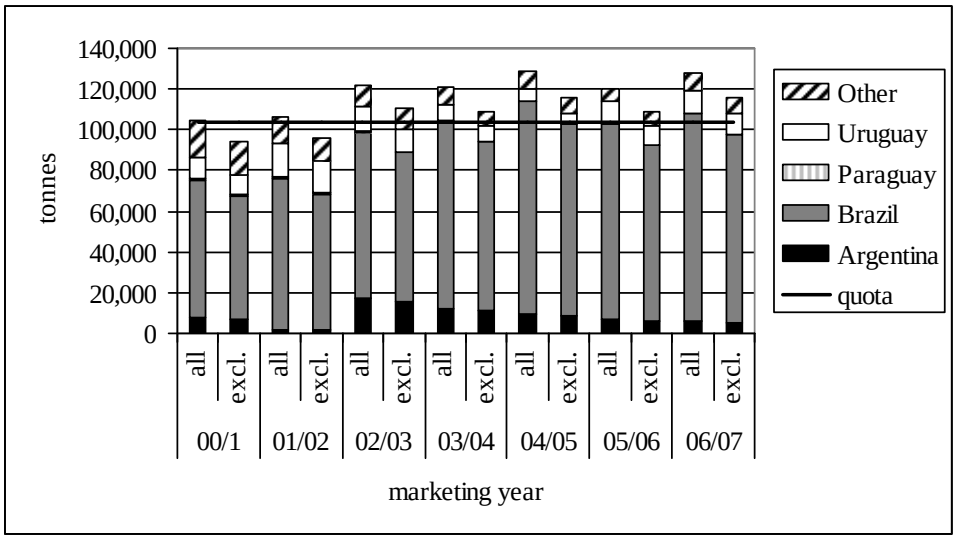
Because of the overlap of the two multilateral TRQs, analyzing their fill rates separately does not seem appropriate as it would most likely result in interpreting the quota as overfilled where in reality part of the commodities enter the European Union under another tariff rate quota. Lacking better information, here the two multilateral beef quotas are treated as one.

Still the problem remains that for Brazil, Uruguay and Paraguay frozen beef can enter under the bilateral high quality beef quota, too. As had been shown previously, frozen beef accounts for relatively large shares of beef introduced from Brazil, Uruguay and Paraguay into the EU.

For these reasons, two different fill rates of the TRQ have been calculated and are shown in Figure 11. One ("all") that includes all imports of the tariff lines covered by the TRQs for frozen beef, and a second one ("excl.") from which the

quantities that can enter under the bilateral TRQs of Brazil and Uruguay have been subtracted[16].

Figure 11 EU imports of frozen beef



Source: Own compilation based on EUROSTAT (n.d.a)

It becomes clear from Figure 11 that for the period of 2000 to 2007, the fill rate of the import quotas for frozen beef might be overestimated if one does not take the fact into account that part of the imports that qualify for the frozen beef quota might enter the EU markets under a different trade regime. In any case, as the bilateral quotas for high quality beef are over-filled, too, it can be stated that small quantities of frozen beef enter the European Union at full tariff.

For the remainder of this study, it is assumed that frozen beef is not imported under the TRQs for high quality beef, but only under the multilateral schemes or at full levy. Paraguay is not further considered due to its limited importance with regards to beef exports to the EU.

3.3 The state of the negotiations

The EU-Mercosur relationship is based on the "EU-Mercosur Interregional Framework Cooperation Agreement" that was signed in 1995. It is based on three pillars: political dialogue, cooperation and trade issues. Negotiations started in

[16] For Paraguay this was not done as only licences for 40 tonnes of high quality beef where requested in 2002/2003 and it has not used its quota for high quality beef since the marketing year 2003/2004 (VERBAND DER FLEISCHWIRTSCHAFT E. V., 2004), (VERBAND DER FLEISCHWIRTSCHAFT E. V., 2005).

1999, and by now 18 negotiation rounds have been carried out, the last one in 2008 (COMMISSION OF THE EUROPEAN COMMUNITIES, 2006), (COMMISSION OF THE EUROPEAN UNION, n.d.b).

Surprisingly little information is available on the current state of the negotiations concerning the agricultural sector. The latest available information dates back to 2005 (USDA (2005) and personal communication with the European Commission). The EU´s proposal classifies agricultural products into three categories: annex one, two and three. For each category, different options for liberalisation are foreseen. For the products in annex one, full liberalisation within 10 years was proposed. For annex two products, 50 percent tariff reduction in import tariffs over 10 years is offered. In annex three the politically sensitive products of the EU are listed, which include, among others, beef. For these products the EU offers to open new TRQs or to expand existing ones with the in-quota tariff at a level of 50 percent of the lowest in-quota duty rate bound in the WTO (USDA, 2005).

The Mercosur countries requested further reaching TRQ expansion and the elimination of the duty within the quota. More detail on the negotiation proposals concerning beef is presented in section 6.1.

3.4 Conclusions of the chapter

For beef, the Mercosur countries benefit from preferential market access to the EU´s agricultural markets through three trading schemes:

First, there is an allocated TRQ for high quality beef. Secondly, there is a multilateral TRQ for frozen beef. Thirdly, there is another multilateral TRQ open for frozen beef that is intended for processing in the EU.

The degree of utilisation of the current trade preferences is in most cases difficult to ascertain. However, it can be stated that with the exception of Paraguay, all Mercosur countries have introduced more fresh beef meat into the European Union than allocated to them by their quota, regardless the high import tax to pay.

It can equally be stated that small quantities of frozen beef enter the European Union at full tariff, too, though it is unclear in which countries these quantities originate.

Negotiations of a free trade agreement started in 1999, and have so far not come to any conclusion. The EU´s latest offer includes expansion or creation of TRQs for politically sensitive products, among which high quality beef is found. The Mercosur countries´ proposal contained more far reaching tariff reductions and quota expansions.

4 Administration of the TRQs between the EU and the Mercosur countries and the distribution of the rents

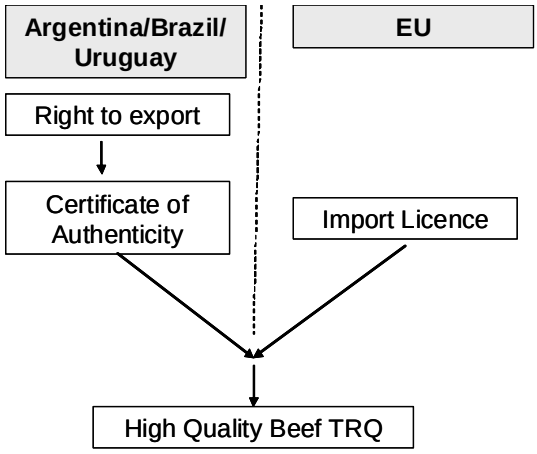
In the following, the administrative procedures applied to beef trade between the EU and the Mercosur countries will be analysed. Furthermore, information on the market structure will be given where this influences the distribution of the rents in a different way than a competitive market structure would do. Part of the information presented in this chapter was obtained from expert interviews that were carried out in the Mercosur countries in winter 2006, and in the European Union over the period from 2006 to 2009. Over 20 representatives from the meat processing industry, farmers´ associations and government institutions were consulted to investigate if quota rents exist. If so, further questions were to what extent the rents arise, how they are distributed and what the factors are that led to that outcome.

4.1 Bilateral TRQ for high quality beef

General aspects of administration

For the bilateral TRQs for high quality beef, the European Union has chosen to administer the importing side and the exporting side through import and export licences, respectively. An overview over the administrational procedure is given in Figure 12: On the exporting side, the actors involved in the business have to apply for the right to export under the preferential scheme at administrational bodies in the respective country. Once they have the right to export a certain quantity under the preferential tariff, for each shipment they wish to export they have to request a specific document which is called certificate of authenticity. On the importing side, traders can directly apply for an import licence. Both the import licence and the certificate of authenticity are needed in order to benefit from the in-quota tariff.

Figure 12 Administration of TRQs for high quality beef



Source: Own representation

The way the rights to export and to import are allocated will be described in the following.

Rationing the importing side

The right to import is given to importing firms in the European Union, and the licences are issued by administrational bodies within the European Union. A detailed description of the rules to be followed is given in COMMISSION OF THE EUROPEAN COMMUNITIES (1997) and can be summarised as follows:

- The import licences are allocated on a monthly basis. The quantity that is made available per month corresponds to one twelfth of the total quantity defined in the legislation plus the quantity remaining from the preceding months (*Article 3*). The import licences are valid for 3 months.

- In order to obtain an import licence, the applicant has to prove that he has been active in beef trade for at least 12 months. The amount requested in each licence can not exceed the quantity that is available for that month *(Article 4).*

- Each applicant can only hand in one application. If the total amount of licences requested exceeds the total quantity available for that month, then all the requests are cut by the same percentage. If the quantity available is not exhausted, the remaining quantities are transferred to the next month *(Article 5).*

– At the time the import licence is requested, it is not necessary to present the certificate of authenticity, so that theoretically one could apply for an import licence and later not fulfil it. In order to prevent from this, a licence security of 120 Euro per tonne has to be lodged when applying for the licence *(Article 12).*

In practice, importers request the licence usually only when they have already purchased the commodity in order not to loose the security.

Rationing the exporting side

The EU has transferred the responsibility to ration the exporting side to the exporting countries. The authorities in the exporting countries allocate the rights to export and issue the certificate of authenticity. The purpose of the latter certificate is two-fold. On the one hand, it states that the product to be exported fulfils the quality requirements; on the other hand it will not be issued without the exporting firm holding a share of the TRQ, thereby restricting exports under the TRQ.

The distribution of the right to export is country specific.

Argentina. Argentina has chosen to administer the right to export under the TRQ for high quality beef by assigning shares to various actors on a yearly basis. In the history of the TRQ for high quality beef, Argentina has amended the system constantly. An overview of the historical development can be found in BONANSEA et al. (2006).

The recent legislation is laid down in SECRETARÍA DE AGRICULTURA (2004) of the Secretary for Agriculture, Livestock Fisheries and Food (*Secretaría de Agricultura, Ganadería, Pesca y Alimentos*). The rules applied for assigning the quota are the following:

– Of the total quota quantity, 7 percent are assigned to cattle producers in cooperation with exporting slaughter houses *(Article 5a).*

– Another 7 percent is distributed between the provinces that have slaughterhouses approved for exportation to the European Union. Between the provinces, the share is determined by the share of cattle in the total herd. The resulting quantity is then distributed equally between the slaughterhouses approved by the EU. However, there is a cap on this distribution mechanism saying that no slaughterhouse is allowed to increment its share in the quota via the mechanism described above by more than 200 tonnes *(Article 5b*).

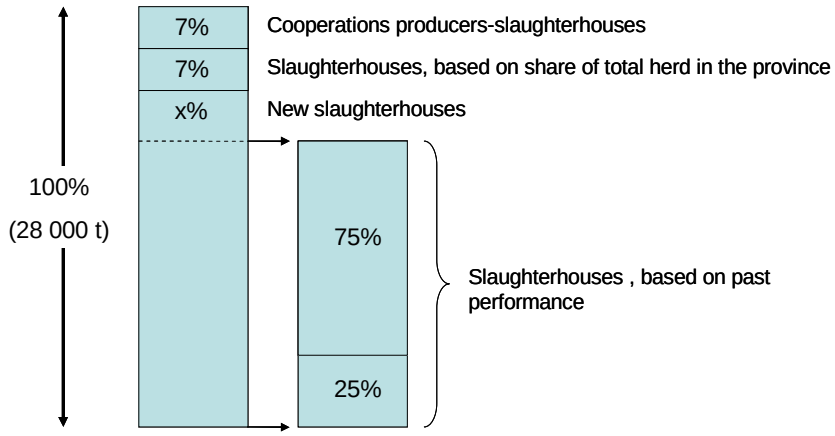
- From the remaining 86 percent of the total quota quantity, new coming companies are assigned 100 tonnes or 200 tonnes for Cycle I[17] establishments or Cycle II establishments respectively *(Article 10).*

- After the abovementioned three positions have been subtracted, 75 percent of the remaining quantity is distributed between companies in accordance with their share in the free on board (FOB) export value of both fresh and frozen meat[18] to any part of the world *(Article 5I).*

- The remaining quantities are also distributed in function of past performance measured in the total FOB export value of various meat products[19] to any part of the world, again excluding the cuts that can be exported under the TRQ for high quality beef. The difference between this and the preceding one is the product coverage that is taken into account in order to calculate the share assigned to the respective company *(Article 5II).*

A schematic overview of the criteria for the distribution of the right to export from Argentina is given in Figure 13.

Figure 13 Distribution of the right to export in Argentina



Source: Own representation

In short, a part of the total quota quantity is reserved to cooperation projects between farmers and slaughterhouses, whereas the largest share goes to slaugh-

[17] Cycle I establishments comprise processing from live animal to carcass, Cycle II establishments from carcass to all further processing steps.

[18] The cuts integrated in the high quality beef TRQ are excluded.

[19] These include both raw and processed meat products

terhouses depending mostly on their past performance, partially taking into account the regional distribution of the slaughterhouses.

Some additional requirements have to be fulfilled. First, the animal whose meat is going to be exported has to be registered in the national traceability system. Secondly, the slaughterhouse has to be approved by the EU and by local authorities as the *Servicio Nacional de Sanindad y Calidad Agroalimentaria (SENASA*) or the *Oficina Nacional de Control Comercial Agropecuario (ONCCA*) (SECRETARÍA DE AGRICULTURA, 2004).

Moreover, the animals for exports to the EU have to be collected directly at the farm, and are not allowed to be purchased through the large cattle market of Liniers. In the slaughterhouse, they have to be kept strictly separated from cattle for the domestic market.

In the slaughterhouse, *SENASA* controls for the quality requirements. If these are fulfilled, the certificate of authenticity is issued by *ONCCA*. The amount of certificates issued is reported to Brussels on a weekly basis.

Brazil. Brazil has chosen to administer the right to export only between exporting companies[20], and not to producers or any other elements of the chain. The procedure how the quota is administered is laid down in MINISTÉRIO DO DESENVOLVIMENTO INDÚSTRIA E COMÉRCIO EXTERIOR (2006). The distribution of the quota is summarised in the following:

- The distribution of the right to export is made year wise, and starts with the manifestation of interest of the approved exporting firms up to seven days after the beginning of the quota year on 1 of July (*Chapter 2, a*)).

- The total amount of 5,000 tonnes for exportation is split up into two parts. 4,700 tonnes are distributed at the beginning of the quota year, after the manifestation of interest has taken place. Each participant has the right to a fixed quota of 24 tonnes and a variable part of the export quota that corresponds to his share in total exports of *in natura* beef into the EU in the year preceding the actual quota year.

- The remaining 300 tonnes are distributed to newcomers during the second semester of the quota year, again up to a maximum of 24 tonnes to each firm *(Chapter 2, Paragraph 3a, 4, 5, 6).* In the case that a company does not use its share of the tariff-rate quota by the end of April of the respective year, its share goes back to the Ministry of Ag-

[20] These can be deboning facilities, slaughterhouses or pure trading companies.

riculture and will be redistributed to newcomers *(Chapter 2, Paragraph 9a)*.

As in the case of Argentina, requirements regarding sanitary standards have to be fulfilled. Following this legislation, firms applying for exports under the TRQs for high quality beef have to be approved as being able to export beef *"in natura"* by the *Departamento Nacional de Inspecçao de Productos de Origem Animal (DIPOA)* and by the EU (MINISTÉRIO DO DESENVOLVIMENTO INDÚSTRIA E COMÉRCIO EXTERIOR, 2006).

The system is monitored through a registration system, the *Registro des Exportação*. In Brazil, every product to be exported to any part of the world must be notified to this system, which monitors the legal correctness of fiscal matters[21]. This achieved, the licence to export under the high quality TRQ is issued.

In the case of Brazil, the certificate of authenticity is issued by the veterinary inspections service of the abovementioned *DIPOA* at the time of slaughtering the animal. According to expert opinions the bureaucratic requirements attached to exports under the TRQ do not impose a noteworthy additional cost, as inspection of the carcass is needed for exports to Europe irrespective of the quota system, and registration to the *Registro des Exportação* as well.

Uruguay. For Uruguay, a detailed description of the rules for the distribution of the quota can be found in JUNTA DEL INSTITUTO NACIONAL DE CARNES (2003). It can be summarised as follows:

- Cycle I and Cycle II establishments as well as pure trading companies can apply for a share of the quota *(Paragraph I, 3°)*. Additionally, "innovative projects" can apply for a share of the quota *(Paragraph V, 12°)*. The distribution of the right to export is made on an annual basis.

- For Cycle I and Cycle II establishments and for exporting companies, the distribution of the quota is made based on past performance. To this end, a weighted average of the export value of fresh beef[22] to whatever export destination over the last three years is calculated. Exports in the year immediately before the current year are given a weight of 50 percent, and 40 percent and 10 percent are given to the second last and the last year respectively *(Paragraph II, 9°)*.

- For companies that apply for the quota for the first time, the quota is distributed on past performance of exports of fresh beef, too. In this case, in the first year the quantity that would be assigned to this com-

[21] This service is free of charge and no export taxes are levied on meat products.

[22] „Carnes Chicas" are exempted from this calculation (Paragraph III, 9°).

pany by applying the past performance criterion is multiplied by 1.5, in the second year of participation in the quota system by 1.25. From the third year on, no coefficient will be applied to the past exports *(Paragraph IV, 11°).*

– Up to 6 percent of the total quantity or 378 tonnes can be distributed to so-called innovative projects that the *Junta del Instituto Nacional de Carnes* wants to promote. For each of these projects, there is a ceiling of 2 percent or 126 tonnes *(Paragraph V, 12°).*

Distribution of the rents

As outlined in Chapter 2, the distribution of the rents depends crucially on whether licences to export or to import (or both) are assigned to firms or other actors in the chain. However, it was also seen that owning rights to export is not always sufficient for obtaining the rents.

In the case of the trade relations between the EU and the Mercosur countries, both the exporting side and the importing side are issued licences and therefore afforded bargaining power. Whether or not this leads to sharing of the rents and how the rents are distributed within the country will be analyzed in the following.

Argentina. In Argentina, the by far largest part of the quota is distributed among slaughterhouses. Hence, an overview over the number of slaughterhouses and their degree of organisation is needed to understand the distribution of market power.

For Argentina, there are 97 establishments approved for meat exports to the European Union belonging to 81 companies (SENASA, 2006). This number has to be understood as a maximum number, as not all of the establishments approved for the EU actually engage in trade with fresh meat under the quota for high quality beef. The largest organisation at the time of investigation was the *Argentine Beef Consortium (ABC).* According to the organisation, 80 percent to 90 percent of the export value of beef is covered by its members.

As the exporting side is administered by certificates of authenticity, the exporter is perfectly informed on the tariff that the importer[23] has to pay when shipping the commodity into the EU. It has been stated by exporters that a different price is charged to the importer, depending on the fact whether the cuts are exported under the TRQ or not. In practice, the price on the EU market is estimated by market research and past experience. Correcting for transportation costs, this is the price charged for beef accompanied by a certificate of authenticity. From this

[23] Meat from Argentina is usually sold FOB, i.e. the import tariffs are paid by the importer.

price, the exporter derives a (lower) price for the same cut without the certificate of authenticity, mainly by subtracting the tariff differential.

In other words, the whole tariff difference and therefore the rent is captured by exporters, a fact on which all experts in the sector agreed upon.

The question arises why the importers are not able to capture a share of the rent given the fact that the certificate of authenticity has to be matched with an import licence, theoretically affording both sides with equal bargaining power. Evidence suggests that this is not the case. Several factors are likely to contribute to this outcome. One of them lies in the administration of the quota rents. The rights to export are distributed on an annual basis, and once this distribution is made, no new firms can enter the market. In contrast, on the importing side, the licences are distributed on a monthly basis, have a limited validity and a security has to be lodged. In other words, market entry on the European side is easy and importers run the risk of loosing the security if no transaction is made[24].

In addition, imports under the high quality beef TRQ add to the past performance that is required for imports of frozen beef where the importers, as will be seen later, capture the rent. This could further intensify the competition between importers.

The next question of interest is who in the production chain inside Argentina captures the rent. As seen earlier, structures can be thought of that do no not allow e.g. the slaughterhouses to keep all of the extra profit, but force them to pass some of the profits to producers. This could for example be the case if the animals that qualify for the high quality beef quota where not easily available on the market, or cooperative market structures would prevail. This is not the case. The experts interviewed unanimously stated that farmers do not know whether the meat produced from their animals is exported or not, and if exported, they do not know whether under a preferential scheme or not. As animals that comply with the requirements for the high quality beef quota are regularly available, producers are not able to capture a share of the rent when the licence is given to a slaughterhouse.

A different situation arises when a share of the quota is assigned to cooperations between farmers and packing houses. In this case, the licences are given to the farmers´ organisations which then capture the rent and distribute them to their members. However, the administrational effort in order to be assigned a share of the TRQ for these cooperations is significant, and the marketing cost is usually higher than for a slaughterhouse with established market relations. Thus it is likely that part of the rent is lost due to rent-seeking activities.

[24] Importers have stated to apply for the import licence only after they have in fact purchased the meat, to avoid the risk of loosing the security. This indicates that beef accompanied by a certificate of authenticity is scarce and importers compete between each others.

Brazil. The number of establishment approved for meat exports to the EU varies, but at the time of research 63 slaughterhouses belonging to 30 companies were approved for exports to the EU (MINISTÉRIO DA AGRICULTURA, PECÚARIA E ABASTECIMENTO, n.d.). The number of companies that are actually engaged in trade with the high quality beef quota have been stated to be only 4. In other words, exports of meat from Brazil can be seen as highly concentrated in only a few meat processing companies. This is true not only for trade with the EU, but also holds true for the sector in general: Experts stated that in the year 2004, the two largest companies accounted for 40 percent of the total Brazilian meat exports, 5 companies for 80 percent, and 98 percent of external trade is realised by only 18 meat processing companies.

Regarding the organisational aspects of the meat processing sector, it can be said that meat exports are highly organised: The meat processing sector involved in international trade is to a large extent organised in the *Associação Brasileira das Indústrias de Carnes (ABIEC)*, whose members account for 95 percent of Brazilian exports to the EU, according to own statement.

As in the case of Argentina, the exporter is perfectly aware of whether his product is exported within the TRQ or at full tariff. Similarly, it has been unanimously stated by various experts that the rent is entirely captured by exporters. As in case of Argentina, high quality beef is sold at two different prices, an in-quota price and an over-quota price. As for Argentina, these prices are determined by the exporters by observing the market price and then discounting freight and the different tariff rates. The factors leading to the appropriation of the rent by the exporting side are the same as for Argentina: A limited validity of the import licence along with the needed security in an environment characterised by easy market entry for European importers and, once the distribution of rights on the exporting side is made, limited competition for exporting entities as well as possibly some strategic interests.

Cattle producers, slaughterhouses and other experts from the sector stated that, as in Argentina, the rents are not shared between actors in the production chain. From the side of the slaughterhouses, at the moment of buying cattle it is not determined whether it goes to exportation or into the domestic market. As animals that are for exportation have to be certified by the SISBOV traceability system, a producer selling a SISBOV certified animal might suspect that its meat is intended for exportation. However, he will not know whether parts of it are going to be exported within quota, and since the farm sector can be characterised as a competitive market, he can not negotiate a price premium.

The other possibility of passing benefits downward in the chain is vertical integration or cooperative structures. These structures play only a very limited role in Brazil; according to experts´ opinion nearly the entire production is marketed on a spot-market basis.

Uruguay. In Uruguay, there are 17 slaughterhouses approved for exports to the EU (INSTITUTO NACIONAL DE CARNES, n.d.a). Exporting companies can legally apply for a share of the high quality TRQ, too, but it has been stated that in fact none is currently involved into the business.

The beef exporting sector in Uruguay is characterised by a very low degree of organisation. Membership in the *Instituto Nacionál de Carnes (INAC)* is mandatory for all slaughterhouses, but apart from that there are no noteworthy industrial organisations.

Despite the fact that the organisational degree within the meat exporting sector is low, the exporting side is said to capture the rent entirely. This indicates that as in Argentina and Brazil, Uruguayan beef exporters can exercise negotiating power over the importing side for the reasons already mentioned.

Regarding the distribution of the rents between the actors in the chain, the same findings hold true as for Argentina and Brazil: The relation between the members of the chain is competitive, i.e. the actor holding the share of the TRQ, that is almost exclusively the slaughterhouse, captures the rent. Vertical integration or cooperative structures do not play a role in the Uruguayan meat producing sector. Only in the cases where the right to export is granted to projects involving producers, the latter can be expected to gain a share of the rent. This was, however, not relevant at the time of research.

4.2 Multilateral TRQs

GATT frozen beef TRQ

For the GATT frozen beef TRQ, there is no administration of the exporting side. The control of the quantities imported takes place exclusively in the EU. Only importers based in the EU can apply for a share of the frozen beef TRQ based on their total imports of fresh and frozen beef as well as edible offal of bovine animals[25] in the year previous to the current marketing year (COMMISSION OF THE EUROPEAN COMMUNITIES, 2004).

No export licences are needed to match the import licence, therefore exporters have no information on the tariff that is going to be charged on their commodity. Hence, the rent is captured entirely by importers in the European Union.

[25] These product correspond to chapters 0201, 0202, 0206 7095 and 0206 2991 of the *combined nomenclature.*

Frozen beef for processing

For the administration of this TRQ, the same holds true as for the GATT frozen beef TRQ: There is no administration of the exporting side. Inside the EU, import rights are allocated to meat processing establishments which will then be issued an import licence. There is no past performance criterion for this TRQ, meat processing companies can apply for as many import rights as they wish. If there are more applications then quota quantity, the quantities will be cut by a certain percentage (COMMISSION OF THE EUROPEAN COMMUNITIES, 2005).

No export licences are needed and therefore the importers are able to capture the rents accruing from this TRQ.

4.3 Conclusions of the chapter

From the analysis carried out above, a couple of things can be concluded concerning the existence and the distribution of the quota rents in the case of the EU and the Mercosur countries.

Thanks to the way the quotas are administrated and to the prevailing market structure, in all three countries the rent from the quota for high quality beef is entirely captured by the exporting country. It has been stated unanimously by experts from the sector that exporters adapt prices depending on whether the export takes place at full tariff or at the preferential tariff.

From the expert interviews it has become clear that there is no significant administrational cost attached to exports under the TRQ for high quality beef, hence the quota rent is approximately the tariff difference. However, for the share of the TRQ that is assigned to producers in Argentina, it can be suspected that part of the rent is dissipated due to the administrational effort necessary to obtain a share of the TRQ.

It has become clear that in Argentina, Brazil and Uruguay internal market structures are such that the rents stay with the actor that receives the licence to export. Issues as market power within the chain, vertical integration, cooperative structures or other factors that would force to share the rent within the chain do not play a role in these Latin American countries.

The picture is different for the multilateral TRQs: Here no export licences are needed in order to benefit from the tariff reduction. Exporters have no information on the tariff that is going to be paid on their commodity, hence the importers capture the rent.

An assessment of the welfare implications of reductions of trade barriers between the EU and the Mercosur countries is the purpose of this study. Different approaches are at hand for the analysis of such trade liberalisation scenarios. The

model developed for the purpose of this study is described in the following chapter.

5 The Model

The aim of this chapter is to provide information on the model that was set up specifically for the analysis of the EU´s and the Mercosur´s proposals with regards to liberalisation of beef trade.

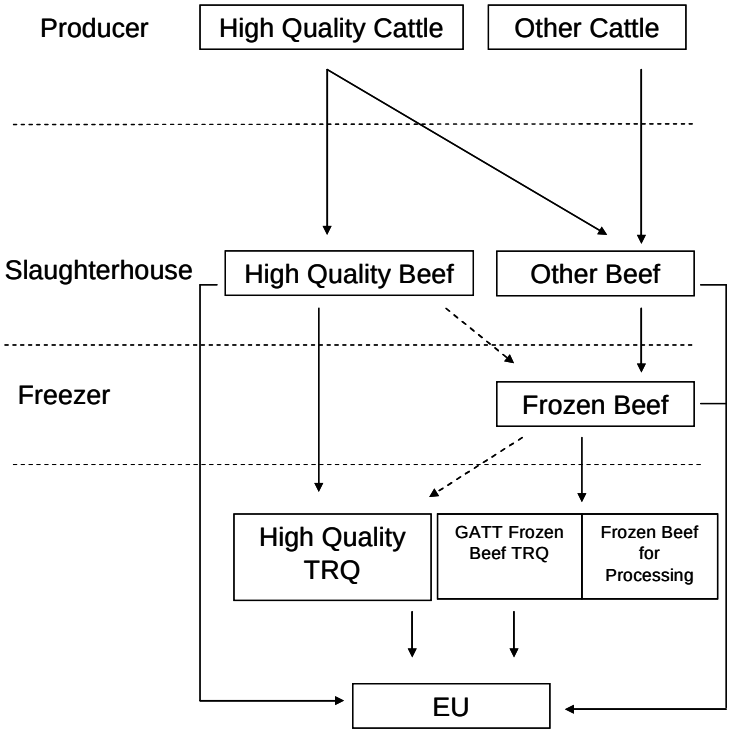
This chapter starts off with a stylised description of the problem to model. Then, the model's general features are discussed along the lines of the preceding chapter. The model´s scope in terms of the covered country and commodity space is presented along with the disaggregation of the economic actors. The description of the behavioural functions is framed by a discussion of their desirable characteristics. After that, other relevant model equations are presented, followed by a description of the model calibration process. The chapter concludes with a description of data sources and processing.

5.1 The problem to model

The relations to be modelled between production, processing and trade policies of beef of different qualities are rather complex. A schematic overview of these relations is given in Figure 14.

The requirements for the high quality beef quota relate not only to special cuts, but also to certain methods of production. Thus, the decision of producing an animal that will supply high quality beef is already taken on farm level. However, as only special cuts qualify as high quality beef, with each animal of high quality slaughtered there will also be a certain percentage of beef meat of other quality. This special characteristic of beef production represents a Leontief technology.

Figure 14 The problem to model



Source: Own representation

The resulting two types of fresh beef can be frozen and thus be converted into frozen beef.

Finally, there are three different trade regimes in place through which beef from the Mercosur countries can enter the EU:

- First, the bilateral TRQ for high quality beef. As described in Chapter 3, for some of the Mercosur countries, the high quality beef quota is open for frozen beef, too.

- Second, the multilateral TRQs for frozen beef for both direct consumption and for processing.

- Third, the MFN regime for all other types of beef.

Of course, all types of beef can be consumed domestically or exported to other destinations than the EU too, but this is not depicted in Figure 14 for simplicity.

Most of these relations are captured by the model. Only the possibility of freezing high quality beef for importation under the high quality TRQ (indicated through dashed arrows) has been abstracted from. For Argentina this reflects the current legal situation (recall Figure 6), but Brazil and Uruguay could in fact

choose to freeze high quality cuts and export it either under their TRQ for high quality beef or under the multilateral scheme for meat for processing. The main reason for not taking this possibility into account in the model is that the quality of frozen beef is not distinguished in the available data. Sector experts also stated limited importance of imports of frozen high quality meat. For the reasons explained in Section 3.2, the two multilateral TRQs for frozen beef are treated as one.

5.2 General features of the model

The model set up for this study belongs to the class of partial equilibrium models. This means that not the whole economy is represented, but only a specific sector. Another way of tackling the question would have been the formulation of a general equilibrium model. General equilibrium models cover the whole economy. They are best applied when the shock that is going to be analysed is likely to impact on several sectors of the economy. The downside of such a comprehensive framework is the necessary loss of detail in product and policy representation.

A partial equilibrium approach on the other hand allows for the representation of the sector or even the product chain in question at considerable detail, but comes at the cost of insight of the effect of shocks on the overall economy. For the question of liberalisation of the high quality TRQs, a detailed representation of products and policies was needed. Hence, a partial equilibrium model was the tool chosen.

The model is formulated as a spatial price equilibrium model (SPE). A SPE renders prices, trade flows as well as quantities produced and demanded that satisfy the equilibrium condition that prices in the importing country are equal to the price in the exporting country plus the transport cost (NAGURNEY, 2002). The concept is based on the work of ENKE (1951), SAMUELSON (1952) and TAKAYAMA et al. (1964), and the models are sometimes referred to as Enke-Samuelson-Takayama-Judge (ESTJ) models.

For this model, a Mixed Complementary Problem (MCP) formulation was chosen. It is particularly attractive in circumstances where TRQs and quota rents are relevant as it allows for an accurate endogenous representation of the quota rent including the characteristic regime switches. This approach is based on the Kuhn-Tucker-Conditions and makes use of what is known as complementary slackness (CHIANG, 1984, p. 722 f.). Examples of models in which this option for modelling TRQs is applied are GTAP, the World Agricultural Trade Simulation Model (WATSIM) (KUHN, 2003) and the model developed by VAN DER MENSBRUGGHE et al. (2003). An alternative way of modelling the quota rent endegenously is to employ a sigmoid function like in the CAPRI model (BRITZ, 2005). This approach has proven to be a possibility to obtain feasible results and

has the advantage of smoothing out some undesired behaviour[26], but it only approximates the regime switch and the amount of quota rent and requires parameters whose values are hard to base empirically, and was thus not further considered here.

The model belongs to the class of bilateral trade models, i.e. other than in a net trade approach where a country can only be a net seller or buyer of a good (VAN TONGEREN et al., 2001), trade flows are differentiated by source and origin. Bilateral trade flows are modelled indirectly through a highly disaggregated commodity specification: Meat is not only characterised by its quality and processing stage, but also by its origin. Beef produced in Argentina is seen as a different product as beef produced in Europe, and imports and exports of the seemingly same commodity are therefore possible. Another option to achieve this would have been to recur to the so-called Armington approach that departs from the idea that products are differentiated by origin and consumers show a different willingness to pay for the same commodity depending on its place of production (ARMINGTON, 1969).The Armington-approach is wide spread, but suffers from some well-knows deficiencies. There is work underway to overcome some of these shortcomings (WITZKE et al., 2005), but in light of the relative small country and commodity space, modelling bilateral trade through a high level of product aggregation was more straightforward for the purpose of this study.

5.3 Country coverage

As the model aims at specifically analyzing trade between the EU and the Mercosur countries, four countries and a "Rest-of-World" aggregate are included:

[26] Using a sigmoid function has the advantage that the switch from one tariff to the other does not take place strictly at the point the quota is over-filled, which can be appealing as statistical errors can potentially lead to misinterpretation of the fill rate. In the modelling context, a falsely reported slight quota over-fill would overestimate the competitiveness of the exporting country. This becomes important when doing simulations including trade liberalisation, because a higher tariff and thus a higher price in the importing country overestimates the "real" willingness to pay that is reflected in the demand function This problem would be smoothed out by the sigmoid function, because for example in the case of a slight overfill of the TRQ, not the full over-quota tariff would be charged, but a tariff in between the in- and the over-quota tariff.

- European Union
- Argentina
- Brazil
- Uruguay
- Rest-of -World.

Paraguay is not included, neither is Venezuela which has become full member of the Mercosur in 2006. This is justified by the fact that they do not play a significant role in beef trade.

5.4 Product coverage

To best reflect the relationships represented in Figure 14, two categories of cattle are distinguished in the model. From these animals, three different kinds of meat are produced. A compound type of meat was introduced in a reduced form to better reflect substitution effects in consumption. This leads to a total of six product categories.

- high quality cattle
- other cattle
- fresh beef of high quality
- other fresh beef
- frozen beef
- other meat.

Each of these product categories is additionally typified by the country of origin. This renders a total of 30 products in the model.

5.5 Actors

As discussed in Section 2.5, the allocation of the rent is not only of interest on the international level, but also on the national level. For a thorough welfare analysis, four actors have to be distinguished in the model:

- farmers
- slaughterhouses
- freezers
- consumers.

The distinction between slaughterhouses and freezers is somewhat artificial: In reality, chilling and freezing certainly takes place in the slaughterhouse itself. The reason behind the distinction here is that it eases explicit modelling of processing fresh to frozen beef depending on profit margins.

5.6 Criteria for the selection of functional forms

A large number of functional forms to reflect human behaviour in a partial equilibrium model can be thought of. Before describing the ones used here, some criteria for the selection of functional forms are discussed here. These are consistency with the assumed economic behaviour, flexibility and other aspects.

Consistency with assumed economic behaviour

Following LAU (1986), theoretical consistency means that the functional form chosen must be capable to reflect the theoretical properties that are required for modelling the particular economic relationship. For the actors in this model, profit or utility maximizing behaviour is assumed. That is, farmers, slaughterhouses and freezers maximise profit under a set of constraints, and consumers maximise the utility from purchases of different goods subject to a budget constraint (see for example VARIAN (1984). The properties that the respective functions must exhibit in order to reflect this behaviour will briefly be discussed in the following.

Supply. If profit-maximising behaviour is assumed, producers choose input and output quantities that maximise their profit. In other words, under this assumption, the supply function gives the optimal choice of output as a function of input and output prices as a solution of the profit maximisation problem. The profit function from which the supply function is derived then has to fulfil certain criteria:

- It must be non-decreasing in output prices and non-increasing in input prices
- It must be homogenous of degree one in output and input prices
- It must be convex in output and input prices
- It must be continuous in output and input prices

(VARIAN, 1984, p. 46).

The supply function can be derived from the profit function via Hotelling´s Lemma (CHIANG, 2005, p. 430). Then, the Hessian matrix contains the second derivatives of the profit function w.r.t. own and cross output prices, and must be *positive* semidefinite for the supply function to have the desired curvature.

In short, there are two main requirements for the supply function to reflect the assumed profit maximising behaviour:

- Homogeneity of degree zero in all prices
- A positive semidefinite Hessian of the profit function.

As will be seen later, these two conditions will be either implied through the functional form chosen or through the choice of the parameter values.

Demand. Analogously to the profit maximisation problem underlying the supply function, here the consumers´ demand function is derived from a utility maximisation problem: Consumers maximise their utility from the purchase of goods under the budget constraint. Unlike in the case of supply and the profit function, some assumptions on the preferences of the consumer have to be made in order to characterise the utility function. These assumptions on the preferences include completeness, reflexivity, transitivity, continuity, monotonicity, convexity and local non-satiation (VARIAN, 1992, p. 95). These so-called well-behaved preferences are then of course reflected in the utility function. A utility function reflecting these well-behaved preferences will

- be continuous, because this is implied by the underlying complete, reflexive, transitive and continuous preferences (VARIAN, 1992, p. 95)

- be monotonically increasing in the bundles consumed as monotonic preferences are assumed, meaning that more goods is always better and bads are not considered (VARIAN, 2006, p. 58).

- exhibit local non-satiation, which implies that even small increases in the consumption bundle imply more utility. Geometrically this means that the indifference curves are lines, not rings (VARIAN, 1992, p. 96).

- have upper level sets that are convex as averages are assumed to be preferred to extremes (VARIAN, 1992, p. 96).

The first order condition for utility maximisation under the budget constraint is achieved using the Lagrange-multiplier method, differentiating the utility function w.r.t. demanded quantities and the Lagrange-multiplier.

The second order condition for utility maximisation implies that the utility function must be locally quasi-concave in quantities (VARIAN, 1984, p. 101).

Under the assumption of well behaved preferences, this means that the derived (Marshall[27]-) demand function is homogenous of degree zero in prices *and* income (VARIAN, 1984, p. 115), i.e. the bundle of goods demanded remains unchanged if all prices and income are multiplied by the same positive number. Another characteristic of the demand function is that in the optimum, the budget is always exhausted if local non-satiation is assumed (VARIAN, 1984, p. 116).

The Hicks demand function can be derived by differentiation of the *expenditure function*[28] w.r.t. *prices* under the condition that utility remains constant. The first derivative of the Hicks demand function w.r.t. prices renders the substitution effects. These in turn represent the second derivatives of the expenditure function w.r.t. prices and therefore the Hessian Matrix of the expenditure function. As the expenditure function *e(p,U)* is concave in prices, its Hessian Matrix is negative semidefinite (SYDSAETER et al., 2005a, p. 170).

In summary, the requirements for a demand system consistent with utility maximizing behaviour is that is ensures

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[27] Marshall demand functions represent demand as a function of prices and income *X(p,Y)* as opposed to Hicks demand functions, that represent the reaction of demand exclusively due to the substitution effect *(X(p,Ū))*, that is a movement along the *same* indifference curve (HENRICHSMEYER et al., 1994, p. 229).

[28] The expenditure function *e(p,U)* is the minimum expenditure needed for obtaining a given utility level at given prices (SYDSAETER et al., 2005a, p.170). It can be derived by substituting the Hicks demand into the definition of expenditure $c = \sum_{i}^{n} x_i \cdot p_i$.

- Budget exhaustion.
- Homogeneity of degree zero in prices and income for the Marshall demand function.
- Correct curvature. For the case of the Hicks demand that is a negative-semidefinite Hessian of the expenditure function when differentiating w.r.t. prices.

As in the case of the supply function, these features must be guaranteed either through the functional forms chosen or the calibration of the parameters.

Flexibility

Another criterion when choosing the functional form is its flexibility (LAU, 1986, p. 1520). A definition of what is a flexible functional form can be found in DIEWERT (2006), p. 2:

> "A flexible functional form is a form that has enough parameters in it so that *f* can approximate an arbitrary twice continuously differentiable function *f** to the second order at an arbitrary point *x** in the domain of definition of *f* and *f**. Thus f must have enough free parameters in order to satisfy the following $1+N+N^2$ equations":
>
> 1. $f(x^*) = f^*(x^*)$ renders one equation to be satisfied
> 2. $\nabla f(x^*) = \nabla f^*(x^*)$ renders *N* equations to be satisfied
> 3. $\nabla^2 f(x^*) = \nabla^2 f^*(x^*)$ renders N^2 equations[29] to be satisfied.

N is the number of elements in the vector *x**. In other words, if the function f is able to reproduce the function value of the true function *f** at *x** as well as the function value of the first and the second derivative w.r.t. the components of *x* and evaluated at *x**, it is said to be flexible. If both *f* and *f** are twice continuously differentiable[30], then the Hessian matrix of the second derivatives of both functions *f* and *f** is symmetric according to Young´s Theorem (DIEWERT, 2006,). The number of free parameters that the function must have in order to be flexible is then reduced to $1+N+N(N+1)/2$ (DIEWERT, 2006). This definition refers only to

[29] The number of equations for which the conditions in 1. to 3. have to hold can be explained by the following reasoning: 1. is simply the equation it self, therefore this condition has to hold only for one equation. The condition in 2. must hold true for all first derivatives versus all elements in the vector *x**. If *x** has the dimension *N*, this gives us *N* equations. 3. gives a restriction for the partial second derivatives and must hold for the entire Hessian matrix. If *x** has the dimension *N* it must consequently hold for N^2 equations.

[30] This can be thought of the function of the second derivatives to be continuous.

the point or vector x^*, and is therefore called a local property. Other authors propose global properties, where an average error over derivatives of different orders is measured (THOMPSON, 1988).

Flexibility is an important criterion because there are functional forms that fulfil the requirements for consistency with the assumed economic behaviour, but have other characteristics that restrain their ability to approximate satisfactorily the economic relationship or behaviour of the agents. An example is a linear cost function that is theoretically consistent, but when deriving the input demand function from it, inputs are always employed in fixed proportions, that is, own and cross price elasticities are zero (LAU, 1986, p. 1540). In the context of this study, inflexible functional forms would complicate the parameter calibration process that is described later in this chapter.

Semiflexibility. The concept of semiflexible forms was introduced by DIEWERT et al. (1988). It addresses the problem that a flexible functional form might be impossible to estimate due to the large number of free parameters required. According to the definition of the authors, the conditions specified in 1. - 3. have to be fulfilled for a semiflexible function, too. The difference is that the rank K of the Hessian matrix $^2 f(x^*)$ is restricted to values smaller than N, that is $K<N$. A semiflexible functional form thus requires less free parameters than a flexible one, as at least one row or column vector of the Hessian matrix must be linearly dependant on at least one other in the Hessian matrix (DIEWERT et al., 1988, p. 327-328). In other words, once $N-1$ rows or columns of the Hessian matrix have been estimated, the values of the (at least) one remaining column or row are unambiguously determined as well.

Other criteria

Other criteria that LAU (1986) mentions that are of interest when choosing the functional form are the domain of applicability, computational facility and factual conformity. The domain of applicability most commonly refers to the set of values of the independent variable, over which the requirements for theoretical consistency are fulfilled. Factual conformity requires the functional form to be consistent with known empirical facts, e.g. Engel´s Law.

5.7 Model equations

In this section, the employed equations are presented in algebraic form. For the ease of reading, the formulation of the Kuhn-Tucker conditions including the shadow values inherent to the MCP approach will be suppressed in the notation unless they are of direct interest.

Behavioural equations

Supply and processing of live animals. The supply of live animals is derived from a normalised quadratic profit function via Hotelling´s Lemma. The profit function is called quadratic because it is quadratic in prices, and normalised because it is normalised with a price index. The resulting supply function depends then only on real output prices, and if both input and output prices increase by the same factor as e.g. in the case of inflation, the supplied quantity will not change. With this, homogeneity of degree zero in prices is achieved for the supply function. Correct curvature is imposed through the calibration of parameters, the procedure is explained later in this chapter.

The supply function *xs* of farmers (indicated through the superscript *f*) for any given $\mathbb{r} \in R$ is defined by

$$(3) \qquad xs^{f}_{\mathbb{r},x}(p) = c^{f}_{\mathbb{r},x} + \sum_{y \in Y} \beta^{f}_{\mathbb{r},x,y} \cdot \frac{p_{\mathbb{r},y}}{px_{\mathbb{r}}} \;\; \forall \; x = (\mathbb{r}, w, alive), w \in W,$$

where $Y = \{(\mathbb{r}, w, alive) \mid w \in W\}$ and

$R = \{ARG, BRA, EU, URU, ROW\}$

$W = \{HIGH, OTHER\}$

$Q = \{ALIVE, FRESH, FROZEN\}$

$X = \{(r, w, q) \mid r \in R, w \in W, q \in Q\}$

.

c represents the constant term of the supply function of farmers and subsumes prices of inputs and outputs that are constant in the mode. β is a slope parameter determining the sign of the influence of the own and cross prices *p*. Prices are normalised with the price index *px*[31].

Demand of the processing industry. The demand functions for animals for slaughter and for fresh meat for freezing are structured identically as the supply of live animals, with the only difference that instead of output prices, the processing margin determines the quantities demanded.

Specifically, the demand of slaughterhouses (indicated by the superscript *s)* for live cattle of different qualities in any given $\mathbb{r} \in R$ is defined by

[31] For this application, the price index was normalised to one.

$$(4) \qquad xd^{s}_{ħ,x}(pm) = c^{s}_{ħ,x} + \sum_{y \in Y} \beta^{s}_{ħ,x,y} \cdot \frac{pm^{s}_{ħ,y}}{px_{ħ}} \forall x = (ħ, w, alive), w \in W,$$

where $Y = \{(ħ, w, alive) \mid w \in W\}$. Here and in the following, *pm* stands for the processing margin realised by the processing industry.
The demand for fresh meat from the deep freezing unit in a processing plant *z* is defined by

$$(5) \qquad xd^{z}_{ħ,x}(pm) = c^{z}_{ħ,x} + \sum_{y \in Y} \beta^{z}_{ħ,x,y} \cdot \frac{pm^{z}_{ħ,y}}{px_{ħ}} \forall x = (ħ, w, fresh), w \in W$$

,

where $Y = \{(ħ, w, fresh) \mid w \in W\}$.

The processing margin for slaughterhouses is defined on the raw product. For any $ħ \in R$ it is given by

$$(6) \qquad pm^{s}_{ħ,x}(p) = \sum_{y \in Y} p^{s}_{ħ,y} \cdot \Lambda_{ħ,x,y} - p^{f}_{ħ,x} \ \forall x = (ħ, w, ali), \ w \in W,$$

where $Y = \{(ħ, w, fresh) \mid w \in W\}$.The factor Λ captures the fact that the classification of beef into high quality beef and beef of other quality is not only based on requirements concerning the production process, but also on the specific cuts. Slaughtering an animal that was raised according to the requirements for high quality beef will therefore always entail not only the production of high quality beef, but also of other beef. On the other hand, an animal whose production process does not fulfil the criteria for being high quality will not render any high quality beef at all. These relations are captured in the factor Λ whose values are shown in Table A 12 of the annex.

For deep freezers the processing margin is simply the difference between input and output cost minus the cost of deep freezing *cf*. For any given pair $(ħ, ẅ) \in R \times W$ this is given by

$$(7) \qquad pm^{z}_{ħ,x}(p^{\cdot}) = p^{z}_{ħ,y} - p^{s}_{ħ,x} - cf_{ħ}, x = (ħ, ẅ, fresh), y = (ħ, ẅ, frozen)$$

.

Supply of processed products. Supply of high or low quality fresh or frozen meat is not price dependant, but determined by the fixed technical coefficients Λ from the processing demand, again representing a Leontief technology. The supply of fresh meat by the slaughterhouses for a given $ħ \in R$ is

(8) $$xs^{s}_{r,x}(xd) = \sum_{y \in Y} xd^{s}_{r,y} \cdot \Lambda_{r,y,x} \quad \forall\, x = (\text{ℍ}, w, fresh), w \in W \ ,$$

where $Y = \left\{ \left(\text{ℍ}, w, ali \right) \mid w \in W \right\}$. Here again, Λ is the coefficient described above, ensuring that high quality beef is only made from high quality cattle but allowing beef of other quality to be made of cattle of both high and other quality.

The supply of frozen beef is in quantitative terms simply equal to the demand of the freezers for fresh meat in each $\text{ℍ} \in R$.

(9) $$xs^{z}_{\text{ℍ},x} = xd^{z}_{\text{ℍ},y}, x = (\text{ℍ}, other, frozen), y = (\text{ℍ}, other, fresh) .$$

Human consumption. The demand system employed in this model has been taken and simplified from RYAN et al. (1999) and is referred to as the Generalised Leontief Quadratic Expenditure System (see Box 2).

As will be seen later, it has the advantage that the resulting demand function is homogenous of degree zero in prices and income, and it is automatically ensured that the budget is exhausted. Budget exhaustion and homogeneity of degree zero are, as explained earlier, two criteria that a demand function reflecting utility maximizing behaviour must fulfil. As in the case of supply, correct curvature is imposed during the calibration process.

Box 2 The generalised Leontief expenditure system

The indirect utility function *v* has the form

$$(10) \qquad v(p,Y) = -\frac{G}{Y-F}.$$

(11) Here *Y* is income (or in a partial equilibrium model the income share allocated to the product group), and *G* and *F* are functions of prices and the parameters *B* and *d*:

$$(12) \qquad G(p) = \sum_{k=1}^{n}\sum_{l=1}^{n} B_{kl} \cdot p_k^{0,5} \cdot p_l^{0,5}$$

and

$$(13) \qquad F(p) = \sum_{k=1}^{n} p_k \cdot d_l .$$

G and *F* are homogenous of degree one in prices. Applying Roy´s Identity to equation (10), the demand function can be derived[32].The function for consumers demand is then given by

$$(14) \qquad xd_i(p,Y) = \frac{G_{(i)}}{G}(Y-F) + F_{(i)} \quad \forall i \in I,$$

where $F_{(i)}$ denotes the first derivative on *F* with respect to p_i[33]:

[32] Roy´s Identity states that the demand function is equal to the negative ratio of the partial derivatives of the indirect utility function versus own price and versus budget (CHIANG, 2005, p. 437). For (10) this becomes

$$\frac{\partial v}{\partial p_i} \Big/ \frac{\partial v}{\partial y} = \frac{\frac{-G_{(i)} \cdot (y-F)}{(y-F)^2} - \frac{-d_i \cdot -G}{(y-F)^2}}{\frac{G}{(y-F)^2}} = -\left[\frac{G_{(i)}}{G} \cdot (y-F)\right] - d_i = -x_i \quad \forall\, i \in I .$$

[33] This demand function ensures budget exhaustion because $\sum_{i=1}^{n} xd_i \cdot p_i = \frac{\sum_{i=1} G_{(i)} \cdot p_i}{G} \cdot (Y-F) + \sum_{i=1}^{n} d_i \cdot p_i = \frac{G}{G} \cdot (Y-F) + F = Y.$ In other

$$(15) \qquad F_{(i)}(p) = \frac{\partial F}{\partial p_i} = d_i \quad \forall\, i \in I$$

and *G(i)* denotes the first derivative of *G* w.r.t. p_i:

$$(16) \qquad G_{(i)}(p) = \frac{\partial G}{\partial p_i} = \sum_{k=1}^{n} B_{ik} \sqrt{(p_k / p_i)}$$

With this specification of *G* and *F*, the Marshall demand function for any given pair $(r, w) \in R \times X'$ becomes

$$(17) \qquad xd^{C}_{r,w}(p, YS) = \left[\frac{\sum_{y \in X'} \beta^{c}_{r,w,y} \cdot p^{-0.5}_{r,w} \cdot p^{0.5}_{r,y}}{\sum_{x \in X'} \sum_{y \in X} \beta^{c}_{r,x,y} \cdot p^{0.5}_{r,x} \cdot p^{0.5}_{r,y}} \right] \cdot (YS_{r} - \sum_{x \in X'}^{n} p_{r,x} \cdot d_{r,x}) + d_{r,w}$$

where $X' = \{(r, w, q) \mid w \in W, q \in Q \setminus alive\}$ (RYAN et al., 1999).

The variable *YS* stands for the income allocated to meat products. The set *X´* contains the consumable goods, consisting of all products in the model with the exception of live animals.

As stated above, this demand function is homogenous of degree zero in prices and group expenditure YS.

The expenditure *YS* that is allocated to meat products is an endogenous variable, allowing for adaption of the income spent on meat products depending on prices[34]. YS is determined through the system described by equation (18) - (21), that is based on the Almost Ideal Demand System (AIDS) as described in SADOULET et al. (1995), p. 43[35].

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words, the sum of all demanded quantities multiplied by its prices it equal to income. $\sum_{i=1}^{n} G_{(i)} \cdot p_i = G$ is computed by applying Euler´s Law for functions homogenous of degree one.

[34] This is desirable because otherwise even if prices for a certain product group would change signifantly, expenditure on that product group would remain constant, which seems a rather strong assumption.

[35] This formulation implies a two stage budget allocation: First, total income is allocated to the two broad product categories “meat products” and “other products”, and then distributed among the different types of meat within the aggregate “meat products”. Assuming that separability exists, this

Equation (18) simply states that the expenditure on meat products is equal to the share of the total income spent on meat products *is* multiplied by the income itself.

$$(18) \qquad YS_r(is) = is_r \cdot Y_r \;\forall r \in R\,.$$

The share *is* in each region is defined according to equation (19) as a function of two price indexes *PM* and *P*

$$(19) \qquad is_r(PM, P) = a_r + \delta_r \cdot \ln PM_r + \vartheta_r \cdot \ln \frac{Y_r}{P_r} \;\forall r \in R\,.$$

P is the stone geometric price index, and if the price index for all non-meat products in the economy is normalised to one, it can be computed by

$$(20) \qquad \ln P_r(PM) = \sum_{x \in X'} \frac{xd^0_{r,x} \cdot p^0_{r,x}}{Y_r} \cdot \ln PM_r \;\; \forall\, r \in R\,,$$

where $X' = X \setminus \{alive\}$. *PM* stands for a meat price index that is calculated as a weighted average of prices and the income share spent on the respective product in the base period:

$$(21) \qquad \ln PM_r(p) = \sum_{x \in X'} \frac{p^0_{r,x} \cdot xd^0_{r,x}}{Y_r} \cdot \ln p_{r,x} \;\forall\, r \in R\,.$$

Other functions

Market clearing equations. The market clearing equations ensure that on each market total supply equals total demand. As mentioned earlier, in an MCP formulation all equations in the model are matched with a slack variable, but this variable was up to now suppressed in the notation. In the case of the market clearing equations, this variable can be interpreted as the product price. The price will only become positive if the market balance holds as an equality, that is, the market is cleared. Otherwise, the price is zero.

As the model has various actors, the market balance must be fulfilled on each level of processing and for each product quality.

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leads to the same final choice as when the allocation is made in one single decision (SADOULET et al., 1995, p. 36).

The market balance for alive cattle is simply the supply of live cattle minus the demand of the slaughterhouses. For any $r \in R$ this is achieved by forcing

$$xs^{f}_{r,x} - xd^{s}_{r,x} \geq 0 \quad \perp \quad p^{f}_{r,x} \geq 0 \tag{22}$$

to hold, where $x = (r, w, alive), w \in W$. The symbol $\perp$ is used to indicate orthogonality, i.e. either the expression on the left of the symbol "$\perp$" must hold as an equality, or the expression to its right.

For fresh meat, the market balance is slightly more complex as it can also be exported, and meat can be imported and consumed by the final consumer. For all $r \in R$, the market balance is defined by

$$\begin{aligned} & xs^{s}_{r,x} - xd^{c}_{r,x} - xd^{z}_{r,x} + \sum_{r' \in R} \sum_{ql \in QL} xt_{r,r',x,ql} - \sum_{r' \in R} \sum_{ql \in QL} xt_{r',r,x,ql} \geq 0 \ \perp \ p^{s}_{r,x} \geq 0 \ , \\ & x = (r, w, fresh), w \in W, \end{aligned} \tag{23}$$

where $QL = \{in - quota\ imports, over - quota\ imports\}$ denotes in-quota and over-quota imports. The variable *xt* denotes trade flows. By definition $xt_{r,r,x,ql} = 0 \ \forall r \in R, x \in X, ql \in QL$.

Deep freezing units receive fresh beef from the slaughterhouses and then freeze it. Frozen beef is either sold domestically to the final consumer or leaves the country as a trade flow. At the same time, it can be imported from other countries. The market balance for frozen beef in any $r \in R$ therefore consists of

$$\begin{aligned} & xs^{z}_{r,x} - xd^{c}_{r,x} + \sum_{r' \in R} \sum_{ql \in QL} xt_{r,r',x,ql} - \sum_{r' \in R} \sum_{ql \in QL} xt_{r,r',x,ql} \geq 0 \ \perp \ p^{z}_{r,x} \geq 0 \ , \\ & x = (r, other, frozen). \end{aligned} \tag{24}$$

Price transmission. The consumer price is determined by multiplication of the wholesale price with a factor reflecting the gap between the wholesale price and the consumer price in the base period. For each given pair $(r, w) \in R \times W$ this leaves us with

$$pc^{c}_{r,x} = p^{s}_{r,x} \cdot \gamma^{s}_{r,x}, x = (r, w, fresh) \tag{25}$$

for fresh beef and

(26) $$pc^{c}_{\text{⋔},x} = p^{z}_{\text{⋔},x} \cdot \gamma^{z}_{\text{⋔},x},\ x = (\text{⋔}, \text{⋓},\ frozen)$$

for frozen beef.

Spatial arbitrage condition. The spatial arbitrage condition is crucial to a SPE model. In the MCP formulation, its dual variable is the choice variable of the underlying Lagrange problem, the interregional trade flow *xt*. As for each type of beef there is only one actor supplying it, the spatial arbitrage condition can be represented in the following form for all $a \in A' \setminus \{ farmer \}$:

(27)
$$p^{a}_{r',x} \cdot (1 + t^{AV}_{r,x,ql}) + t^{SP}_{r,x,ql} + ct_{r,r',x} + qr^{B}_{r,r',x,ql} + qr^{M}_{r,x,ql} \geq p^{a}_{r,x} \perp xt_{r,r',x,ql} \geq 0$$
$$\forall\ r \in R, r' \in R\ with\ r \neq r', x = (r', w, q), w \in W, q \in Q \setminus \{alive\}, ql \in QL$$

with

$$A' = \{ farmer, slaughterhouse,\ freezing\ unit \}.$$

Because in the model only processed products are traded internationally, equation (27) is only defined for meat products, not for live cattle. Moreover, intra-regional trade is suppressed. The parameters t^{AV} and t^{SP} stand for the ad-valorem tariff and the specific tariff applied by country *r,* respectively. Both tariffs have three indices, *r, x* and *ql*. The latter represents the quota level, that is, it defines whether the in-quota tariff or the over-quota tariff is applied. *ct* is the transport cost per unit between the regions *r* and *r´*. The variable *qr* is a model endogenous variable for the quota rent.

Quota rents. The quota rents are, as already mentioned, an endogenous variable to the model. For the bilateral TRQs for high quality beef its value is determined as the dual multiplier of the quota constraint (28) shown below.

(28)
$$trqnt^{B}_{r,r',x,ql} \geq xt_{r,r',x,q,ql} \perp qr^{B}_{r,r',x,ql} \geq 0$$
$$\forall\ r \in R, r' \in R\ with\ r \neq r',\ x = (r', w, q), w \in W, q \in Q \setminus \{alive\}, ql \in QL.$$

trqnt represents the quota quantity and is specified for each pair of importing and exporting country, each product and each quota level. This formulation ensures the desired relation of the level of imports and the quota rent described earlier in this section: As long as the quota quantity is larger than the trade flow, the quota rent is zero. When the trade flow is exactly at the level of the quota quantity, that is the quota is filled, the slack variable *qr* becomes positive which means

that a quota rent exists. This is consistent with the economic theory presented in Chapter 2[36].

To allow for prices differentiated by origin for frozen beef, and the multilateral TRQ had to be split up into parts allocated to the different exporting countries based on past exports, hence making it *de facto* bilateral. Merely the range of products for which the TRQs are defined differ between the multilateral and the bilateral one:

$$(29) \qquad \begin{aligned} & trqnt^{M}_{r,r',x,ql} \geq xt_{r,r',x,ql} \perp qr^{M}_{r,x,ql} \geq 0 \\ & \forall\ r \in R, x = (r', other,\ frozen), ql \in QL. \end{aligned}$$

Here, $trqnt^M$ stands for the multilateral quota quantity. Analogously to the bilateral TRQ, qr^M stands for the quota rent arising from the multilateral quota and is only positive when the quota is either filled or over-filled.

As mentioned above, it must be assured that first the quota is filled, before over-quota imports can take place. This is achieved by the interaction of the spatial arbitrage condition (27) and equation (28) defining the quota rent:

The spatial arbitrage condition is defined on the quota level *ql*, that means, for each part of the quota. Therefore, it must hold for both quota parts, but both are linked via the domestic price in the importing country, which is the same for each of the two parts[37]. The quota rent from the second part of a two-tier quota will always be zero by definition. The total over-quota tariff will always be higher than the in-quota tariff. The combination of these two facts assures that the spatial arbitrage condition is either satisfied only for the first part or for both parts simultaneously, and it will only then be satisfied for both parts if the quota rent from the first part is positive and equal to the tariff difference.

This holds equivalently for the multilateral TRQ for frozen beef, only that in this case the interaction takes place between equation (27) and (29).

5.8 Calibration of the parameters in the behavioural functions

As discussed in Section 5.6, theoretical consistency is one desired property of the functions used in a model. Choosing an appropriate functional form is one step towards a theoretically consistent system of behavioural functions. If through this choice not all the conditions following from the assumed economic behaviour are

[36] This equation is defined for all products in the model except for live cattle. For the qualities that are not comprised in the high-quality beef TRQ, the in-quota tariff and the over-quota tariff are simply equal.

[37] Note that the price has only a country index, not a „quota part“ index.

satisfied, the parameters must be determined in a way that the desired properties are guaranteed.

In the calibration process, the parameters of the behavioural functions are treated as variables. Their values are not completely free, but *a priori* information from other studies is used. Where available, econometrically estimated elasticities taken from other studies were used as a benchmark from which the deviation was minimised under a set of constraints. Where possible, these estimated elasticities where taken from CAP et al. (2007), where the authors present estimates of demand and long-term elasticities for several agricultural products in different Mercosur countries. Another source of elasticity estimates is the World Food Model. For some elasiticities, no estimates were available, and they had to be set by the authors judgement.

The calibration process can be seen as an optimisation process under constraints, providing

1. parameters that render equations with the desired properties

2. elasticities that are as close as possible to the a priori information.

Calibration of the parameters for supply of live animals and demand for processing

For supply, homogeneity of degree zero in prices is guaranteed through the functional form.

For farmers, β^f for any $\mathbb{n} \in R$ is given as

$$\beta^{f}_{\mathbb{n},x,y} = \varepsilon^{f}_{\mathbb{n},x,y} \cdot \frac{xs^{f,0}_{\mathbb{n},x}}{p^{f,0}_{\mathbb{n},y}} \quad \forall\, x = (\mathbb{n}, w, alive), y = (\mathbb{n}, w', alive), w, w' \in W \tag{30}$$

where ε is the price elasticity of supply. xs^0 stands for the production quantity of the base year and p^0 for the price in the base year[38].

For the processing industry, the price is replaced by the processing margin, and equation (30) becomes

$$\beta^{s}_{\text{⋔},x,y} = \varepsilon^{s}_{\text{⋔},x,y} \cdot \frac{xs^{s,0}_{\text{⋔},x}}{pm^{s,0}_{\text{⋔},y}} \quad \forall\, x = (\text{⋔}, w, alive), y = (\text{⋔}, w', alive), w, w' \in W \tag{31}$$

for the slaughterhouse and

$$\beta^{z}_{\text{⋔},x,y} = \varepsilon^{z}_{\text{⋔},x,y} \cdot \frac{xs^{z,0}_{\text{⋔},x}}{pm^{z,0}_{\text{⋔},y}} \quad \forall\, x = (\text{⋔}, w, fresh), y = (\text{⋔}, w', fresh), w, w' \in W \tag{32}$$

for the deep freezing unit.

Regarding the correct curvature, it has been stated in 5.6 that to produce a profit function that reflects the assumed behaviour, the matrix of slope parameters $\mathbf{B}^S$ has to be positive semidefinite. This is ensured by forcing all leading principal minors D_k of $\mathbf{B}^S$ to values greater than zero (SYDSAETER et al., 2005b, p. 36). Hence, for all $r \in R$ and $a \in A'$,

$$\begin{aligned} & D^{a}_{r,x(a),k} > 0, \quad for\ k = 1, 2, ..., n \\ & where \\ & X(a) = \left\{ \left(\text{⋔}, w, q(a) \right) \right\} \\ & q(a) = \begin{cases} alive,\ for\ a = farmer, slaughter\ house, \\ fresh,\ for\ a = freezing\ unit \end{cases} \end{aligned} \tag{33}$$

is enforced.

The calibrated elasticities must add up to zero. This is achieved by forcing the sum of own and cross output price elasticities for each product to values greater

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[38] The definition of β can be easily explained: According to Hotelling´s Lemma, $\frac{\partial \pi}{\partial p} = x^*$, and the elasticity is defined as $\varepsilon = \frac{\partial x^*}{\partial p} \cdot \frac{p}{x}$ or equivalently $\varepsilon = \frac{\partial \pi}{\partial p \partial p} \cdot \frac{p}{x}$. Denominating $\beta = \frac{\partial \pi}{\partial p \partial p}$ and rearranging renders equation (30).

than zero, and the elasticity of supply to input prices is then calculated residually. For any $r \in R$ and $a \in A'$, this is given by

$$(34) \qquad \sum_{y \in X(a)} \varepsilon^{a}_{\#,x(a),y} > 0 \;\; \forall \;\; x(a) \in X(a).$$

Finally, the set of parameters minimizing the square deviation of the calibrated elasticities from the original ones is found by

$$(35) \qquad \min_{\varepsilon^N} \; dev = \sum_{r \in R} \sum_{a \in A'} \sum_{y \in X(a)} \sum_{x \in X(a)} (\varepsilon^{a}_{r,x,y} - \varepsilon'^{a}_{r,x,y})^2$$

with ε' being the elasticity estimates taken from the literature[39]. The resulting elasticities can be found in the annex Table A 8.

Calibration of the parameters of human consumption

For human consumption, the functional form chosen ensures budget exhaustion and homogeneity of degree zero in prices and income. The parameters of the β matrix must therefore only ensure the correct curvature.

Despite the fact that the function of human consumption represents a Marshallian demand function, in the calibration of the β^D matrix only Hicksian substitution effects are accounted for, i.e. the income effects of a price change are ignored. The Marshall and Hicks demand functions can be expected to differ considerably from each other in those cases only where either the budget share or the income elasticity for the product under consideration is significant[40]. In light of the nature and the fairly narrow range of products covered in this model, this is unlikely to be the case.

In the calibration process, the cross price elasticities (36) of demand are specified for each $\# \in R$ by

[39] For the processing industry, no estimates were available. For slaughterhouses, the ones for farmers were used and then forced to more elastic values than the ones for farmers.

[40] This can be seen through the Slutsky Equation, that establishes the relationship between the Marshall and the Hicks demand.

$$\varepsilon^{c}_{h,x,y} = \frac{\partial xd_x}{\partial p_y} \cdot \frac{p_y}{xd_x}$$

$$= \left[\left(\left(\frac{G_{(ij)h}}{G_h} - \frac{G_{(i)h} \cdot G_{(j)h}}{G^2_h}\right)\right) \cdot \left(Y_h - F_h\right) - \frac{G_{(i)h}}{G_h} \cdot F_{(i)}\right] \cdot \frac{pc^0_{h,y} / px^0_h}{xd^{c,0}_{h,x}} \quad (36)$$

$$\forall x \in X', y \in X' \text{ with } x \neq y$$

with G, $G_{(j)}$, F and $F_{(i)}$ being the functions described earlier in this chapter. $G_{(ij)}$ stands for the second derivative of G w.r.t. cross prices.

$$G_{(ij)h}(p) = \frac{\partial G_{(i)}}{\partial p_j} = 0.5\beta^{c}_{h,x,y} / \sqrt{p^{c}_{h,x} \cdot p^{c}_{h,y}} \quad \forall \; x \in X', y \in X' \text{ with } x \neq y. \quad (37)$$

For any $h \in R$ the own-price elasticities are defined as

$$\varepsilon^{c}_{h,x,x} = \frac{\partial xd_x}{\partial p_x} \cdot \frac{p_x}{xd_x}$$

$$= \left[\left(\left(\frac{G_{(ii)h} \cdot G_h - G^2_{(i)h}}{G^2_h}\right)\right) \cdot \left(YS_h - F_h\right) + \frac{G_{(i)h}}{G_h} \cdot F_{(i)}\right] \cdot \frac{pc^0_{h,x} / px^0_h}{xd^{c,0}_{h,x}} \quad (38)$$

$$\forall x \in X',$$

and $G_{(ii)}$ is given by

$$G_{(ii)h}(p) = \frac{\partial G_{(i)}}{\partial p_{(i)}} = \sum_{y \in X', y \neq x} \beta_{h,x,y} \cdot -0.5 \cdot p^{c^{-1.5}}_{h,x} \cdot p^{c^{0.5}}_{h,y} \; \forall x \in X'. \quad (39)$$

The income elasticity ε^{Y} is given by

$$\varepsilon^{Y}_{r,x} = \frac{\partial xd_x}{\partial y} \cdot \frac{y}{xd_x} = \frac{G_{(i)r}}{G_r} \cdot \frac{Y_r}{xd^{c,0}_{r,x}} \quad \forall \; \forall x \in X'. \quad (40)$$

For correct curvature, some restrictions on the elements in the matrix of substitution terms $\mathbf{B^D}$ must be fulfilled. In the demand system, $\mathbf{B^D}$ is the Hessian matrix of the expenditure function and must thus be symmetric. This is achieved by forcing equation (41) to hold.

(41) $$\beta^{c}_{r,x,y} = \beta^{c}_{r,y,x} \quad \forall x \in X', y \in X' .$$

The off-diagonal elements of $\mathbf{B^D}$ are forced to be greater than zero and the diagonal elements to values smaller than zero through equation (42) and (43):

(42) $$\beta^{c}_{r,x,y} < 0 \quad \forall x \in X', y \in X' \; with \; x = y$$

(43) $$\beta^{c}_{r,x,y} > 0 \quad \forall x \in X', y \in X' \; with \; x \neq y .$$

These restrictions imply two things: One is that negative own-price effects are assured. The other one is that positive cross-price effects in combination with negative own-price effects guarantee that the Hessian Matrix of the expenditure function is negative semidefinite and therefore correct curvature is achieved[41].

Obviously, equation (42) and (43) put a restriction on the signs of the entries in the Hessian matrix, and therefore full flexibility of the system is not given. In practical terms the conditions posed on the off-diagonal elements states that all goods are Hicks substitutes, and no complementary relations between two goods are allowed for.

As in the case of the derivation of the parameters for supply and for demand of the processing industry, the calibrated elasticities are forced to values as close as possible to given ones by seeking a set of parameters that minimises the deviation of the calibrated elasticities from the given ones. This set is determined by

(44) $$\min_{\varepsilon^c, \varepsilon^Y} dev^D = \sum_{r \in R} \sum_{x \in X'} \sum_{y \in X'} (\varepsilon^{c}_{r,x,y} - \varepsilon'^{c}_{r,x,y})^2 + \sum_{r \in R} \sum_{x \in X'} (\varepsilon^{Y}_{r,x} - \varepsilon'^{Y}_{r,x})^2 .$$

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[41] For calibration of the parameters of the demand function, it is not necessary to restrict the leading principal minors to positive values. All the cross-price effects are forced to positive values. This ensures concavity of the expenditure function (and therefore a negative semidefinite Hessian matrix) for the following reason: The expenditure function can be derived from the indirect utility function solved for income *Y* and then equated to expenditure (because the budget is always exhausted): $Y = F - \frac{G}{\overline{V}(p,Y)} = e(\overline{U}, p)$. *G* is a sum of either concave functions (for cross-prices) or linear functions (for own-prices). This implies that *G* is concave. In addition, the value of *G* is forced to values greater than zero in the calibration point. As *V(p,Y)* is negative as long as *Y>F*, the term $-\frac{G}{\overline{V}(p,Y)}$ is concave as well. *F* is linear, and as stated before, addition of a linear and a concave function renders again a concave function. Hence, *e(U, p)* is concave if the off-diagonal elements of the Hessian are positive.

Here, ε'^{C} stands for the estimated demand elasticities taken from the literature, and ε'^{Y} for the ones of income. The outcome of the calibration process is presented in Table A 9 of the annex.

Calibration of the parameters in the income allocation system

The price elasticity of meat consumption *M* is given by equation (45)

$$\varepsilon_{M}^{cM} = \frac{\partial M}{\partial PM} \cdot \frac{PM}{M} = -1 + \frac{\delta_r}{is_r} - \vartheta_r \quad \forall r \in R \,. \tag{45}$$

The price elasticities are additionally restricted to values smaller than zero. The income elasticity of meat consumption is defined through

$$\varepsilon_r^{YM} = \frac{\partial M}{\partial Y} \cdot \frac{Y}{M} = 1 + \frac{\vartheta_r}{is_r} \quad \forall r \in R \,. \tag{46}$$

Homogeneity of the income allocation system and a positive income elasticity are guaranteed by forcing the sum of income and price elasticities to zero:

$$\varepsilon_{M}^{cM} + \varepsilon_r^{YM} = 0 \quad \forall \in R \,. \tag{47}$$

As for the parameters of the supply function and the demand function for individual meat products, a penalty function minimises the deviation of the calibrated elasticities from the ones taken from the literature, which are denoted by ε'^{cM}_r and ε'^{YM}_r:

$$\min_{\varepsilon_r^{cM}, \varepsilon_r^{YM}} dev^{M} \sum_{r \in R} \left[(\varepsilon_r^{cM} - \varepsilon'^{cM}_r)^2 + (\varepsilon_r^{YM} - \varepsilon'^{YM}_r)^2 \right]. \tag{48}$$

Additionally, the parameters must be such that *is* as defined as through equation (19) must hold with prices, quantities and the income share fixed to their base year values. Thus again, the procedure renders parameters that replicate the elasticities taken from the literature as close as possible and exactly replicate the base year situation.

5.9 Welfare Analysis

The possibility of carrying out a welfare analysis is included into the model. It is based on the approach of economic surplus that is based on the change in real income of the agents in the market (HENRICHSMEYER et al., 1994, p. 151).

In the present study, four subcategories of income are distinguished: The Marshallian producer surplus, the Hicksian equivalent variation, the economic rent accruing from the binding quotas and the state budget.

Producer surplus for farmers and processing industry

The producer surplus for farmers is computed by evaluating the integral under the farmers' supply function between the initial price and the price in the simulation. This renders the economic surplus since the supply function has a one-to-one correspondence with the marginal cost function. So, for any given $\eta \in R$ we obtain

$$PS_{\eta,x} = \int_{p^{f,0}_{\eta,x}}^{p^{f,1}_{\eta,x}} xs(p)^{F}_{\eta,x}\, dp \quad , x = (\eta, w, alive), w \in W \; . \tag{49}$$

For the processing sector, the price is replaced by the processing margin (not shown).

The model comprises multiple interdependent markets: Price changes in the market *j* influence the position of the curves in market *i*. In order to disentangle the effects of the prices on each market, a sequential procedure was adopted following VON LAMPE (1993) to compute the producer surplus on each market. The procedure can be described in the following manner:

In the first step, all prices p_i are set to their initial value p_i^0. Then, the integral on the first market *k* is evaluated between the limits p_k^0 and p_k^1, all other prices being constant. Subsequently, the integral of the second market *l* is evaluated between the limits p_l^0 and p_l^1. Again, all other prices are held constant at p_i^0 with the exception of p_k, that maintains the value p_k^1. Continuing in this manner, the welfare changes on every market are successively evaluated.

Consumers' welfare

Consumers' welfare is assessed according to the concept of the money metric utility.

Box 3 Money Metric Utility

The change in the consumers´ welfare is expressed in terms of the money metric utility measure as defined by DEATON et al. (1980). According to the authors, the money metric utility measure directly corresponds to the expenditure function *e(p,U)*, that on its hand defines the minimum expenditure to achieve a given level of utility at given prices (DEATON et al., 1980, p. 38 and 179-180). The money metric utility is thus a welfare measure expressed in monetary units. In fact, it is nothing else than the equivalent variation defined as

$$EV = e(p^0, U^1) - e(p^1, U^1) \tag{50}$$

(HENRICHSMEYER et al., 1994, p. 230).

Thus, the equivalent variation in monetary terms for each region can be computed as

$$MM_r = e(p_r^0, U_r^1) - e(p_r^0, U_r^0) = F_r^0 + \frac{G_r^0}{G_r^1} \cdot (YS_r^1 - F_r^1) - YS_r^0 \text{ [42]}. \tag{51}$$

The equivalent variation can be interpreted as the income transfer that would be necessary to enable the consumer to achieve the new utility level at the initial price vector (HENRICHSMEYER et al., 1994, p. 228).

Quota rent and state revenue

The computation of the quota rent and the state revenue are straightforward. The quota rent is computed as the per unit quota rent multiplied by the quantity that generates the rent. The distribution between the actors is then made drawing on the information presented in Chapter 4: In Brazil and Uruguay, the quota rents arising from the high quality beef TRQ are fully assigned to the meat processing sector. In Argentina, 7 percent of the quota rent is allotted to farmers, and the

[42] Due to the underlying minimisation approach (dual solution to utility maximisation), the minimum expenditure to reach a given utility level is equal to the income. Hence, the expenditure function is defined as $e(U, p) = Y = F - \frac{G}{v} = F - \frac{G}{G} \cdot (Y - F)$.

remaining 93 percent to the meat processing sector. The quota rents arising from the multilateral TRQs for frozen beef contribute entirely to the welfare changes of the meat processing sector in the EU.

The tariff revenue is the tariff per unit times the quantity imported under the respective tariff regime, and allotted to the country that levies the tariff.

5.10 Data sources

Base year

The model was calibrated on a three year average reaching from 2004-2006 wherever possible[43].

Production on farm

For this exercise, animals produced on farms had to be classified as being appropriate for producing meat exportable under the TRQ for high quality or not. The requirements that the EU demands differ between the exporting countries (COMMISSION OF THE EUROPEAN COMMUNITIES, 1997). Depending on the data availability, the closest match between the legislation or, where appropriate, expert statements and the animal categories for which data was available was made.

As regards for feed, it was assumed that all animals are exclusively grass fed, which reflects reality pretty closely for the Mercosur countries. An overview of the resulting matching can be found in annex Table A 2 - Table A 6.

Data on slaughter production in Argentina is available from the *Indicadores del Sector Vacuno* of the Secretary of Agriculture (SECRETARÍA DE AGRICULTURA GANADERÍA PESCA Y ALIMENTOS, n.d.).

For Brazil, quantities of animals slaughtered and the carcass weight are available on the website of the Brazilian statistical institute (IBGE) (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, n. d.a).

For Uruguay, the *Instituto Nacional de Carnes* provides a comprehensive set of data. It comprises the number of animals slaughtered at considerable detail, as well as the average carcass weight (INSTITUTO NACIONAL DE CARNES, n.d.b).

Data on slaughter production in heads in the EU were obtained from EUROSTAT (n.d.b). The data set differentiates between various types of cattle. An average carcass weight was also available from Eurostat and used to convert the number of animals slaughtered into meat production.

[43] For some variables like for example population data, no average over 2006-2004 could be calculated because the data was not available. In those cases, the most recent data was used.

Data on production of animals on farm for the Rest-of-World aggregate was taken from FAOSTAT. The data does not differentiate between different types of animals. Hence, the herd structure of the U.S. was used as an indicator of the global herd structure (USDA, 2006)[44].

Generally, errors that are made in this step of data sampling and compilation are unlikely to be decisive for the assessment of the trade liberalisation scenarios. Production capacities were never considered as a limiting factor as regards the ability to benefit from trade liberalisation.

Production of fresh meat

Production of meat of different qualities was derived from slaughtered animals by applying the fixed coefficients presented in the annex Table A 12. Of each carcass of high quality, 25 kg are assumed to be high quality cuts, whereas the remaining is assumed to be cuts of other than high quality. This figure was derived from expert interviews stating that the weight of cuts exported to Europe (mostly tenderloins, striploins, rumps, cuberolls, eye rounds, topsides and silversides, depending on the exporting country) is on average 25 kg per carcass. These high quality cuts were set in relation to average carcass weight in the respective country. For the Rest-of-World aggregate, the average carcass weight in the U.S. was used (USDA, 2006).

For animals of other than high quality, this procedure was not necessary as 100 percent of the carcass is seen as meat of other than high quality. The resulting quantities can be found in annex Table A 2 - Table A 6

Production of frozen meat

For the European Union, data on the quantities of frozen beef sold are available from Eurostat (EUROSTAT, n.d.b).

Data for the production of frozen meat could not be retrieved for the Mercosur countries. The assumption was made that meat is mainly frozen for transportation purposes, and production has been equalised to exports of frozen beef. Though this is likely to underestimate the production of frozen meat, it was the only feasible solution. At the same time, experts from the Mercosur countries confirmed the limited extent to which meat is frozen for storage reasons and then consumed domestically.

For the Rest-of-World aggregate, not only exports of frozen meat with partners external to the aggregate, but also the quantities traded inside the aggregate were

[44] Given that that the U.S. are the largest beef producer, and other large beef producers like Brazil, Argentina, Uruguay and the EU are not part of the Rest-of-World aggregate, the U.S. data represent this aggregate fairly well.

summed up to approximate total production. Information on the resulting quantities are presented in annex Table A 2 - Table A 6.

Processing demand

As described earlier, demand of slaughterhouses for live cattle is simply equalised to the production of meat, and the demand for fresh meat for deep freezing is equal to the production of frozen beef.

Consumption data

Consumption data for meat is readily available for most countries. In the framework of this study however, it was necessary to distinguish between consumption of different kinds of beef. For some countries, data on the consumed quantities of different cuts is provided, that could then be matched with the different qualities of beef considered for this model. Where this was not the case, this was extrapolated from other countries or calculated residually from the market balance.

For Brazil, the quantities of domestic per capita consumption of different cuts are compiled by IBGE and are available through its website (INSTITUTO BRASILEIRO DE GEOGRAFÍA E ESTATÍSTICA, n. d.b). The latest survey dates back to 2003, so under the assumption of unchanged consumption patterns, this data has been updated with World Bank population data and adjusted for out of house consumption with FAO data.

For Argentina, consumption data was available on a per capita basis from the Secretary of agriculture (SECRETARÍA DE AGRICULTURA GANADERÍA PESCA Y ALIMENTOS, n.d.). Total consumption was derived using World Bank population statistics.

Consumption data for Uruguay was taken from the OECD´s outlook database (OECD, n.d.a).

Data for different fresh meat cuts was not available for the European Union. Consumption of different qualities of meat was thus calculated residually from the market balance. The same procedure had to be applied for the Rest-of-World aggregate.

Information on consumption of frozen meat could not be retrieved for any of the countries in question. The assumption was made that all imported frozen beef is consumed domestically, i.e. no transit trade takes place. Together with the assumption made for production of frozen meat, consumption of this type of meat can be equalised to imports.

The outcome of this process is presented in annex Table A 2 - Table A 6

Prices

Producer prices. Average producer prices are published by national authorities in many countries. Here, the challenge was to retrieve prices for different qualities of animals. Generally, it was aimed at achieving consistency with the matching between type of animal and type of meat made for the production data. This was not always possible, and other ways of approximating the price for different animal types had to be thought of.

For Argentina, producer prices for live cattle of different categories quoted on the Mercado de Liniers were made available (MERCADO DE LINIERS, n.d.).

Producer prices for live cattle Brazil could not be obtained from any national sources. FAO data was therefore used to derive a ratio between the Argentine producer price and the Brazilian producer price reported by FAO, and that factor was then applied to the Brazilian producer price.

Producer prices for live cattle in Uruguay are available at great level of detail from several issues of the market information provided by the MINISTERIO DE GANADERIA, AGRICULTURA Y PESCA.

For the EU, producer prices were taken from the OECD´s Producer Support Estimate database (OECD, n.d.b). These are assumed to reflect the price for animals of high quality.

Farm prices for the Rest-of-World aggregate for high quality animals were taken from the OECD´s Agricultural Outlook Database (OECD, n.d.a) and are represented through the U.S. Nebraska Choice Steers price. Prices for other than high quality animals were derived from USDA livestock prices (USDA, 2006). The farm price data is presented in Table A 7.

Consumer prices of domestic meat. In order to achieve consumer prices for different qualities of beef, prices for different cuts were mapped to the categories of beef used in the model.

In the case of Argentina, consumer prices for different cuts of beef are available from the SECRETARÍA DE AGRICULTURA GANADERÍA, PESCA Y ALIMENTOS (2006).

Consumer prices in Brazil for different fresh cuts were not available from official sources, but were obtained from the consulting company *Scot Consultoria*.

Consumer prices in Uruguay were obtained from the Ministry for Agriculture for two cuts of beef from several issues of the MINISTERIO DE GANADERIA, AGRICULTURA Y PESCA.

Consumer prices were hard to retrieve for the EU. It was necessary to use a local price as an indicator for the EU price (ZENTRALE MARKT- UND PREISBERICHTSSTELLE, 2007). While this is clearly a strong assumption, the fact

that Germany is by far the biggest market for South American beef in the EU palliates the error introduced.

Consumer prices for the Rest-of-World aggregate were taken from the USDA for different cuts (ERS-USDA, n.d.).

The data on consumer prices can also be found in Table A 7.

Prices on the level of meat processing. Domestic market prices on the level of the meat processing sector were difficult to obtain. In the Mercosur countries, the export unit value taken from EUROSTAT (EUROSTAT, n.d.a) of the respective products on 8-digit level of the *combined nomenclature* was used as proxy for the wholesale price.

It should be noted that the resulting price has to be interpreted as the export price for meat designated to exports to Europe. It is important to distinguish these prices from prices for the – seemingly – same quality of meat for the internal market[45].

Approximating wholesale prices with export unit values was not seen as an appropriate measure for the EU, as the meat exported under the tariff lines that are eligible for the high quality beef quota is highly heterogeneous, other than for the Mercosur states that export mainly high quality cuts. Therefore, a price reported by the German *Zentrale Markt und Preisberichtsstelle* (ZMP) was used as a proxy for the price of beef on the European market (ZENTRALE MARKT- UND PREISBERICHTSSTELLE, 2007). No satisfying indicator for the price of other than high quality meat was available from this source. It was therefore derived assuming that the ratio between high and other quality meat is the same on consumer and wholesale level.

Approximating wholesale prices for the Rest-of-World aggregate for beef of different quality through export unit values did not render satisfying results for this aggregate because of the high heterogeneity of exports. Information on the margins between consumer and wholesale prices for the U.S. were available (USDA, 2006), which were exploited to compute wholesale prices back from consumer prices.

Prices on processing level are also presented in Table A 7.

Processing Margins

The processing margins were calculated from the price data obtained from different sources and the factor representing the Leontief technology. For slaughter-

[45] The latter is likely to differ significantly from the export price when like in this case, quality aspects play a role. This is why in some cases, the domestic consumer price is lower than the export price.

houses and deep freezing units, it was derived evaluating equation (6) or equation (7) at the observed prices.

Exchange Rates

Annual exchange rates of the US Dollar, the Argentine Peso and the Brazilian Real were obtained from the Bank of Canada (BANK OF CANADA, n.d.). The exchange rate of the Uruguayan Peso was not available from this source, but was taken from the German Office for Foreign Trade (BUNDESAGENTUR FÜR AUßENWIRTSCHAFT, 2007). Where available, an average from 2004 to 2006 was used, in the case of Uruguay, only data for 2006 and 2007 was available.

Trade data

Data sources. Two main sources of trade data were used. One is EUROSTAT, which provides trade flows between the European Union and all its trading partners at 8-digit level through the web interface COMEXT (EUROSTAT, n.d.a). Eurostat provides only bilateral trade flows in which the EU is involved, so a second source of trade data had to be used for all other trade flows in which the EU is not involved.

To cover this part of the data, the trade database provided by the United Nations (UN), COMTRADE (UNITED NATIONS, n.d.), was used. There are two main differences between the data bases: While Eurostat provides data on monthly level, the United Nations do this only on a calendar year basis. Using UN data to analyze the trade flows under the quota schemes of the EU would necessarily introduce an error, as the quota quantities are defined on marketing years, not on calendar years. To circumvent this problem, monthly data has been aggregated to marketing years for all the trade flows concerning the EU.

The other difference is the level of product aggregation. For all trade flows between partners other than the EU, UN data on the more aggregated 6-digit level was used. The level of product aggregation does not present a major problem in the context of the study, as TRQs and the corresponding disaggregated product specification apply only for the EU. The resulting data can be found in annex Table A 2 - Table A 6.

Product aggregation. The trade data had to be matched to the product aggregation for this model. This was done making three assumptions:

- high quality beef is traded always fresh or chilled
- beef of other quality can be fresh or frozen
- the composite commodity “other meat” consists of pork, meat from sheep and goats as well as poultry.

The mapping of the respective tariff lines and these meat categories is given in annex Table A 1.

5.11 Balancing data

When compiling data from different sources, the data set is very unlikely to be balanced initially. A procedure has to be set up to make the data consistent with the assumption that markets are in equilibrium in the initial state. Generally, three methods are common to generate consistent market balances.

The first one consists of calculating one item of the market balance residually from the others. Typically, consumption is the item that is calculated residually, because it is frequently subject to severe data limitations. Another approach consists of introducing an error term reflecting the statistical differences in the market balance, and keeping it constant in the model solution. A more refined method includes searching a dataset that is internally consistent with a market clearing assumption and at the same time as close as possible to the original data.

This latter approach was used here. An optimisation procedure under constraints was set up, that minimises the percentage difference from the original data and at the same time renders a balanced data set. The solution is found by

$$\min dev = \sum_{r\in R}\sum_{a\in A}\sum_{x\in X(a)}\left[(xs^{a}_{r,x} - xs^{'a}_{r,x})/(xs^{'a}_{r,x})\right]^2 + \left[\left(xd^{a}_{r,x} - xd^{'a}_{r,x}\right)/\left(xd^{'a}_{r,x}\right)\right]^2 + \tag{52}$$

$$+\sum_{r\in R}\sum_{r'\in R}\sum_{x\in X''}\left[\left(xt_{r,r',x,over-quota} - xt'_{r,r',x,over-quota}\right)/\left(xt'_{r,r',x,over-quota}\right)\right]^2$$

s. t.

$$0 = xs^{S}_{\mathbb{R},x} - xs^{F}_{\mathbb{R},y}\cdot\Lambda_{\mathbb{R},y,x},\ \forall\mathbb{R}\in R, x=(\mathbb{R},high,\ fresh), y=(\mathbb{R},high,alive) \tag{53}$$

$$0 = xs^{a}_{\text{ⓜ},z} - \left(xs^{f}_{\text{ⓜ},x} \cdot \left(1 - \Lambda_{\text{ⓜ},x,y}\right) + xs^{f}_{\text{ⓜ},z} \right) \quad (54)$$
$$\forall \text{ⓜ} \in \mathrm{R},\ x = (\text{ⓜ}, high,\ fresh),\ y = (\text{ⓜ}, high, alive),\ z = (\text{ⓜ}, other, alive)$$

$$0 = xd^{C}_{r,x} - \sum_{ql \in QL} xt_{r,r',x,ql} \quad \forall\ r \in R, r' \in R\ with\ r \neq r', x \in X'' \quad (55)$$

$$NT_{r,x} = \sum_{r' \in R} \sum_{ql \in QL} xt_{r',r,x,ql} - \sum_{r' \in R} \sum_{ql \in QL} xt_{r,r',x,ql} \quad \forall\ x \in X'' \quad (56)$$

$$0 = \sum_{r \in R} NT_{r,x} \quad \forall\ x \in X'' \quad (57)$$

as well as equation (22), (23) and (24) are satisfied simultaneously and where $X'' = \left\{ (r', w, q) \mid r' \in R, w \in W, q \in Q \setminus alive \right\}$.

xs´, *xd´* and *xt´* represent the observed data. *NT* denotes the net-trade of each country $r \in R$.

Equation (53) and (54) are a restatement of the production technology where slaughterhouses purchase live animals from the farming sector and then decompose them into different types of meat.

Equation (55) states that consumption of foreign beef equals imports. Equation (56) defines the net-trade of each country, and global market clearing is ensured in equation (57).

5.12 Conclusions of the chapter

The model was designed to allow for a highly detailed representation of the meat sector.

Three different qualities of beef are distinguished, high quality fresh beef, other quality fresh beef and frozen beef. Furthermore, each type of beef is characterised through its place of production. Hence, each type of beef is described by three attributes. This allows for bilateral trade of the group product beef.

On the regional dimension, the model covers Argentina, Brazil, Uruguay, the EU and a Rest-of-World aggregate.

In the production chain, farmers and the processing sector are represented through individual behavioural equations.

Desired properties such as the consistency with assumed economic behaviour and sufficient flexibility are partially achieved through the functional forms, partially through the choice of their parameters.

Market clearing equations for each product ensure that supply meets the demand for each product, and determine the price.

The economic rents arising from a binding or over-filled quota are an endogenous variable that is determined exploiting the Kuhn-Tucker conditions.

A broad range of national and international data sources were used. The model is calibrated to a 2004-2006 average.

The contribution of this model to the assessment of the economic impact of trade liberalisation scenarios between the EU and the Mercosur countries is presented in the following chapter.

6 Quantitative analysis

In this section, an attempt is made to assess the impact of a possible free trade agreement between the EU and the Mercosur countries applying the model described in the previous chapter. Key indicators in this context will be the development of trade flows under different outcomes of the negotiations as well as the resulting changes in producer and consumer welfare, state revenue and quota rents. The analysis will reveal not only which countries, but also which economic agent within the country will loose or benefit from the policy change.

6.1 Scenario definition

This quantitative assessment is based on the proposals exchanged by the two negotiating parties in 2005. The analysis based on the EU proposal will hereinafter be referred to as the *EU-proposal*, the proposal presented by the Mercosur countries as the *Mercosur-proposal*.

For the beef sector, the *EU-proposal* includes, in the absence of a conclusion of the Doha round, the expansion of the existing TRQ for high quality beef by additional 100,000 tonnes. According to this proposal, the in-quota tariff shall be fixed at "50 percent of the lowest of the bound in-quota duty rates for the existing WTO bound tariff quotas for the relevant product" (USDA, 2005). In the case of the high quality beef TRQs of the EU, this materialises into an in-quota tariff reduction of 50 percent. The over-quota tariff remains unchanged. The EU proposal does not contain any provisions on how to allocate the additional quota quantities among the Mercosur countries. The industry consultation that was carried out in the framework of this study revealed an intra industry agreement that lays down the distribution of the additional quota among the Mercosur countries. The agreed distribution of additional quota quantities as well as the resulting total quota quantities for high quality beef are presented in Table 3.

Table 3 Trade liberalisation proposals for high quality beef

		EU-Proposal		**Mercosur-Proposal**	
	Agreed distribution	*additional quota (tonnes)*	*total quota (tonnes)*	*additional quota (tonnes)*	*total quota (tonnes)*
Uruguay	21.0%	21,000	27,300	63,000	69,300
Argentina	29.5%	29,500	57,500	88,500	116,500
Brazil	42.5%	42,500	47,500	127,500	132,500
Paraguay	7.0%	7,000	8,000	21,000	22,000
Sum	100%	100,000	140,300	300,000	340,300
		in-quota tariff reduction			
		50%		100%	

Sources: Own compilation based on USDA (2005), personal communication with the Commission of the European Union and industry representatives.

The Mercosur proposal differs from the proposal made by the European Union mainly in two points: First, the additional quantities of high quality beef are three times higher. Instead of additional 100,000 tonnes as offered by the EU, the Mercosur countries requested 300,000 tonnes of additional quota for high quality beef. Second, the Mercosur countries requested the abolition of the in-quota tariff instead of a reduction as proposed by the EU. Allocation of the quota among the Mercosur countries would also be achieved according to the abovementioned intra industry agreement, leading to the additional quota presented in Table 3.

6.2 Impact assessment

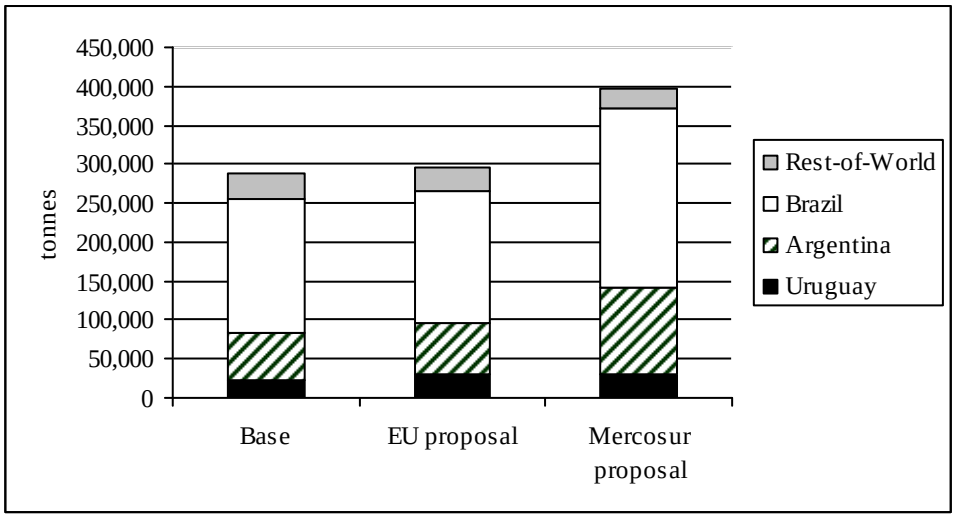
In this section, the adjustments of the economy to the changed political framework will be discussed. It starts off with an analysis of the most directly affected economic variable, the trade flows. This is followed by analysis of the welfare changes, giving a monetary indication of losses and benefits due to the trade liberalisation.

Impact on trade flows

The development of beef trade between the EU and the Mercosur countries under both scenarios is presented in Figure 15.

The first observation is that under the *EU-proposal*, the expansion of imports is very limited. Though the quota quantity is increased by 100,000 tonnes, total beef imports of the EU increase by less than 7,000 tonnes or 2 percent. This limited response of trade flows to the new conditions is explained by the quota-overfill in the base situation. As described in Chapter 2, expansion of an over filled quota does not automatically imply additional export opportunities, the quota may remain over-filled in the new policy environment. In how far this is the case for the individual countries and quotas will be discussed in more detail later in this chapter.

Figure 15 EU imports of beef



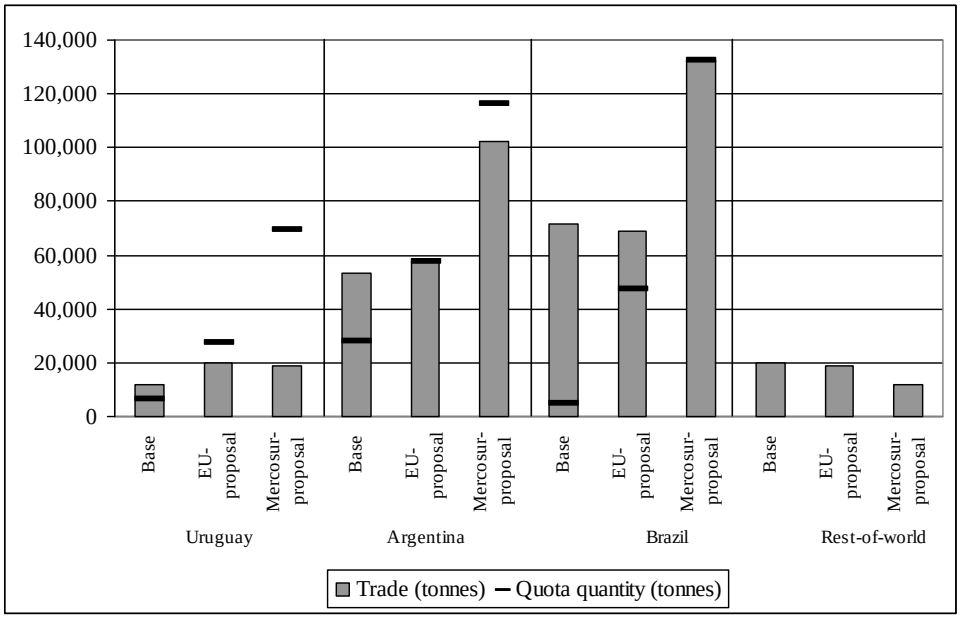
Source: Model results

A second observation is that under the *Mercosur-proposal* with a much stronger quota expansion in combination with the abolishment of the tariffs, the shipments of beef meat into the EU increase much stronger than under the provisions set out in the *EU-proposal*. Under the *Mercosur-proposal*, the EU purchases more than 100,000 additional tonnes of beef meat from the South American free trade area, which is equivalent to an increase of over 37 percent compared to the base situation.

Imports from other countries than Argentina, Brazil and Uruguay decrease only by around 3,000 tonnes, indicating limited substitution effects.

While giving an overview, the aggregated representation in Figure 15 hides away some interesting detail. A more disaggregated view on the development of imports of the EU from the Mercosur countries is presented in Figure 16, where the developments of trade are shown only for high quality beef.

Figure 16 EU imports of high quality beef



Source: Model results

The model results indicate that Uruguay, that in the base situation exports the smallest quantities of beef to the EU, increases its exports to the latter country group by more than 65 percent under the conditions set out in the *EU-proposal*. Already under these relatively modest provisions, this small country does not fill the allocated quota anymore. The same finding holds true for the more far reaching *Mercosur-proposal*, but what is more, exports of high quality beef from Uruguay to the EU decrease slightly compared to the simulation result under the *EU-proposal*, as meat originating in Uruguay is crowded out by meat originating in other Mercosur countries.

For Argentina the picture is different. With considerable quantities exported at full levy in the base situation, the trade expansion under the *EU-proposal* follows the quota expansion, and the quota becomes the binding element in the trade regime. As the quota was over-filled in the base situation, this materialises into only slightly more than 4,000 additional tonnes of high quality beef from Argentina on the European market. The expansion of exports is far less than the additional quota of 29,500 tonnes allocated to this country. Under the *Mercosur-proposal* however, exports stay behind the largely increased quota. Imports of the EU of Argentinean high quality beef increase by over 48,000 tonnes or over 90 percent compared to the base situation.

Brazil has, in the current situation and despite its considerable exports, the smallest allocated quota among the three Mercosur countries considered here. Consequently, the *EU-proposal* does not provide this South American state with any further trade opportunities, the quota remains over-filled and the over-quota tariff the binding instrument. On the contrary, Brazil even reduces its exports to the EU slightly under this scenario, a development that can be explained by competing exports from the other two Mercosur countries. If on the other hand, an agreement was based on the bid of the South American country group, shipments of high quality beef from Brazil to the EU would increase considerably to the new quota level of 132,500 tonnes, which implies a more than 85 percent increase compared to the base situation.

The above discussion shows that the *Mercosur-proposal* would *de facto* provide Uruguay and Argentina with a tariff and quota free access for high quality meat to the European market. Brazil on the other hand would be bound by the enlarged quota.

Welfare analysis

A natural question is the one for winners and losers of a possible understanding between the EU and the Mercosur countries. To answer this question, a welfare analysis for the different countries and actors involved is carried out[46].

An overview of the welfare changes is given in Table 4. It shows that both trade liberalisation scenarios would result in increased global welfare, though the absolute changes are small. Another salient feature of the welfare effect is that the EU would incur losses if an agreement was to be based on its own proposal, and for Uruguay, both liberalisation proposals would imply a negative welfare effect, though in absolute terms the effect is negligible. Interestingly, on national level, an agreement based on the *EU-proposal* would leave the Mercosur countries with a slightly superior economic situation than when an agreement was based on the *Mercosur-proposal*. This result deserves further attention and will be discussed later in this chapter.

[46] It should be kept in mind that this welfare analysis is based on a partial approach, taking into account only changes related to the meat and in particular the beef sector, both in terms of the scenario set up as well as in terms of economic adjustment to the new situation. In a framework covering the entire economy, a simulation of a free trade agreement covering other sectors like, for example, services is likely to lead to a different outcome.

Table 4 Welfare changes compared to the base situation

		EU-proposal	Mercosur proposal
		European Union	
Farmers	*percent*	0.0	-0.5
	absolute (Mio. EURO)	-4.6	-53.1
Meat processing	*percent*	0.0	-0.4
	absolute (Mio. EURO)	-3.3	-36.3
Quota rent	*percent*	0.0	0.0
	absolute (Mio. EURO)	0.0	0.0
Consumers	*percent*	0.1	1.0
	absolute (Mio. EURO)	96.8	989.0
Budget	*percent*	-47.0	-87.6
	absolute (Mio. EURO)	-280.6	-523.2
Total	*percent*	-0.2	0.3
	absolute (Mio. EURO)	-191.6	376.4
		Uruguay	
Farmers	*percent*	2.5	2.6
	absolute (Mio. EURO)	7.8	7.9
Meat processing	*percent*	0.1	0.1
	absolute (Mio. EURO)	1.5	1.4
Quota rent	*percent*	-100.0	-100.0
	absolute (Mio. EURO)	-16.5	-16.5
Consumers	*percent*	-3.1	-3.3
	absolute (Mio. EURO)	-16.9	-18.3
Budget	*percent*	0.0	0.0
	absolute (Mio. EURO)	0	0
Total	*percent*	-0.3	-0.4
	absolute (Mio. EURO)	-7.6	-9.0
		Argentina	
Farmers	*percent*	0.4	2.0
	absolute (Mio. EURO)	12.9	69.6
Quota rent	*percent*	137	-100
	absolute (Mio. EURO)	7.2	-5.2
Meat processing	*percent*	1.2	1.0
	absolute (Mio. EURO)	112.3	89.0
Quota rent	*percent*	137	-100
	absolute (Mio. EURO)	95.4	-69.4
Consumers	*percent*	-0.1	-1.5
	absolute (Mio. EURO)	-9.6	-112.7
Budget	*percent*	2.1	27.8
	absolute (Mio. EURO)	4.1	53.5
Total	*percent*	0.6	0.5
	absolute (Mio. EURO)	119.7	99.4
		Brazil	
Farmers	*percent*	-0.1	2.3
	absolute (Mio. EURO)	-1.4	54.4
Meat processing	*percent*	1.5	1.4
	absolute (Mio. EURO)	133.3	124.1
Quota rent	*percent*	1,013	9
	absolute (Mio. EURO)	136.8	1.2
Consumers	*percent*	0.0	-0.6
	absolute (Mio. EURO)	1.5	-99.7
Budget	*percent*	0.0	0.0
	absolute (Mio. EURO)	0	0
Total	*percent*	0.5	0.3
	absolute (Mio. EURO)	133.5	78.8
		World	
Total	*percent*	0.0	0.1
	absolute (Mio. EURO)	66.5	631.2

Source: Model results

Looking at a more disaggregated level, for the EU, three sub-items of national welfare contribute to the losses under its own proposal: The farm sector and the meat processing industry experience welfare losses due to the increased competition from South America. The state revenue is reduced because less tariff revenue is generated. This is an outcome of the reduced in-quota tariff for imports of high quality beef, the regime switches for Argentina und Uruguay and the expanded TRQ for Brazil. The loss of tariff revenue accounts for the bulk of the total losses. The positive income effect for consumers in the EU is not sufficient to outweigh these losses. Under the scenario based on the *Mercosur-proposal*, the direction of the changes for individual economic agents is not altered, but they are more pronounced. Particularly, the increases in consumer welfare over-compensate for losses in the other components, leading to an overall positive welfare effect for the EU.

In Uruguay, under both policy proposals, the agricultural sector and the meat processing industry benefit from increased export opportunities and consequently higher prices for animals and meat of high quality, that outweigh the loss of the quota rent incurred by the slaughter houses. At the same time, consumers are adversely affected by higher consumer prices under both scenarios. In the simulation based on the *Mercosur-proposal*, the latter effect is even more pronounced, not because Uruguay exports more high quality beef, but because of decreased imports of Uruguay as trade from Brazil is diverted away towards the European markets. This leaves Uruguay with a slightly smaller increase in national welfare than under the *EU-proposal*.

Like in Uruguay, Argentine cattle farmers and the meat processing sector benefit from the liberalisation proposals. For both, the increase in welfare under the *EU-proposal* is largely due to an increase in the quota rent that is captured by these agents. In the simulations based on the *Mercosur-proposal*, the quota rent vanishes away. For the meat processing sector, that captured a large share of the quota rent in the initial situation, this loss is not fully compensated by gains from additional trade, so that from the perspective a meat processor owning the rent, the *EU-proposal* is slightly more attractive. This is true for the national level, too, but is mainly due to a pronounced loss of consumer surplus under the policy scenario based on the Mercosur countries request, that is not offset by the increases in export taxes and producer surplus.

In Brazil, cattle farmers experience a small loss of welfare in the simulations based on the *EU-proposal* since exports decrease slightly due to increased competition from Argentina. The meat processing sector on the other hand increases its welfare compared to the base situation by 1.5 percent, because the increase of the quota rent compensates for the losses accruing from reduced export opportunities. Consumers benefit from lower prices, but to a very limited extent. Under the *Mercosur-proposal*, the picture is changed. Farmers benefit from higher prices

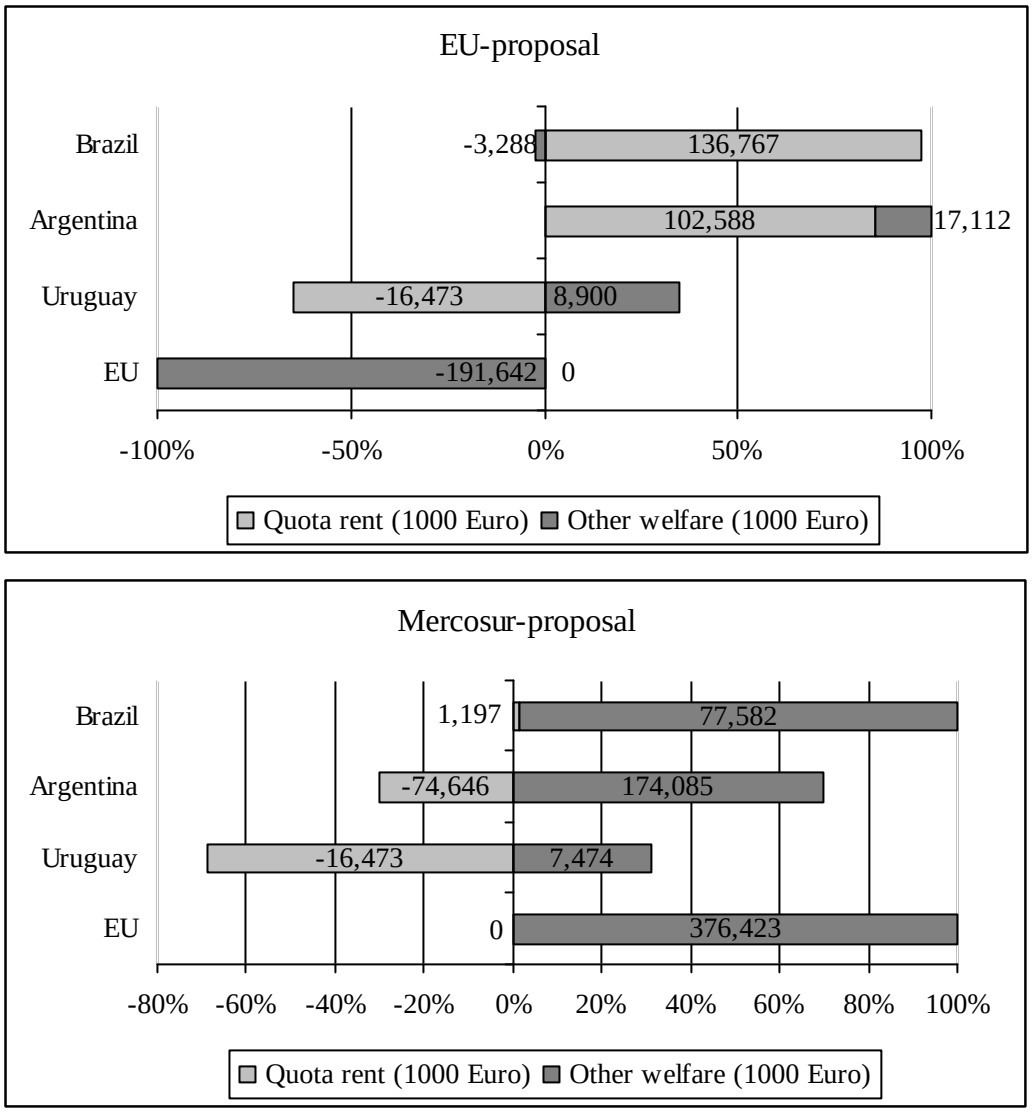
triggered by increased exports. So does the meat processing industry, but at the same time, the quota rent increases only modestly, and consumers´ expenditure for meat increases. Taking these latter two effects together, trade liberalisation under the *Mercosur-proposal* is still welfare enhancing compared to the base situation, but slightly inferior to the impact under the *EU-proposal*.

The role of the quota rents

Quota rents are a windfall profit generated from the specific trade policy instrument. As discussed earlier, their distribution can be decisive in the assessment of the welfare effects. In the case of the TRQs for high quality beef between the EU and the Mercosur countries, the quota rents remain fully in the exporting country, and there, with the exception of Argentina, entirely in the meat processing sector.

The changes of the quota rents and their share in total welfare effects are depicted in Figure 17. In the upper panel, the contribution of the changes in the quota rent as a share of the total welfare effects is depicted for the *EU-proposal*, in the lower panel, for the *Mercosur-proposal*.

Figure 17 Contribution of the quota rents to welfare changes



Source: Model results

Under the *EU-proposal*, substantive shares of the total welfare effects can be attributed to changes in the quota rents arising from the high quality beef TRQs. Especially in the case of Brazil, where the quota is still over-filled under the *EU-proposal*, the quota rent is the determining factor for the sign of the overall welfare change. This is an example of the economic mechanism discussed in Section 2.3, where expansion of an overfilled quota leads almost exclusively to the conversion of tariff revenue into quota rent. If this rent was captured by the im-

porting country, i.e. the EU, liberalisation according to the *EU-proposal* would result in welfare losses for Brazil.

In Argentina, despite accounting for roughly 85 percent of the economic gains, the quota rent is not critical for the overall welfare effect. Even if it was captured by the importing side, the policy change would be advantageous for Argentina. Another interesting detail here is that despite the fact that the quota is binding now, the change in the quota rent is still positive, a result of both the in-quota tariff reduction and the intersection of the supply and demand curves. In other words, the circumstances outlined in Section 2.3 under which the quota rent is reduced as a consequence of the quota expansion have not come into place, or are over-compensated by the increase of the quota rent triggered by the reduction of the first-tier tariff.

Uruguay is a particular case: As the quota rent vanishes away under the provisions of the *EU-proposal*, Uruguay would have greater interest in this agreement if the quota rent was initially captured by the importing country, and consequently the importer would be the party incurring the loss. The distribution of the rent is decisive for the direction of the total income change for Uruguay: While in the current setting, the welfare impact on national level is negative, it would be positive if the quota rent was initially captured (and consequently lost) by the importing party.

From the perspective of the EU, liberalisation according to the *EU-proposal* would be welfare enhancing if the quota rents were captured by European importers.

The role of the quota rents is less marked in the scenario based on the *Mercosur-proposal*. For Brazil, the role of the quota rent is limited, thus an alternative distribution on international level would not change the picture for Brazil much. Argentina looses the entire quota rent, but the quota rent is not key to the overall national welfare effect either. Only for Uruguay, the quota rent determines the sign of the overall economic impact.

6.3 Sensitivity analysis of parameters

As for any simulation, the model output depends on the input parameters. For this study, available estimated parameters have been altered to achieve consistency with the assumed microeconomic behaviour. In some cases, estimates were not available, and a pragmatic approach with “guesstimates” as described in SADOULET et al. (1995), p. 163 was taken: The elasticity values from which the squared deviation was minimised in the calibration process were set using common sense and economic intuition. Both implies uncertainty about the values of the parameters and the resulting elasticities.

In order to analyze the influence of the parameters on the model output and to test for the robustness of modelling results to changes in the parameter values, several methods have been proposed in the literature. An overview is provided in OECD (2001) p. 65. The authors distinguish five methods for dealing with parameter uncertainty in economic models:

1. Conditional systematic sensitivity analysis (CSSA) based on HARRISON et al. (1993). This method consists of variation of each parameter of the economic model individually, leaving the others unchanged.

2. Unconditional systematic sensitivity analysis (USSA), as also proposed by HARRISON et al. (1993), where each parameter is varied from its point estimate, but simultaneously all other parameters are varied, too (HARRISON et al. 1993).

3. A variation of the USSA was proposed by HARRISON AND VINOD (1992). The statistical procedure proposed consists of randomly selecting only a subset of all possible parameter constellations (HARRISON et al., 1992).

4. A procedure based on the Gaussian quadrature, that reproduces the moments of the endogenous variables in the model as proposed by PRECKEL et al. (1992).

5. Monte Carlo experiments are a fifth method mentioned. A Monte Carlo experiment consists of randomly sampling sets of parameters from an assumed distribution.

A key limitation of the CSSA is that it ignores the possibility of simultaneous variation of more than one parameter at a time. This is overcome by the USSA, which on the other hand is only computational feasible for models with a very limited number of parameters. The same criticism is brought forward against the fourth method based on the Gaussian quadrature. The third procedure is not as demanding in terms of computational power, but bears the risk of miss-representing the moments of the parameter distribution (OECD, 2001, p. 66). The authors finally recommend a Gaussian quadrature in cases where it is feasible, and a Monte Carlo experiment elsewhere.

Given the relatively large number of parameters in the model and the ease of implementation, a Monte Carlo method was applied in this study.

Procedure

The parameters that were randomly disturbed from their initial values are the elasticities, from which the deviation in the calibration process is minimised. In other words, the elasticities of supply and demand of beef and other meat as well as the income and price elasticities of group expenditure were systematically altered. They were sampled from a normal distribution, with the original, deterministic values as the mean. The standard deviation of the distribution was chosen making use of information concerning the accuracy of the estimated elasticities where possible. Unfortunately, confidence intervals or the standard error of the estimation were rarely available, in fact only for human consumption, and here only for Argentina and Uruguay. For Argentina, the standard error of the estimation of the price effects was available from CAP et al. (2007). The standard error was set into relation with the parameter estimate, and the resulting factor applied to determine the standard deviation of the distribution from which the elasticities were randomly sampled.

For Uruguay, it was not the standard error of the estimation that was available, but the upper and the lower bounds of the 90 percent confidence level of the elasticity estimate. The bounds were available from CAP et al. (2007) only for own price elasticities. These bounds were used as the standard deviation of the distribution from which the elasticities were sampled.

For all elasticities where either no estimate or no information on the accuracy of the estimate was available, the standard deviation was set rather arbitrarily to 0.5 times the elasticity estimate. Subsequently, the calibration process was repeated, with the difference that the elasticities from which the squared deviation was minimised were now the randomly generated ones.

To test for the robustness of the main policy conclusions, each policy scenario was repeated 210 times with alternative sets of parameters. Not for all sets of parameters a model solution could be achieved. The policy scenario based on the *EU-proposal* could be solved 192 times, the one based on the *Mercosur-proposal* 199 times.

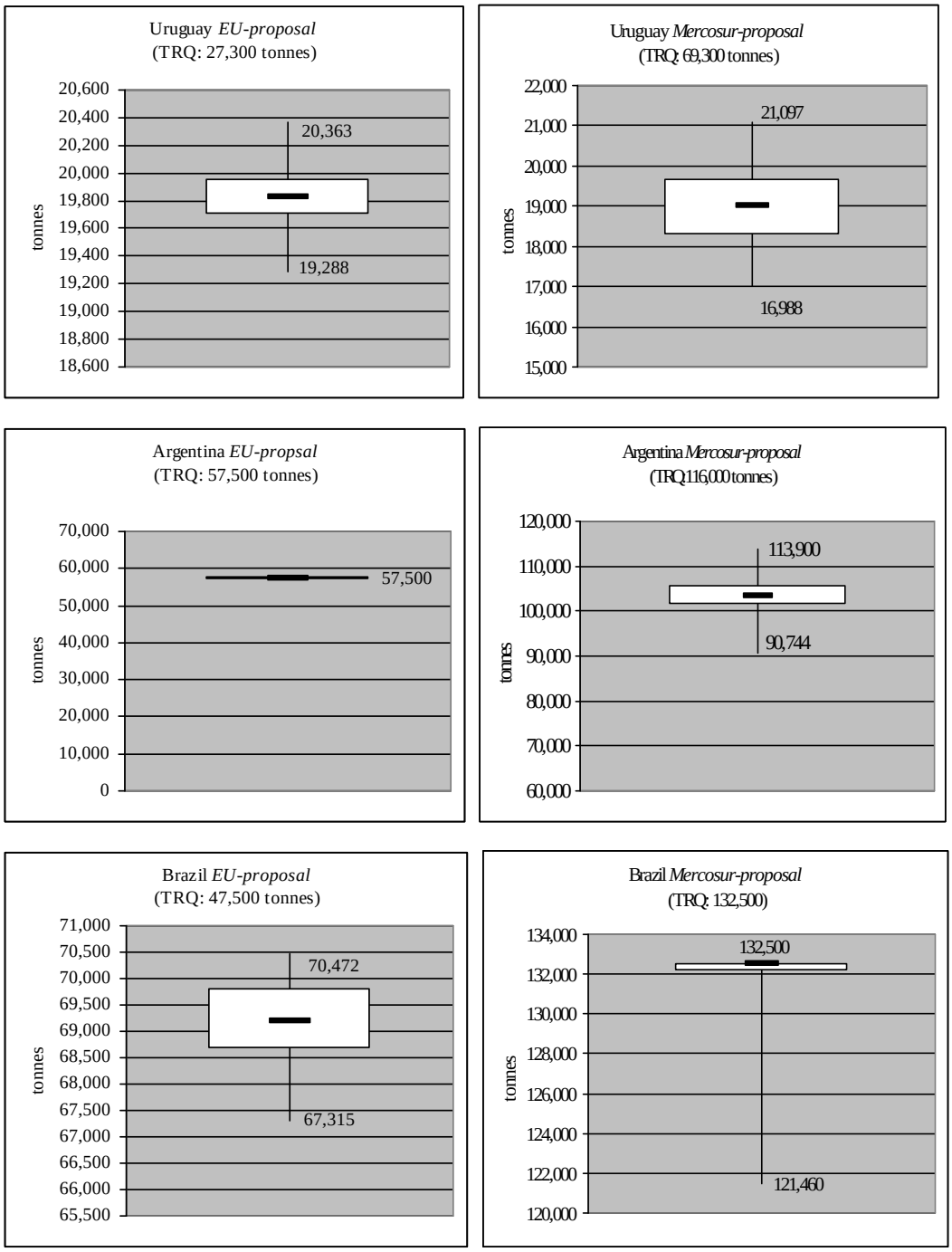
Sensitivity of trade impacts

The first variable to be looked at in the context of trade liberalisation scenarios is the sensitivity of the trade flows to changes in the model parameters. The results of the stochastic simulations have been summarised in the box-whiskers diagrams[47] in Figure 18.

[47] A box-whiskers diagram shows the two extreme values of the distribution (minimum and maximum), the median and the range in between which 50 percent of the observations are found.

In none of the simulations carried out, Uruguay fills the expanded quota. In other words, the finding that Uruguay does not fill the quota and looses the quota rent under both scenarios is robust to the variations of the parameters carried out here. The same holds true for Argentina under both scenarios: The quota is always binding under the provisions of the *EU-proposal*, and always under-filled in the scenario based on the *Mercosur-proposal*. Equally, in the case of Brazil, the quota is always found to be over-filled in all the simulations based on the proposal made by the European Union, irrespective of the parameters chosen. In the simulations involving the *Mercosur-proposal*, more variation was found in the results: The expanded TRQ is not filled in all stochastic iterations, but is under-filled in almost 30% of the simulations. At the same time, the expanded TRQ was not found to be over-filled in any of the simulations.

Figure 18 Sensitivity of trade flows



Source: Modelling results

Some additional descriptive statistics are presented in Table 5. In the case of the *EU-proposal,* the variation in trade flows is small both in absolute terms as well as measured in terms of the coefficient of variation.

For all countries except Brazil, the variability in trade flows is higher under the *Mercosur-scenario*. This is especially true for Argentina, where the TRQ is no longer binding.

Table 5 Statistics of the sensitivity of trade flows

	Mean (tonnes)	Standard deviation (tonnes)	Coefficient of variation
		EU-proposal	
Uruguay	19,817	203	0.01
Argentina	57,500	0	0.00
Brazil	69,191	688	0.01
Rest-of-World	18,598	635	0.03
		Mercosur-propsal	
Uruguay	19,009	907	0.05
Argentina	103,386	3,354	0.03
Brazil	131,722	1,787	0.01
Rest-of-World	12,099	1,763	0.15

Source: Calculations based on model results

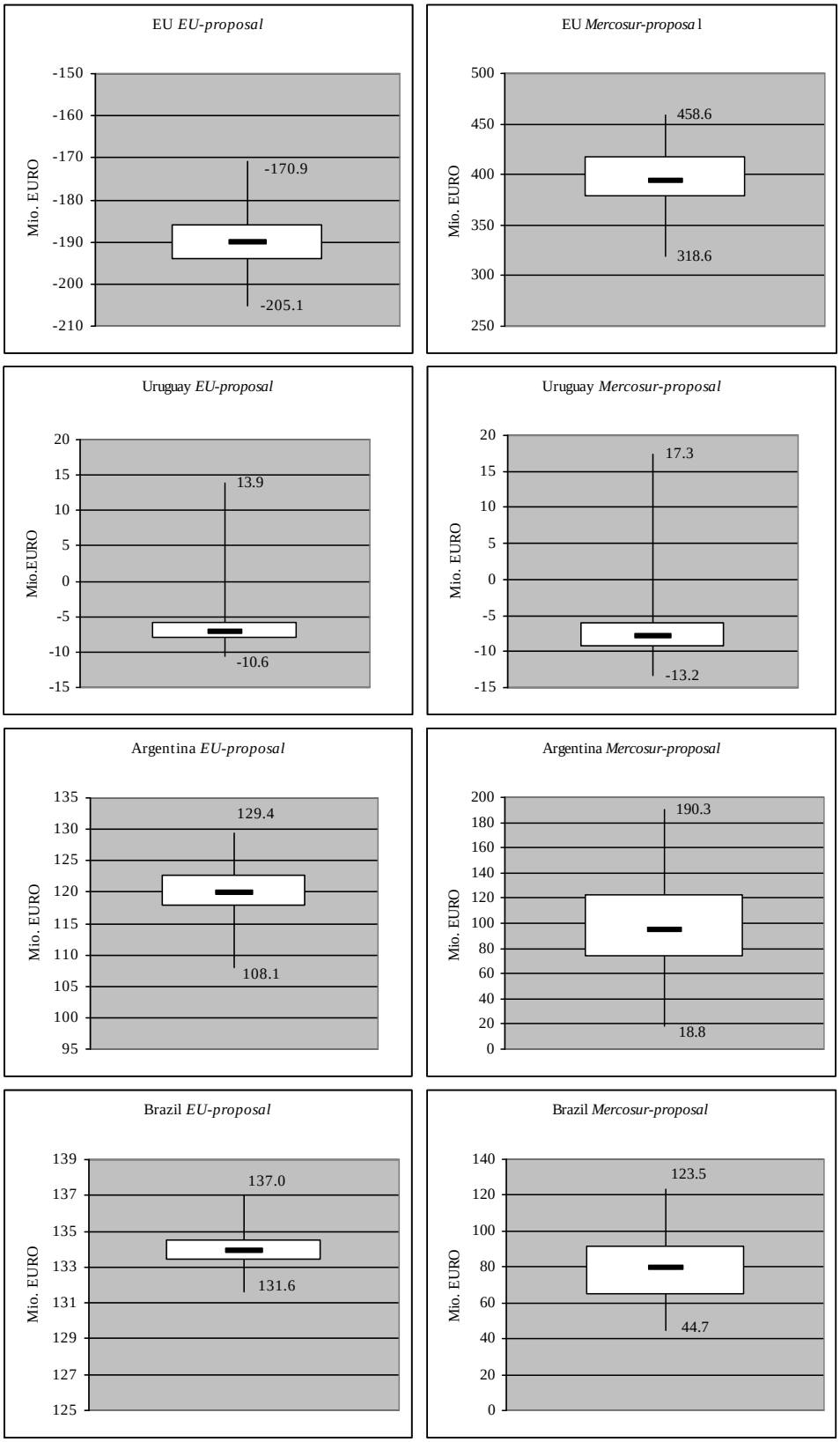
Sensitivity of welfare impacts

The impact of the variation of the elasticities on national and global welfare effects under both scenarios is shown in the box-whiskers diagrams in Figure 19.

Perhaps the most interesting case is Uruguay, where in some of the stochastic simulations, the national welfare effect changes the direction compared to the deterministic simulations. Under the *EU-proposal*, 5 percent of the parameter sets led to a positive national welfare effect for Uruguay. This is the case for 5 percent of the parameter sets under the *Mercosur-proposal*. Under both policy scenarios, this change in sign can be attributed to an increase in producer surplus on farm level that is much more pronounced than when the policy scenarios are run with other parameter constellations. In the iterations where the switch of sign takes place, the supply of high quality animals was found to be rather inelastic, leading to a more pronounced increase of prices on the farm level. However, it should be noted that these changes in national welfare, whatever the direction, are small in absolute terms and close to zero in relative terms.

For the other countries in this study, no change of sign occurs for the national welfare effect: Under the *EU-proposal*, the EU looses no matter on which set of parameters the simulation was based, whereas for Argentina and Brazil the policy change proves to be advantageous. For the Rest-of-World aggregate as well as the world the total welfare effect never switches sign neither, but remain positive under each of the stochastic simulations based on the EU´s offer (not shown).

Figure 19 Sensitivity of welfare changes



Source: Model results

Similarly, the key message for all countries except Uruguay remains unchanged when comparing the stochastic simulations of the *Mercosur-proposal* to the deterministic ones: No change in the direction of change was observed under any of the simulations.

A detail that is worth mentioning is found in the case of Argentina: Though the median of the economic gain is higher under the *EU-proposal* than under the *Mercosur-proposal*, the maximum increase in welfare is with around 190 million Euro higher than under the *EU-proposal* with roughly 130 million Euros. This implies that for some sets of parameters, the ranking between the different policy scenarios is changed, and the *Mercosur-proposal* is superior to the *EU-proposal* from the perspective of Argentina.

Some additional descriptive statistics are presented in Table 6.

Table 6 Sensitivity of welfare changes

	Mean (Mio EURO)	Standard deviation (Mio. EURO)	Coefficient of variation
EU-proposal			
EU			
Farmers	-5.6	2.9	-0.52
Meat processing	-2.9	1.4	-0.48
Quota rent	0.0	0.0	0.31
Consumers	99.0	6.5	0.07
Budget	-280.2	2.7	-0.01
Total	-189.7	6.6	-0.03
Uruguay			
Farmers	9.7	6.5	0.67
Meat processing	1.0	3.3	3.26
Quota rent	-16.5	0.0	0.00
Consumers	-17.0	0.6	-0.04
Budget	0.0	0.0	0.00
Total	-6.3	3.7	-0.59
Argentina			
Farmers	14.7	4.0	0.27
Quota rent	7.2	3.1	0.03
Meat processing	110.5	4.8	0.04
Quota rent	95.7	3.1	0.03
Consumers	-9.5	0.8	-0.08
Budget	4.1	0.2	0.04
Total	119.8	3.8	0.03
Brazil			
Farmers	-1.8	1.3	-0.74
Meat processing	134.0	1.5	0.01
Quota rent	136.8	0.0	0.00
Consumers	1.8	1.7	0.93
Budget	0.0	0.0	0.00
Total	134.0	0.9	0.01
World			
Total	71.2	6.1	0.09
Mercosur-proposal			
EU			
Farmers	-63.3	25.1	-0.40
Meat processing	-33.9	13.0	-0.38
Quota rent	0.0	0.0	0.52
Consumers	1,018.1	40.6	0.04
Budget	-524.3	8.5	-0.02
Total	396.6	26.5	0.07
Uruguay			
Farmers	10.0	6.9	0.69
Meat processing	1.4	4.2	2.92
Quota rent	-16.5	0.0	0.00
Consumers	-18.4	2.0	-0.11
Budget	0.0	0.0	0.00
Total	-7.0	4.2	-0.60
Argentina			
Farmers	96.5	53.0	0.55
Quota rent	-5.2	0.0	0.00
Meat processing	63.9	48.0	0.75
Quota rent	-69.4	0.0	0.0
Consumers	-114.9	8.6	-0.07
Budget	54.2	3.7	0.07
Total	99.8	35.6	0.36
Brazil			
Farmers	70.8	47.9	0.68
Meat processing	124.1	40.4	0.33
Quota rent	3.7	17.1	4.60
Consumers	-115.3	39.9	-0.35
Budget	0.0	0.0	0.00
Total	79.6	17.7	0.22
World			
Total	651.6	41.5	0.1

Source: Model results

Often, the coefficient of variation is higher for farmers than for the other economic agents in the model. This finding holds true for both scenarios. Under the

provisions set out in the *EU-proposal*, the variation of the welfare impact on national level is with the exception of Uruguay, between 1 and 9 percent. A particularly high coefficient of variation was found for the meat processing industry in Uruguay, where the mean value is small, and changes in the sign occur in cases where the loss of the quota rent is not offset by gains in producer surplus.

Under the stochastic simulations based on the *Mercosur-proposal*, the coefficient of variation on national level, again excluding Uruguay, is higher than under the *EU-proposal*, ranging between 1 and 36 percent approximately. Again, the coefficient of variation of the meat processing sector in Uruguay stands out for the same reasons as above. Another variable that exhibits a large coefficient of variation in this policy setting is the quota rent for Brazil, where, as explained above, the quota is not always filled, thus the quota rent takes a zero value in some iterations.

6.4 Discussion of results and comparison with other studies

Discussion

The analysis of the sensitivity of the model results to changes in parameter values has shown that the simulation results and thus the conclusions drawn from them are fairly robust for most countries. With the exception of Uruguay, the direction of change in national welfare is not sensitive to changes in the parameters as carried out here, and only for Argentina the ranking between the two policy options changes in a limited number of cases. Moreover, the quota regime that is in place in the alternative policy settings is sensitive to the parameter values only in Brazil, and only in light of the *Mercosur-proposal*. However, beyond parameter uncertainties, the model results certainly rely on a number of other assumptions and conditions.

One is the representation of a limited number of goods, which may or may not be critical to the validity of the results. By restricting the model to the meat markets, it is implicitly assumed that the prices of all other products and services as well as the GDP remain unchanged. Assuming a fixed GDP is a typical assumption in the context of partial equilibrium modelling, and is valid when the shocks to which the economy is exposed are small. As the latter is the case in this analysis, assuming fixed income seems defendable.

The assumption of fixed prices for capital and other agricultural goods is another debatable presumption. For capital goods, no direct effect e.g. through increased imports from the Mercosur countries can be expected. An indirect impact, e.g. on land prices, can be expected to be negligible in light of the proposals made. Nevertheless, it is unlikely that prices for other agricultural products may remain completely unaffected if trade between the two country blocks was to be

liberalised. At the same time, these effects were estimated to be limited: Prices for wheat were estimated to remain almost unchanged in simulations employing more comprehensive modelling systems. Changes in corn prices are only noteworthy under the *Mercosur-proposal,* and even under this proposal are limited to around 5 percent (WEISSLEDER et al., 2008). Grains play only a limited role as a feed input in European beef production, hence the influence of small changes in grain prices on the profitability of beef production will be limited. In addition, no clear picture with regards to the fill rate of the existing TRQ for corn could be observed in the past. In most of the years, the EU imported less than the TRQ quantity, and no obvious reason why this should change in the medium term could be identified. This means that whether or not the proposed creation of a TRQ for corn for the Mercosur countries leads to increased imports and hence to decreasing prices depends heavily on changing market conditions and the extent of the in-quota tariff reduction[48]. Finally, the negotiations between the EU and the Latin American country group go beyond trade of agricultural and non-agricultural goods, and an inclusion of liberalisation of trade in services may not significantly impact meat or other agricultural markets, but certainly play a role in the national and global welfare assessment.

The model established here captures cross effects in consumption from other meat products only to a limited extent, as these are represented merely in an aggregated fashion. According to the study carried out by WEISSLEDER et al. (2008), that considers pork and poultry in a more explicit way, prices hardly change in consequence of the policy change, backing the validity of the partial approach taken in this study up.

Generally, it seems counterintuitive that the Mercosur countries request a policy change that leaves them worse off than under the proposal made by the European commission, and that the EU rather concedes market access that triggers a loss in welfare than a gain. These results are in most cases robust to changes in the model parameters. Besides the abovementioned limitations and caveats attached to this study, lobbying power of certain economic groupings, lack of information or different assumptions on market developments could provide an explanation. Finally, with regards to the ranking for the two proposals from the perspective of the Mercosur countries, it should be reiterated that the absolute differences are small, and a reversal of the ranking under different assumptions does not seem completely outside the range of possibilities, though this study confirms this possibility only for Argentina.

[48] How much the in-quota tariff for maize would be decreased is not easy to determine. In reality, the in-quota tariff is adapted according to the prevailing market conditions, complicating the assessment of initial in-quota tariff and consequently the degree of its reduction.

Comparison with other studies

A number of studies deal with the potential effect of trade liberalisation between the EU and the Mercosur countries. Comparison across these studies is difficult, as different model scope, design, suppositions, parameter values and data issues necessarily lead to different model results. Nevertheless, a brief discussion of similarities and differences shall be given here.

DROGUÉ et al. (2005) apply the well know GTAP modelling system to the question of the free trade negotiations between the Mercosur and the EU. This study estimates a surge of beef purchases of the EU from the South American country group of almost 100 percent under the *EU-proposal*. The TRQ for the product group "cattle meat" remains over-filled (DROGUÉ et al., 2005). Welfare changes can not be compared, since they are not reported by commodity, but only as an aggregate across commodities. The conclusions on the development of trade flows of bovine meat are strikingly different from the findings of this study. One reason that is likely to contribute to this are differences in the scenario specification: DROGUÉ et al. (2005) assume an expansion of the bilateral TRQ for high quality beef of 160,000 tonnes under the EU-proposal instead of 100,000 tonnes in this study. Furthermore, the level of aggregation both on regional as well as commodity level adds to the approximate character of the analysis. However, the fact that the quota remains over-filled in the simulation and at the same time exports increase contradicts economic theory. Though interpreting the quota fill rate of 126% as imports at quota level, the paper falls short of a satisfying explanation for this result.

A second comprehensive ex-ante assessment of EU-Mercosur trade liberalisation was carried out by WEISSLEDER et al. (2008), applying the CAPRI modelling system. CAPRI is a partial equilibrium model that operates at a relatively low level of product aggregation. The Mercosur countries are represented as individual countries, and beef is not mingled with other meat products. At the same time, the model considers only one single quality of beef. For a further description of the modelling system see (BRITZ, 2005). The policy scenario set up is identical to the one in this study, but the distribution of the additional TRQs differs. Another difference lies in the time horizon of the two studies: While here, no future developments on agricultural markets are incorporated, CAPRI solves for the year 2013.

There are significant differences in the findings with regard to the development of bilateral trade flows. Whereas WEISSLEDER et al. (2008) find an expansion of beef imports of over 92,000 tonnes or 50 percent under the *EU-proposal*, this study indicates an increase of around 7,000 tonnes or 2 percent compared to the base situation.

The differences can partly be attributed to different allocation of the additional bilateral TRQs: Lacking further information, WEISSLEDER et al. (2008) assume a repartition based on past performance, which leads to higher allocation of additional TRQ to Brazil than when these are distributed as agreed in the intra-industry agreement. This provides Brazil with additional export opportunities, whereas this was not the case in this study.

But also the base year, that in the study carried out by WEISSLEDER et al. (2008) is 2002, contributes to this likely over-estimation of the consequences of trade liberalisation: Brazil has been increasing its shipments to the European Union rapidly since then, and Argentina was still impacted by the consequences from the FMD epidemic that hit the country in 2000, 2001, 2002 and was not eradicated until 2003 (OIE, n.d.). This implies that the degree of over-fill in the base situation is underestimated in the simulations with CAPRI, and consequently, the impact of the quota expansion is likely to be overestimated.

The same general picture holds true for the simulations based on the *Mercosur-proposal*. According to the CAPRI results, beef imports increase by over 270,000 tonnes, or 137 percent. This stands in sharp contrast to the results obtained here, were beef imports increase only by around 100,000 tonnes or 37 percent compared to the base situation. The same reasoning as above holds true.

Little can be stated with regards to the welfare impact, as WEISSLEDER et al. (2008) present welfare aggregated across all markets. For the EU, the welfare changes found here under the *EU-proposal* are generally smaller in absolute terms, with the exception of the changes in tariff revenue, that were found to be in a similar range. Under *Mercosur-proposal* however, WEISSLEDER et al. (2008) find a negative overall welfare impact for the EU. This is probably attributable to the much more increased meat imports, and also to increased corn imports, which drive prices down and cause losses to the cereals producing sector in the EU that are not outweighed by benefits from lower feed prices in other parts of the agricultural economy.

Comparing the welfare effects of the two studies for the other countries, all that can be said is that the ones found here are of opposite sign for Uruguay, higher for Argentina under the *EU-proposal* and in a similar range under the *Mercosur-proposal*. For Brazil, the welfare impact estimated in this study is well below the one estimated by WEISSLEDER et al. (2008).

A third study assesses EU trade liberalisation and Mercosur exports. The authors state clearly that *"[…] our simulations should not be interpreted as a realistic outcome of the negotiation as far as the substitution between domestic and imported beef is concerned*" (RAMOS et al., 2007). Moreover, the Mercosur countries are not represented individually but as an aggregate. Taking this together, further analysis of similarities or discrepancies seems undue.

Three other studies could be identified, but none of them seems suitable for a detailed comparison for different reasons. The study carried out by BERRETTONI et al. (2002) departs from completely different assumptions with regards to the policy changes, and consequently renders different results.

The paper prepared by NIEMI et al. (2005) approaches the question of trade liberalisation between the EU and the Mercosur countries from a different angle, but underlines that trade liberalisation would lead to increased trade mainly for beef and sugar, leaving other commodities rather unaffected.

Finally, BCHIR et al. (2001) compare different options for establishing free trade areas for the Mercosur countries, including a free trade agreement with the EU. Though the scenario set up is little detailed, it states that among the agricultural commodities modelled, beef will be the most affected one in case of lowering barriers to trade between the two country groups.

6.5 Conclusions of the chapter

Simulations based on the negotiation proposals made by the EU and the Mercosur countries were carried out with the model described in the preceding chapter. For beef, the two scenarios differ in the extent of the proposed quota expansion and reduction of the in-quota tariff: The EU´s offer was of additional 100,000 tonnes of high quality beef, the Mercosur countries requested three times this quantity. The EU proposed a reduction of the in-quota tariff by 50 percent, whereas the Mercosur countries aimed at its abolishment.

The simulations indicate that if an agreement was to be based on the EU´s offer, limited impact on beef trade can be expected. This is explained by the largely overfilled high quality beef TRQs of Argentina and Brazil, and the limited ability of Uruguay to respond with additional exports.

Nonetheless, Argentina and Brazil would experience welfare gains under this scenario. Uruguay on the other hand would loose, though the change is very small. For the EU, the welfare impact would be negative as gains in consumer surplus to not compensate for losses of tariff revenue.

The quota rents play a prominent role in the changes of total welfare for the Mercosur countries. Almost all the welfare impact observed for Brazil can be attributed to changes in the quota rent, and for Argentina they account for around 85 percent of the total welfare gain.

For Brazil, an alternative distribution of the rent on international level would in fact make beef trade liberalisation based on the *EU-proposal* an economically unattractive option, where as for Uruguay the opposite case is true.

The picture is changed under the simulations based on the *Mercosur-proposal*. It would lead to *de facto* free trade of high quality beef for Argentina and Uru-

guay, because the bilateral TRQs would not be filled anymore, and the in-quota tariff is reduced to zero.

Argentina, Brazil as well as the EU would experience welfare gains, as for the latter, gains in consumer surplus outweigh the losses of tariff revenue.

The quota rents of Argentina and Uruguay vanish, but the loss is for the first two countries by far over-compensated through the economic gains from the largely improved market access.

On a national level, of the two policy options the *EU-proposal* is preferable to the Mercosur countries, whereas for the EU, trade liberalisation based on the *Mercosur-proposal* would lead to greater welfare.

Some of these general findings are sensitive to the value of the parameters used. Among these are the total welfare effects for Uruguay, the ranking of the two policy options for Argentina and the binding element of the TRQ for Brazil under the *Mercosur-proposal*.

Direct comparison of the results with other studies is difficult because of differences in the country and product aggregation, the policy scenarios simulated or the underlying database.

7 Summary, limitations of the work and conclusions

7.1 Summary

This work analyses the economic impact that different options for reducing barriers to beef trade between the EU and the Mercosur countries may have.

The paper starts with a discussion of the economic theory underlying TRQs and their administration. A TRQ is constituted of three elements, and whether or not liberalisation of these or combinations of these elements are relevant for trade and/or welfare depends on the regime that is in place prior to the policy change as well as on the extent of liberalisation of the elements. Liberalisation of an element that was redundant in the initial setting and remains being so after the policy change will bring no change to trade flows, and may even leave welfare of the involved parties unchanged. Whether the latter is true depends on the existence and the distribution of the quota rents. It was shown that in some cases, the welfare effects can not be determined unambiguously without information on the repartition of the quota rents. This repartition depends crucially on two factors: One is the administration of the quota, and the other one is the prevailing market structure.

An overview of the trade patterns and the current trade policies between the two country groups is given. For beef, the Mercosur countries enjoy preferential market access through three different TRQ regimes: Bilateral TRQs for high quality beef, the so-called "*GATT frozen beef quota*", and the quota for frozen beef for processing. The fill rates of the beef TRQs could not be unequivocally assessed, but it was shown that with the exception of the high quality beef TRQ for Paraguay, all existing preferential schemes for beef are fully utilised. The proposals of both the EU and the Mercosur countries put forward in 2005 foresee expansion of the existing TRQs for high quality beef.

For the high quality beef TRQs allocated to Argentina, Brazil and Uruguay, the rent is fully captured by the exporting country, and there mostly by the meat processing sector. It was found that two key factors drive the distribution of the rent. One is the design of the administrational process related to the TRQ. Because the import certificate has to be matched with an export licence, the exporting party is aware of the tariff to be paid at the border. Moreover, a security has to be lodged by the importer, that has a limited validity and is lost if no transaction takes place. In addition, the market structure influences the distribution of rents between the parties involved such that the rent is entirely captured by the exporting side.

A detailed description of the model set up for the purpose of this study was given. The model belongs to the class of SPE models, and covers five regions, six meat products and four economic actors. Bilateral trade is captured by characterising each type of meat by its country of origin. The model features a supply system derived from a normalised quadratic profit function, and a demand system based on the generalised Leontief expenditure system. TRQs are accurately reflected through an MCP approach. The model is calibrated to a 2004-2006 average.

In the following chapter, the results of different policy scenarios were discussed. The model results indicate that the liberalisation steps that the EU proposed leads only to a very limited expansion of shipments of high quality beef from the Mercosur countries to the EU, which is mainly explained by the quota overfill in the base situation. Nevertheless, welfare is impacted due to changes in the arising quota rent. Interestingly, the EU would be worse off under its own proposal. The same holds true for Uruguay, whereas the EU´s proposal proves to be advantageous for the other countries in the South American country group. Under the *EU-proposal*, substantive shares of the total welfare effects can be attributed to changes in the quota rents arising from the high quality beef TRQs, and their distribution is decisive for the overall welfare effect in more than one country.

If the Mercosur countries were to achieve acceptance of their request in terms of access to the European beef markets, exports to the EU would be expanded by roughly 37 percent, leading to welfare gains for all countries except Uruguay. The relative importance of the quota rent is reduced under this hypothetical policy setting, but for Uruguay the change in the quota rent is still the determining factor for the direction of change of its welfare.

Interestingly, trade liberalisation based on the *Mercosur-proposal* is neither on national level nor for all economic agents in the Mercosur countries superior to the outcome of the liberalisation scenario based on the *EU-proposal*. Again, the quota rents are key among the factors that lead to this result.

Though the changes to the analysed indicators vary with changes in the parameter values, most of the general findings are fairly robust to changes in the parameter values chosen. Exceptions to this are the total welfare effects for Uruguay, the ranking of the two policy options for Argentina and the binding element of the TRQ for Brazil under the *Mercosur-proposal*.

The results from the simulations are mostly in line with the ones from similar studies, at least in qualitative terms. Differences can be explained e.g. from different policy scenario specifications, product coverage, base year data and assumptions on future developments of the agricultural markets. It is judged that the results of this study are not challenged by these differing findings.

7.2 Limitations and further research areas

Though considerable effort has been made to capture the complexity of the research question as precisely as possible, this could not always be achieved to a fully satisfying extent.

First and foremost, as any empirical work, this study is subject to limitations in the availability of accurate data. The TRQs for high quality beef are defined at a more detailed level than the available trade data, and overlap with other preferential trading schemes are a challenge that could not be fully overcome in this study. The same holds true for the share of high quality beef that enters the EU as a frozen product, a possibility that has not been accounted for in this study. Though the assumptions made were discussed with experts from the meat industry, they remain assumptions that are unlikely to fully replicate reality. As better data is unlikely to become available in the near future, calibrating the model to different data sets with alternative assumptions on the data aggregation and repeating the policy scenarios would help to judge on the sensitivity of the results to data issues.

Another limitation relates to the values of the parameters. Empirically estimated elasticities were not always available, and were certainly not estimated for the same level of product aggregation. In addition, the existing values were altered to achieve consistency with the assumed economic behaviour. In some cases, this process led to values that deviate notably from their original ones, because a compromise between given values, consistency with the assumed microeconomic behaviour and achieving a technical solution had to be made. Nonwithstanding the sensitivity analysis that revealed the limited importance of the parameters to the overall findings of this study, an econometric estimation of the full set of elasticities including the constraints imposed by economic theory would provide value added.

In the model, two-step budgeting was assumed. The underlying assumptions on consumers´ preferences may or may not appropriately reflect reality.

One could also challenge the model results on the grounds of the time horizon of the applied model. It is benchmarked to a 2004-2006 average, and does not include any projection into the future. This presents a constraint as beef production in the EU is projected to decline in the coming years, and further reforms of the CAP foreseen for 2013 can be expected to enhance this development. The simulated policy changes are unlikely to be implemented in the near future. This may lead to a systematic over-estimation of the impact of the policy change on trade flows and welfare. On the other hand, technical progress over time could further improve productivity in the Mercosur countries, enabling them to export larger quantities to the European market than foreseen in this study. Incorporating

(different) forecasts into the analysis would be a way to narrow down the uncertainties attached to the time horizon of the model.

Another point of criticism can be seen in the coverage of different policy scenarios. The negotiations did not only cover bilateral trade liberalisation, but also multilateral reductions of trade barriers in the context of an agreement in the WTO. The latter has sometimes been advocated as the policy option with more prospects of becoming reality, but is not analysed here. Another scenario could be run to see the impact of combined multilateral and bilateral reduction of trade barriers, but it was judged that the current model setup in terms of country and commodity space is not adequate for answering questions of multilateral trade liberalisation.

This leads to another shortcoming of the employed model. The product coverage limits the validity of the quantitative analysis. Services and trade of other (agricultural) goods have been completely ignored in this study. One of the distinctive features of the agricultural sector are the close and complex relations of different sub-sectors. On the production side, corn as a feed input has been mentioned earlier in this study. On the demand side, pork and poultry as substitutes for beef are likely to play a role. The latter have been captured to some degree in this analysis, and the magnitude of the former is probably not very relevant for the research question here. Other studies have underlined the limited impact of the proposed liberalisation steps to these other commodities. Nevertheless, an assessment of the impact on beef in a more comprehensive framework would be preferable. But it is questionable in how far it is feasible to capture all the necessary detail of the meat sector while at the same time covering the whole range of other commodities and services from which economic spill-over effects or welfare changes can be expected.

7.3 Conclusions

The overall objective of this study was to assess the economic impact of beef trade liberalisation scenarios between the EU and the Mercosur countries. On this subject, the main findings can be summarised as follows:

- The rents arising from the high quality beef TRQs allocated to the Mercosur countries are fully captured by the exporting country.

- The rents from the multilateral frozen beef TRQs are fully captured by importers in the EU.

- The impact on trade is limited under the provisions set out in the proposal the EU made. However, welfare is affected as redistribution of tariff revenues to quota rents takes place.

- The impact on trade is more pronounced under the proposal made by the Mercosur countries and would lead to *de facto* free trade for Argentina and Uruguay.

- The quota rents are reduced in the scenarios based *on the Mercosur-proposal*, making this policy option less attractive than the *EU-proposal* for some economic agents.

- With some exceptions, the results are robust againts changes in the parameter values.

The analysis has confirmed the hypothesis that the quota rents and their distribution can be decisive for the assessment of the overall economic gains or losses to be realised when barriers to trade are reduced. Any evaluation that falls short of taking this sub-item of total welfare into account runs the risk of seriously misinterpreting the economic consequences of the change in trade policies.

If the preference giving country pursues certain political or development goals by establishing TRQs, it should carefully check the prevailing market structure and tailor the quota administration process accordingly.

The modelling results differ from the ones found in studies applying models working at a higher level of product aggregation. This underlines the value that a model operating at a product definition as close as possible to the one found in real economy can add.

From a methodological point of view, setting up a bilateral trade model by differentiating products explicitly by country of origin (instead of recurring to the Armington approach) is feasible and produces satisfactory results. At the same time, the resulting number of model equations, variables and parameters is large. The calibration of the resulting system is challenging and not always satisfactory, and the possibility of expanding the commodity coverage to other sectors is likely to reach its limits fairly quickly. The approach seems to be suitable for research questions where a low level of product aggregation is desired, but at the same time economic spill-over effects from other sectors are limited either because of the nature of the product under study, or the political change envisaged.

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ANNEX I DATA AND PARAMETERS

Table A 1 Mapping of trade data to meat qualities

Product	Source	Combined Nomenclature (CN 8)		Harmonised System (HS)	
fresh beef, high quality	Argentina	02013000	02061095	020130	020610
	Brazil	02013000	02061096	020130	020610
	Uruguay	02013000	02061098	020130	020610
	Rest-of-World	02013000	02061099	020130	020610
frozen beef		02021000		020210	
		02022010		020220	
		02022030			
		02022050			
		02022090			
		02023010		020230	
		02023050			
		02023090			
		02062991		020629	
fresh beef, other quality		02012020		020120	
		02012030			
		02012050			
		02012090			
		02061091		020610	
		02061099			
		02062100		020621	
		02062200		020622	
		02062910		020629	

Table A 2 Base data EU

Country	Item	Product	Actor		Raw data	Balanced data	Absolute difference	Percentage difference
EU	production (t)	alive cattle, high quality (a)	farmers		5,932,001	5,954,398	22,397	0.4
		alive cattle, other quality (a´)	farmers		1,996,163	1,990,015	1,990,015	-0.3
		fresh beef, high quality (b)	slaughterhouse		530,915	532,920	2,005	0.4
		fresh beef, other quality (b)	slaughterhouse		7,397,249	7,411,493	14,245	0.2
		frozen beef c)	deep freezing unit		929,161	932,463	3,302	0.4
	processing demand (t)	alive cattle, high quality (d)	slaughterhouse		5,932,001	5,954,398	22,397	0.4
		alive cattle, other quality (d)	slaughterhouse		1,996,163	1,990,015	-6,148	-0.3
		fresh beef, other quality (e)	deep freezing unit		929,161	932,463	3,302	0.4
	consumption (t)	fresh beef, high quality (from Argentina) (f)	consumers		54,052	53,391	-661	-1.2
		fresh beef, other quality (from Argentina) (f)	consumers		157	0	-157	-100.0
		frozen beef (from Argentina) (f)	consumers		8,420	8,420	0	0.0
		fresh beef, high quality (from Brazil) (f)	consumers		73,625	71,391	-2,234	-3.0
		fresh beef, other quality (from Brazil) (f)	consumers		58	0	-58	-100.0
		frozen beef (from Brazil) (f)	consumers		100,178	100,177	-1	0.0
		fresh beef, high quality (from Uruguay) (f)	consumers		11,610	11,862	252	2.2
		fresh beef, other quality (from Uruguay) (f)	consumers		2,591	2,584	-7	-0.3
		frozen beef (from Uruguay) (f)	consumers		8,358	8,355	-3	0.0
		fresh beef, high quality (from Rest-of-World) (f)	consumers		20,051	20,051	0	0.0
		fresh beef, other quality (from Rest-of-World) (f)	consumers		4,988	4,988	0	0.0
		frozen beef (from Rest-of-Worldl) (f)	consumers		7,867	7,870	3	0.0
		fresh beef, high quality (from EU) (g)	consumers		514,413	500,423	-13,990	-2.7
		fresh beef, other quality (from EU) (g)	consumers		7,507,044	6,410,040	-1,097,005	-14.6
		frozen beef (from EU) (g)	consumers		855,361	835,493	-19,868	-2.3
		Country of origin	Product	Trade regime				
	imports (t)	Uruguay (h)	fresh beef, high quality	in-quota	6,300	6,300	0	0.0
		Uruguay (h)	fresh beef, high quality	over-quota	5,310	5,562	252	4.7
		Uruguay (h)	fresh beef, other quality		2,591	2,584	-7	-0.3
		Uruguay (h)	frozen beef	in-quota	6,965	6,965	0	0.0
		Uruguay (h)	frozen beef	over-quota	1,393	1,390	-3	-0.2
		Argentina (h)	fresh beef, high quality	in-quota	28,000	28,000	0	0.0
		Argentina (h)	fresh beef, high quality	over-quota	26,052	25,391	-661	-2.5
		Argentina (h)	fresh beef, other quality		157	0	-157	-100.0
		Argentina (h)	frozen beef	in-quota	7,017	7,017	0	0.0
		Argentina (h)	frozen beef	over-quota	1,403	1,403	0	0.0
		Brazil (h)	fresh beef, high quality	in-quota	5,000	5,000	0	0.0
		Brazil (h)	fresh beef, high quality	over-quota	68,625	66,391	-2,234	-3.3
		Brazil (h)	fresh beef, other quality		58	0	-58	-100.0
		Brazil (h)	frozen beef	in-quota	83,486	83,486	0	0.0
		Brazil (h)	frozen beef	over-quota	16,692	16,690	-1	0.0
		Rest-of-World (h)	fresh beef, high quality	in-quota	Eps	0	Eps	0.0
		Rest-of-World (h)	fresh beef, high quality	over-quota	20,051	20,051	0	0.0
		Rest-of-World (h)	fresh beef, other quality		4,988	4,988	0	0.0
		Rest-of-World (h)	frozen beef	in-quota	6,556	6,556	0	0.0
		Rest-of-World (h)	frozen beef	over-quota	1,311	1,314	3	0.2

Legend: See after Table A 6

Table A 3 Base data Uruguay

Country	Item	Product	Actor	Raw data	Balanced data	Absolute difference	Percentage difference
Uruguay	production (t)	alive cattle, high quality (i)	farmers	583,716	447,928	-135,788	-23.3
		alive cattle, other quality (i´)	farmers	15,472	15,423	-49	-0.3
		fresh beef, high quality (j)	slaughterhouse	63,392	48,646	-14,747	-23.3
		fresh beef, other quality (j)	slaughterhouse	535,796	414,706	-121,090	-22.6
		frozen beef (k)	deep freezing unit	244,997	229,093	-15,904	-6.5
	processing demand (t)	alive cattle, high quality (d)	slaughterhouse	583,716	447,928	-135,788	-23.3
		alive cattle, other quality (d)	slaughterhouse	15,472	15,423	-49	-0.3
		fresh beef, other quality e)	deep freezing unit	244,997	229,093	-15,904	-6.5
	consumption (t)	fresh beef, high quality (from Argentina) (l)	consumers	497	0	-497	-100.0
		frozen beef (from Argentina) (l)	consumers	21	0	-21	-100.0
		fresh beef, high quality (from Brazil) (l)	consumers	2,566	2,561	-5	-0.2
		frozen beef (from Brazil) (l)	consumers	250	0	-250	-100.0
		fresh beef, high quality (from Uruguay) (v)	consumers	27,443	33,844	6,401	23.3
		fresh beef, other quality (from Uruguay) (v)	consumers	224,065	168,610	-55,455	-24.7
		frozen beef (from EU) (f)	consumers	0	0	0	0.0
	imports (t)	Country of origin	Product				
		EU (h)	frozen beef	0	0	0	0.0
		Argentina (m)	fresh beef, high quality	497	0	-497	0.0
		Argentina (m)	frozen beef	21	0	-21	-100.0
		Brazil (m)	fresh beef, high quality	2,566	2,561	-5	-0.2
		Brazil (m)	frozen beef	250	0	-250	-100.0

Legend: See after Table A 6

Table A 4 Base data Argentina

Country	Item	Product	Actor		Raw data	Balanced data	Absolute difference	Percentage difference
Argentina	production (t)	alive cattle, high quality (n)	farmers		2,261,038	2,440,700	179,662	7.9
		alive cattle, other quality (n´)	farmers		801,962	793,636	-8,325	-1.0
		fresh beef, high quality (o)	slaughterhouse		258,109	278,619	20,509	7.9
		fresh beef, other quality (o)	slaughterhouse		2,804,891	2,955,718	150,827	5.4
		frozen beef (k)	deep freezing unit		316,786	315,571	-1,216	-0.4
	processing demand (t)	alive cattle, high quality (d)	slaughterhouse		2,261,038	2,440,700	179,662	7.9
		alive cattle, other quality (d)	slaughterhouse		801,962	793,636	-8,325	-1.0
		fresh beef, other quality e)	deep freezing unit		316,786	315,571	-1,216	-0.4
	consumption (t)	fresh beef, high quality (from Argentina) (p)	consumers		413,834	220,916	-192,918	-46.6
		fresh beef, other quality (from Argentina) (p)	consumers		3,036,781	2,578,609	-458,171	-15.1
		fresh beef, high quality (from Brazil) (l)	consumers		6	0	-6	-100.0
		fresh beef, other quality (from Brazil) (l)	consumers		75	0	-75	-100.0
		frozen beef (from Brazil) (l)	consumers		76	0	-76	-100.0
		fresh beef, other quality (from Uruguay) (l)	consumers		2,673	2,665	-7	-0.3
		frozen beef (from Uruguay) (l)	consumers		119	0	-119	-100.0
		fresh beef, other quality (from Rest-of-World) (l)	consumers		69	0	-69	-100.0
		frozen beef (from Rest-of-Worldl) (l)	consumers		234	0	-234	-100.0
		frozen beef (from EU) (f)	consumers		4	0	-4	-100.0
		Country of origin	Product					
	imports (t)	EU (h)	frozen beef		4	0	-4	-100.0
		Uruguay (m)	fresh beef, other quality		2,673	2,665	-7	-0.3
		Uruguay (m)	frozen beef		119	0	-119	-100.0
		Brazil (m)	fresh beef, high quality		6	0	-6	-100.0
		Brazil (m)	fresh beef, other quality		75	0	-75	-100.0
		Brazil (m)	frozen beef		76	0	-76	-100.0
		Rest-of-World (m)	fresh beef, other quality		69	0	-69	-100.0
		Rest-of-World (m)	frozen beef		234	0	-234	-100.0

Legend: See after Table A 6

Table A 5 Base data Brazil

Country	Item	Product	Actor		Raw data	Balanced data	Absolute difference	Percentage difference
Brazil	production (t)	alive cattle, high quality (q)	farmers		3,421,942	3,622,444	200,502	5.9
		alive cattle, other quality (q´)	farmers		2,933,300	2,779,027	-154,273	-5.3
		fresh beef, high quality (s)	slaughterhouse		331,916	351,364	19,448	5.9
		fresh beef, other quality (s)	slaughterhouse		6,023,326	6,050,108	26,782	0.4
		frozen beef (k)	deep freezing unit		1,068,456	1,065,985	-2,470	-0.2
	processing demand (t)	alive cattle, high quality (d)	slaughterhouse		3,421,942	3,622,444	200,502	5.9
		alive cattle, other quality (d)	slaughterhouse		2,933,300	2,779,027	-154,273	-5.3
		fresh beef, other quality e)	deep freezing unit		1,068,456	1,065,985	-2,470	-0.2
	consumption (t)	fresh beef, high quality (from Argentina) (l)	consumers		4,327	4,312	-16	-0.4
		fresh beef, other quality (from Argentina) (l)	consumers		5,279	5,278	-1	0.0
		frozen beef (from Argentina) (l)	consumers		3,662	3,662	0	0.0
		fresh beef, high quality (from Brazil) (w)	consumers		695,254	277,412	-417,843	-60.1
		fresh beef, other quality (from Brazil) (x)	consumers		5,150,547	4,918,124	-232,423	-4.5
		frozen beef (from Brazil) (l)	consumers		0	0	0	0.0
		fresh beef, high quality (from Uruguay) (l)	consumers		2,880	2,940	60	2.1
		fresh beef, other quality (from Uruguay) (l)	consumers		3,733	3,721	-12	-0.3
		frozen beef (from Uruguay) (l)	consumers		2,105	2,102	-3	-0.1
		fresh beef, other quality (from Rest-of-World) (l)	consumers		0	0	0	-100.0
		frozen beef (from Rest-of-Worldl) (l)	consumers		974	0	-974	-100.0
		fresh beef, high quality (from EU) (f)	consumers		10	0	-10	-100.0
		frozen beef (from EU) (f)	consumers		22	0	-22	-100.0
		Country of origin	Product					
	imports (t)	EU (h)	fresh beef, high quality		10	0	-10	-100.0
		EU (h)	frozen beef		22	0	-22	-100.0
		Uruguay (m)	fresh beef, high quality		2,880	2,940	60	2.1
		Uruguay (m)	fresh beef, other quality		3,733	3,721	-12	-0.3
		Uruguay (m)	frozen beef		2,105	2,102	-3	-0.1
		Argentina (m)	fresh beef, high quality		4,327	4,312	-16	-0.4
		Argentina (m)	fresh beef, other quality		5,279	5,278	-1	0.0
		Argentina (m)	frozen beef		3,662	3,662	0	0.0
		Rest-of-World (m)	fresh beef, other quality		0	0	0	-100.0
		Rest-of-World (m)	frozen beef		974	0	-974	-100.0

Legend: See after Table A 6

Table A 6 Base data Rest-of-World

Country	Item	Product	Actor		Raw data	Balanced data	Absolute difference	Percentage difference
Rest-of-World	production (t)	alive cattle, high quality (t)	farmers		37,136,288	36,888,594	-247,694	-0.7
		alive cattle, other quality (t´)	farmers		5,082,735	5,072,430	-10,304	-0.2
		fresh beef, high quality (u)	slaughterhouse		3,594,793	3,570,816	-23,977	-0.7
		fresh beef, other quality (u)	slaughterhouse		38,624,230	38,390,209	-234,022	-0.6
		frozen beef (k)	deep freezing unit		2,158,337	734,980	-1,423,357	-65.9
	processing demand (t)	alive cattle, high quality (d)	slaughterhouse		37,136,288	36,888,594	-247,694	-0.7
		alive cattle, other quality (d)	slaughterhouse		5,082,735	5,072,430	-10,304	-0.2
		fresh beef, other quality e)	deep freezing unit		2,158,337	734,980	-1,423,357	-65.9
	consumption (t)	fresh beef, other quality (from Argentina) (l)	consumers		56,342	56,261	-82	-0.1
		frozen beef (from Argentina) (l)	consumers		304,684	303,489	-1,195	-0.4
		fresh beef, other quality (from Brazil) (l)	consumers		66,018	65,998	-20	0.0
		frozen beef (from Brazil) (l)	consumers		967,892	965,809	-2,083	-0.2
		fresh beef, other quality (from Uruguay) (l)	consumers		8,077	8,032	-45	-0.6
		frozen beef (from Uruguay) (l)	consumers		234,407	218,637	-15,770	-6.7
		fresh beef, high quality (from Rest-of-World) (y)	consumers		3,574,742	3,550,765	-23,976	-0.7
		fresh beef, other quality (from Rest-of-World) (y)	consumers		38,619,173	37,650,241	-968,933	-2.5
		frozen beef (from Rest-of-Worldl) (l)	consumers		545,178	727,109	181,932	33.4
		fresh beef, high quality (from EU) (f)	consumers		32,526	32,497	-30	-0.1
		fresh beef, other quality (from EU) (f)	consumers		69,038	68,990	-48	-0.1
		frozen beef (from EU) (f)	consumers		97,101	96,970	-130	-0.1
		Country of origin	Product					
	imports (t)	EU (h)	fresh beef, high quality		32,526	32,497	-30	-0.1
		EU (h)	fresh beef, other quality		69,038	68,990	-48	-0.1
		EU (h)	frozen beef		97,101	96,970	-130	-0.1
		Uruguay (m)	fresh beef, other quality		8,077	8,032	-45	-0.6
		Uruguay (m)	frozen beef		234,407	218,637	-15,770	-6.7
		Argentina (m)	fresh beef, other quality		56,342	56,261	-82	-0.1
		Argentina (m)	frozen beef		304,684	303,489	-1,195	-0.4
		Brazil (m)	fresh beef, other quality		66,018	65,998	-20	0.0
		Brazil (m)	frozen beef		967,892	965,809	-2,083	-0.2

Legend: See next page

(a) EUROSTAT (n. d.b), calculation: Slaughter numbers of bullocks, bulls and heifers (head) x carcass weight
(a´) EUROSTAT (n. d.b), calculation: Slaughter numbers of cows (head) x carcass weight
(b) EUROSTAT (n. d.b), calculation: Slaughter numbers (head) x carcass weight x leontief coefficient
(c) EUROSTAT, n. d.b
(d) Calculation: Equalised to production of live animals
(e) Calculation: Equalised to production of frozen beef
(f) EUROSTAT (n.d.a), calculation: Equalised to imports
(g) EUROSTAT (n. d.b), calculation: Total consumption - imports
(h) EUROSTAT (n.d.a): Aggregation see Table A 1
(i) INSTITUTO NACIONAL DE CARNES (n.d.), calculation: Slaughter numbers of young bulls (*novillos*) and cows (head) x carcass weight
(i´) INSTITUTO NACIONAL DE CARNES (n.d.), calculation: Slaughter numbers of bulls and calves (head) x carcass weight
(j) INSTITUTO NACIONAL DE CARNES (n.d.), calculation: Slaughter numbers (head) x carcass weight x leontief coefficient
(k) UNITED NATIONS (n.d.), calculation: Equalised to exports
(l) UNITED NATIONS (n.d.), calculation: Equalised to imports
(m) UNITED NATIONS (n.d.), calculation: Aggregation see table Table A 1
(n) SECRETARÍA DE AGRICULTURA GANADERÍA PESCA Y ALIMENTOS (n.d.), calculation: Total slaughter production (CW) x share of young bulls *(novillos)* and cows
(n´) SECRETARÍA DE AGRICULTURA GANADERÍA PESCA Y ALIMENTOS (n.d.), calculation: Total slaughter production (CW) x share of calves and bulls
(o) SECRETARÍA DE AGRICULTURA GANADERÍA PESCA Y ALIMENTOS (n.d.), calculation: Total slaughter production (CW) x share of animal type x leontief coefficient
(p) SECRETARÍA DE AGRICULTURA (2006), WORLD BANK, (n.d.), calculation: Per capita consumption x population x consumption share from Brazil
(q) INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (n. d.a), calculation: Slaughter production of young bulls *(novilhos)* (CW)
(q´) INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (n. d.a), calculation: Slaughter production of cows, calves and bulls (CW)
(s) INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (n. d.a), calculation: Slaughter production (CW) x leontief coefficient
(t) FAO (n.d.), USDA (2006), calculation: World slaughter production (CW) x share of steers, bulls and heifers - production EU, Uruguay, Argentina, Brazil
(t´) FAO (n.d.), USDA (2006), calculation: World slaughter production (CW) x share of cows - production EU, Uruguay, Argentina, Brazil
(u) FAO (n.d.), USDA (2006), calculation: World slaughter production (CW) x share of cows - production EU, Uruguay, Argentina, Brazil) x leontief coefficient
(v) OECD (n.d.), WORLD BANK (n.d.): Per capita consumption x population x consumption share from Brazil
(w) INSTITUTO BRASILEIRO DE GEOGRAFÍA E ESTATÍSTICA (n.d.b), WORLD BANK (n.d.): Consumption of tenderloin, *(alactrá, filet mignon, Contrafilé)*
(x) INSTITUTO BRASILEIRO DE GEOGRAFÍA E ESTATÍSTICA, n. d.b), WORLD BANK (n.d.): Consumption of 21 other meat cuts
(y) Residual from market balance

Table A 7 Price data

		Farm price	Wholesale price (Export Unit value/Import Unit value)	Consumer price
		Euro/Tonne		
EU	fresh beef, high quality (from Argentina)		9,567	13,833
	frozen beef (from Argentina)		5,584	8,039
	fresh beef, high quality (from Brazil)		8,272	13,002
	frozen beef (from Brazil)		5,248	8,181
	fresh beef, high quality (from Uruguay)		9,602	15,093
	fresh beef, other quality (from Uruguay)		6,400	9,976
	frozen beef (from Uruguay)		6,350	9,899
	fresh beef, high quality (from Rest-of-World)		8,739	13,736
	fresh beef, other quality (from Rest-of-World)		5,283	8,235
	frozen beef (from Rest-of-World)		4,089	6,375
	alive cattle, high quality (a)	2,673		
	alive cattle, other quality (a´)	2,208		
	fresh beef, high quality (from the EU)		7,100	11,160 (b)
	fresh beef, other quality (from the EU)		4,189	6,530 (b´)
	frozen beef (from the EU)		2,920	4,552
Uruguay	fresh beef, high quality (from Brazil)		4,162	2,327
	alive cattle, high quality c)	1,310		
	alive cattle, other quality (c´)	1,190		
	fresh beef, high quality (from Uruguay)		5,510	3,080 (d)
	fresh beef, other quality (from Uruguay)		3,637	2,040 (d´)
	frozen beef (from Uruguay)		3,657	
Argentina	alive cattle, high quality e)	1,150		
	alive cattle, other quality (e´)	950		
	fresh beef, high quality (from Argentina)		4,823	2,580 (f)
	fresh beef, other quality (from Argentina)		3,811	2,030 (f´)
	frozen beef (from Argentina)		2,382	
	fresh beef, other quality (from Uruguay)		3,637	1,937
Brazil	fresh beef, high quality (from Argentina)		5,547	4,508
	fresh beef, other quality (from Argentina)		4,382	4,011
	frozen beef (from Argentina)		2,739	2,484
	alive cattle, high quality (g)	788		
	alive cattle, other quality (g´)	651		
	fresh beef, high quality (from Brazil)		4,162	3,890 (h)
	fresh beef, other quality (from Brazil)		2,622	2,760 (h´)
	frozen beef (from Brazil)		2,447	
	fresh beef, high quality (from Uruguay)		5,510	5,150
	fresh beef, other quality (from Uruguay)		3,637	3,828
	frozen beef (from Uruguay)		3,657	3,813
Rest-of-World	fresh beef, other quality (from Argentina)		4,382	7,083
	frozen beef (from Argentina)		2,739	6,976
	fresh beef, other quality (from Brazil)		2,622	4,874
	frozen beef (from Brazil)		2,447	7,166
	fresh beef, other quality (from Uruguay)		3,637	6,759
	frozen beef (from Uruguay)		3,657	10,709
	alive cattle, high quality i)	2,450		
	alive cattle, other quality (i´)	1,568		
	fresh beef, high quality (from Rest-of-World)		5,057	9,400 (j)
	fresh beef, other quality (from Rest-of-World)		2,959	5,500 (j´)
	frozen beef (from Rest-of-World)		1,901	5,567
	fresh beef, high quality (from the EU)		7,100	13,197
	fresh beef, other quality (from the EU)		4,189	7,786
	frozen beef (from the EU)		2,920	8,551

Legend: see next page

(a) EU beef producer price at farm gate (OECD, n. d.)

(a´) Calculation based on (a) and the price ratio in the U.S.

(b) Calculation based on (b´) and price ratio in the U.S.

(b´) Hamburg central market roast beef (ZENTRALE MARKT- UND PREISBERICHTSSTELLE, n.d.)

(c) Average of *novillos gordos exportacion (especiales, buenos, generales), vaquillonas gordas (especiales, buenas) (MINISTERIO DE GANADERÍA, AGRICULTURA Y PESCA(2004), MINISTERIO DE GANADERÍA, AGRICULTURA Y PESCA (2005), MINISTERIO DE GANADERIA, AGRICULTURA Y PESCA (2006))*

(c´) Average of *novillos abasto (especiales, buenos), vacas gordas (especiales, buenas, generales), toros gordos, novillos gordos indústria, vacas manufactura alta (MINISTERIO DE GANADERÍA, AGRICULTURA Y PESCA (2004), MINISTERIO DE GANADERÍA, AGRICULTURA Y PESCA (2005), MINISTERIO DE GANADERIA, AGRICULTURA Y PESCA, (2006))*

(d) Topside or rump *(nalga o quadríl) (MINISTERIO DE GANADERIA, AGRICULTURA Y PESCA, 2007)*

(d´) Chuck *(*aguja *de primera)* (MINISTERIO DE GANADERIA, AGRICULTURA Y PESCA, 2007)

(e) Average price of young bulls and cows *(novillos, novillitos, vaquillonas)*, Liniers cattle market quotation (MERCADO DE LINIERS, n.d.)

(e´) Average price of cows and bulls *(vacas, toros y torunos),* Liniers cattle market quotation (MERCADO DE LINIERS, n.d.)

(f) Average price of topsides and rump *(nalga and quadril) (SECRETARÍA DE AGRICULTURA GANADERÍA, PESCA Y ALIMENTOS, 2006)*

(f´) Average price of roast, minced meat, shoulder, golden coin *(asado, carne picada, paleta, bife angosto) (SECRETARÍA DE AGRICULTURA GANADERÍA, PESCA Y ALIMENTOS, 2006)*

(g) Calculation based on FAO livestock prices and price ratio observed in Argentina (FAO, n.d.)

(g´) Calculation based on FAO livestock prices and price ratio observed in Argentina (FAO, n.d.)

(h) Average price of tenderloin, sirloin and rump *(filet mignon, contra filet, alcatra) (SCOT CONSULTORIA, n.d.)*

(h´) Average price of needle point, hump, thin skirt, shoulder, brisket, rump cap, parts of topsides *(costela, cumpim, fraldinha, patela, peito, picanha, coxao mole, coxao duro) (SCOT CONSULTORIA, n.d.)*

(i) Nebraska choice steers (OECD, n.d.)

(i´) Calculation based on (i) and USDA price data (USDA, 2006)

(j) Average price of steak and sirloin (ERS-USDA, n.d.)

(j´) Average price of ground chuck, ground beef, chuck roast, round roast, boneless beef for stew (ERS-USDA, n.d.)

Table A 8 Elasticities of supply

			Actor	Raw data	Balanced data	Absolute difference	Percentage difference	Source
EU	alive cattle, high quality	alive cattle, high quality	farmers	0.93	0.91	-0.02	-2.5	World Food Model*
		alive cattle, other quality	farmers	-0.20	-0.10	0.10	-50.0	
		other animals	farmers		-0.04	-0.04		
		alive cattle, high quality	slaughter houses	0.93	0.95	0.02	2.4	World Food Model*
		alive cattle, other quality	slaughter houses	-0.20	-0.10	0.10	-50.0	
	alive cattle, other quality	alive cattle, high quality	farmers	-0.20	-0.36	-0.16	81.1	
		alive cattle, other quality	farmers	0.93	0.91	-0.02	-2.5	World Food Model*
		other animals	farmers		-0.13	-0.13		
		alive cattle, high quality	slaughter houses	-0.20	-0.27	-0.07	34.2	
		alive cattle, other quality	slaughter houses	0.93	0.95	0.02	2.4	World Food Model*
	fresh beef, other quality	fresh beef, other quality	deep freezing unit	0.30	0.30	0.30		
	other animals	alive cattle, high quality	farmers	-0.02	-0.01	0.01	-35.8	
		alive cattle, other quality	farmers	-0.02	-0.01	0.01	-35.8	
		other animals	farmers	1.02	1.03	0.01	0.7	World Food Model*
Uruguay	alive cattle, high quality	alive cattle, high quality	farmers	1.66	0.97	-0.69	-41.6	Cap et al. (2007)*
		alive cattle, other quality	farmers	-0.20	-0.01	0.19	-96.7	
		other animals	farmers		0.00	0.00		
		alive cattle, high quality	slaughter houses	1.66	1.02	-0.64	-38.7	Cap et al. (2007)*
		alive cattle, other quality	slaughter houses	-0.20	-0.02	0.18	-91.0	
	alive cattle, other quality	alive cattle, high quality	farmers	-0.20	-0.21	-0.01	5.5	
		alive cattle, other quality	farmers	1.66	1.47	-0.19	-11.5	Cap et al. (2007)*
		other animals	farmers		-0.26	-0.26		
		alive cattle, high quality	slaughter houses	-0.20	-0.54	-0.34	171.5	
		alive cattle, other quality	slaughter houses	1.66	1.54	-0.12	-7.0	Cap et al. (2007)*
	fresh beef, other quality	fresh beef, other quality	deep freezing unit		0.30	0.30		
	other animals	alive cattle, high quality	farmers	-0.02	-0.02	0.00	0.0	
		alive cattle, other quality	farmers	-0.02	-0.05	-0.03	134.1	
		other animals	farmers	0.70	0.69	0.00	0.0	World Food Model*

* Same values were used for different qualities and stages of processing

Table A 8 Elasticities of supply (continued)

			Actor	Raw data	Balanced data	Absolute difference	Percentage difference	Source
Argentina	alive cattle, high quality	alive cattle, high quality	farmers	0.52	0.51	-0.01	-2.5	Cap et al. (2007)*
		alive cattle, other quality	farmers	-0.20	-0.10	0.10	-50.0	
		other animals	farmers		-0.01	-0.01		
		alive cattle, high quality	slaughter houses	0.52	0.53	0.01	2.4	Cap et al. (2007)*
		alive cattle, other quality	slaughter houses	-0.20	-0.10	0.10	-50.0	
	alive cattle, other quality	alive cattle, high quality	farmers	-0.20	-0.37	-0.17	86.1	
		alive cattle, other quality	farmers	0.52	0.51	-0.01	-2.5	Cap et al. (2007)*
		other animals	farmers		-0.05	-0.05		
		alive cattle, high quality	slaughter houses	-0.20	-0.30	-0.10	49.2	
		alive cattle, other quality	slaughter houses	0.52	0.53	0.01	2.4	Cap et al. (2007)*
	fresh beef, other quality	fresh beef, other quality	deep freezing unit		0.30	0.30		
	other animals	alive cattle, high quality	farmers	-0.02	-0.02	0.00	0.0	
		alive cattle, other quality	farmers	-0.02	-0.02	0.00	0.0	
		other animals	farmers	0.87	0.87	0.00	0.0	World Food Model*
Brazil	alive cattle, high quality	alive cattle, high quality	farmers	1.01	0.98	-0.03	-2.5	Cap et al. (2007)*
		alive cattle, other quality	farmers	-0.20	-0.15	0.05	-26.1	
		other animals	farmers		-0.03	-0.03		
		alive cattle, high quality	slaughter houses	1.01	1.03	0.02	2.4	Cap et al. (2007)*
		alive cattle, other quality	slaughter houses	-0.20	-0.17	0.03	-15.0	
	alive cattle, other quality	alive cattle, high quality	farmers	-0.20	-0.23	-0.03	16.6	
		alive cattle, other quality	farmers	1.01	0.98	-0.03	-2.5	Cap et al. (2007)*
		other animals	farmers		-0.05	-0.05		
		alive cattle, high quality	slaughter houses	-0.20	-0.22	-0.02	11.5	
		alive cattle, other quality	slaughter houses	1.01	1.03	0.02	2.4	Cap et al. (2007)*
	fresh beef, other quality	fresh beef, other quality	deep freezing unit		0.30	0.30		
	other animals	alive cattle, high quality	farmers	-0.02	-0.02	0.00	0.0	
		alive cattle, other quality	farmers	-0.02	-0.02	0.00	0.0	
		other animals	farmers	0.85	0.85	0.00	0.0	World Food Model*

* Same values were used for different qualities and stages of processing

Table A 8 Elasticities of supply (continued)

			Actor	Raw data	Balanced data	Absolute difference	Percentage difference	Source
Rest-of-World	alive cattle, high quality	alive cattle, high quality	farmers	0.78	0.76	-0.02	-2.5	Cap et al. (2007)*
		alive cattle, other quality	farmers	-0.20	-0.10	0.10	-50.0	
		alive cattle, high quality	slaughter houses	0.78	0.80	0.02	2.4	Cap et al. (2007)*
		alive cattle, other quality	slaughter houses	-0.20	-0.10	0.10	-50.0	
	alive cattle, other quality	alive cattle, high quality	farmers	-0.20	-1.14	-0.94	468.2	
		alive cattle, other quality	farmers	0.78	1.14	0.36	45.7	Cap et al. (2007)*
		alive cattle, high quality	slaughter houses	-0.20	-0.37	-0.17	86.2	
		alive cattle, other quality	slaughter houses	0.78	1.19	0.41	53.0	Cap et al. (2007)*
	fresh beef, other quality	fresh beef, other quality	deep freezing unit		0.30	0.30		
	other animals	alive cattle, high quality	farmers	-0.02		0.02	-100.0	
		alive cattle, other quality	farmers	-0.02		0.02	-100.0	
		other animals	farmers	0.94	1.00	0.06	7.0	World Food Model*

* Same values were used for different qualities and stages of processing

Table A 9 Elasticities of demand (legend see end of table)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
EU	fresh beef, high quality (from Argentina)	fresh beef, high quality (from Argentina)	-0.66	-0.66	0.00	0.0	WFM
EU	fresh beef, high quality (from Argentina)	frozen beef (from Argentina)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Argentina)	fresh beef, high quality (from Brazil)	0.66	0.59	-0.07	-11.3	calculation 2)
EU	fresh beef, high quality (from Argentina)	frozen beef (from Brazil)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Argentina)	fresh beef, high quality (from Uruguay)	0.66	0.10	-0.56	-85.5	calculation 2)
EU	fresh beef, high quality (from Argentina)	fresh beef, other quality (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Argentina)	frozen beef (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Argentina)	fresh beef, high quality (from Rest-of-World)	0.66	0.16	-0.50	-75.9	calculation 2)
EU	fresh beef, high quality (from Argentina)	fresh beef, other quality (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Argentina)	frozen beef (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Argentina)	fresh beef, high quality (from the EU)	0.66	0.57	-0.09	-14.1	calculation 2)
EU	fresh beef, high quality (from Argentina)	fresh beef, other quality (from the EU)	0.04	0.05	0.01	17.9	calculation 1)
EU	fresh beef, high quality (from Argentina)	frozen beef (from the EU)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Argentina)	other meat (from Argentina)	0.19	0.00	-0.19	-98.2	WFM 1)
EU	fresh beef, high quality (from Argentina)	other meat (from Brazil)	0.19	0.02	-0.17	-91.9	WFM 1)
EU	fresh beef, high quality (from Argentina)	other meat (from Uruguay)	0.19	0.00	-0.19	-99.7	WFM 1)
EU	fresh beef, high quality (from Argentina)	other meat (from Rest-of-World)	0.19	0.07	-0.12	-60.8	WFM 1)
EU	fresh beef, high quality (from Argentina)	other meat (from the EU)	0.19	0.05	-0.14	-73.6	WFM 1)
EU	frozen beef (from Argentina)	fresh beef, high quality (from Argentina)	0.04	0.01	-0.03	-85.6	calculation 1)
EU	frozen beef (from Argentina)	frozen beef (from Argentina)	-0.66	-0.66	0.00	0.0	WFM
EU	frozen beef (from Argentina)	fresh beef, high quality (from Brazil)	0.04	0.01	-0.03	-82.0	calculation 1)
EU	frozen beef (from Argentina)	frozen beef (from Brazil)	0.66	0.34	-0.32	-48.0	calculation 2)
EU	frozen beef (from Argentina)	fresh beef, high quality (from Uruguay)	0.04	0.00	-0.03	-96.5	calculation 1)
EU	frozen beef (from Argentina)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-99.9	
EU	frozen beef (from Argentina)	frozen beef (from Uruguay)	0.66	0.33	-0.33	-50.5	calculation 2)
EU	frozen beef (from Argentina)	fresh beef, high quality (from Rest-of-World)	0.04	0.00	-0.03	-94.6	calculation 1)
EU	frozen beef (from Argentina)	fresh beef, other quality (from Rest-of-World)	0.20	0.00	-0.20	-99.2	
EU	frozen beef (from Argentina)	frozen beef (from Rest-of-World)	0.66	0.23	-0.43	-65.3	calculation 2)
EU	frozen beef (from Argentina)	fresh beef, high quality (from the EU)	0.04	0.04	0.00	8.6	calculation 1)
EU	frozen beef (from Argentina)	fresh beef, other quality (from the EU)	0.20	0.34	0.14	67.5	
EU	frozen beef (from Argentina)	frozen beef (from the EU)	0.66	0.30	-0.36	-54.1	calculation 2)
EU	frozen beef (from Argentina)	other meat (from Argentina)	0.19	0.02	-0.17	-89.2	WFM 1)
EU	frozen beef (from Argentina)	other meat (from Brazil)	0.19	0.00	-0.19	-99.9	WFM 1)
EU	frozen beef (from Argentina)	other meat (from Uruguay)	0.19	0.01	-0.18	-97.2	WFM 1)
EU	frozen beef (from Argentina)	other meat (from Rest-of-World)	0.19	0.00	-0.19	-99.5	WFM 1)
EU	frozen beef (from Argentina)	other meat (from the EU)	0.19	0.34	0.15	77.0	WFM 1)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
EU	fresh beef, high quality (from Brazil)	fresh beef, high quality (from Argentina)	0.66	0.47	-0.19	-29.4	calculation 2)
EU	fresh beef, high quality (from Brazil)	frozen beef (from Argentina)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Brazil)	fresh beef, high quality (from Brazil)	-0.66	-0.66	0.00	0.0	WFM
EU	fresh beef, high quality (from Brazil)	frozen beef (from Brazil)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Brazil)	fresh beef, high quality (from Uruguay)	0.66	0.08	-0.58	-88.4	calculation 2)
EU	fresh beef, high quality (from Brazil)	fresh beef, other quality (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Brazil)	frozen beef (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Brazil)	fresh beef, high quality (from Rest-of-World)	0.66	0.13	-0.53	-80.3	calculation 2)
EU	fresh beef, high quality (from Brazil)	fresh beef, other quality (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Brazil)	frozen beef (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Brazil)	fresh beef, high quality (from the EU)	0.66	0.68	0.02	2.5	calculation 2)
EU	fresh beef, high quality (from Brazil)	fresh beef, other quality (from the EU)	0.04	0.05	0.01	17.9	calculation 1)
EU	fresh beef, high quality (from Brazil)	frozen beef (from the EU)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Brazil)	other meat (from Argentina)	0.19	0.00	-0.19	-98.6	WFM 1)
EU	fresh beef, high quality (from Brazil)	other meat (from Brazil)	0.19	0.01	-0.18	-93.3	WFM 1)
EU	fresh beef, high quality (from Brazil)	other meat (from Uruguay)	0.19	0.00	-0.19	-99.8	WFM 1)
EU	fresh beef, high quality (from Brazil)	other meat (from Rest-of-World)	0.19	0.07	-0.12	-64.1	WFM 1)
EU	fresh beef, high quality (from Brazil)	other meat (from the EU)	0.19	0.12	-0.07	-38.2	WFM 1)
EU	frozen beef (from Brazil)	fresh beef, high quality (from Argentina)	0.04	0.01	-0.03	-83.6	calculation 1)
EU	frozen beef (from Brazil)	frozen beef (from Argentina)	0.66	0.03	-0.63	-95.7	calculation 2)
EU	frozen beef (from Brazil)	fresh beef, high quality (from Brazil)	0.04	0.01	-0.03	-79.4	calculation 1)
EU	frozen beef (from Brazil)	frozen beef (from Brazil)	-0.66	-0.66	0.00	0.0	WFM
EU	frozen beef (from Brazil)	fresh beef, high quality (from Uruguay)	0.04	0.00	-0.03	-96.0	calculation 1)
EU	frozen beef (from Brazil)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-98.9	
EU	frozen beef (from Brazil)	frozen beef (from Uruguay)	0.66	0.04	-0.62	-94.3	calculation 2)
EU	frozen beef (from Brazil)	fresh beef, high quality (from Rest-of-World)	0.04	0.00	-0.03	-93.9	calculation 1)
EU	frozen beef (from Brazil)	fresh beef, other quality (from Rest-of-World)	0.20	0.01	-0.19	-97.1	
EU	frozen beef (from Brazil)	frozen beef (from Rest-of-World)	0.66	0.02	-0.64	-97.2	calculation 2)
EU	frozen beef (from Brazil)	fresh beef, high quality (from the EU)	0.04	0.04	0.01	24.0	calculation 1)
EU	frozen beef (from Brazil)	fresh beef, other quality (from the EU)	0.20	0.38	0.18	87.7	
EU	frozen beef (from Brazil)	frozen beef (from the EU)	0.66	0.77	0.11	16.2	calculation 2)
EU	frozen beef (from Brazil)	other meat (from Argentina)	0.19	0.00	-0.19	-98.3	WFM 1)
EU	frozen beef (from Brazil)	other meat (from Brazil)	0.19	0.02	-0.17	-91.8	WFM 1)
EU	frozen beef (from Brazil)	other meat (from Uruguay)	0.19	0.00	-0.19	-99.7	WFM 1)
EU	frozen beef (from Brazil)	other meat (from Rest-of-World)	0.19	0.09	-0.10	-54.9	WFM 1)
EU	frozen beef (from Brazil)	other meat (from the EU)	0.19	0.38	0.19	98.4	WFM 1)
EU	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from Argentina)	0.66	0.39	-0.27	-40.4	calculation 2)
EU	fresh beef, high quality (from Uruguay)	frozen beef (from Argentina)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from Brazil)	0.66	0.40	-0.26	-40.0	calculation 2)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
EU	fresh beef, high quality (from Uruguay)	frozen beef (from Brazil)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from Uruguay)	-0.66	-0.66	0.00	0.0	WFM
EU	fresh beef, high quality (from Uruguay)	fresh beef, other quality (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Uruguay)	frozen beef (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from Rest-of-World)	0.66	0.35	-0.31	-47.2	calculation 2)
EU	fresh beef, high quality (from Uruguay)	fresh beef, other quality (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Uruguay)	frozen beef (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from the EU)	0.66	0.32	-0.34	-51.7	calculation 2)
EU	fresh beef, high quality (from Uruguay)	fresh beef, other quality (from the EU)	0.04	0.05	0.01	17.9	calculation 1)
EU	fresh beef, high quality (from Uruguay)	frozen beef (from the EU)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Uruguay)	other meat (from Argentina)	0.19	0.01	-0.18	-93.8	WFM 1)
EU	fresh beef, high quality (from Uruguay)	other meat (from Brazil)	0.19	0.03	-0.15	-81.6	WFM 1)
EU	fresh beef, high quality (from Uruguay)	other meat (from Uruguay)	0.19	0.00	-0.19	-98.9	WFM 1)
EU	fresh beef, high quality (from Uruguay)	other meat (from Rest-of-World)	0.19	0.00	-0.19	-100.0	WFM 1)
EU	fresh beef, high quality (from Uruguay)	other meat (from the EU)	0.19	0.05	-0.14	-73.6	WFM 1)
EU	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Argentina)	0.04	0.01	-0.03	-81.6	calculation 1)
EU	fresh beef, other quality (from Uruguay)	frozen beef (from Argentina)	0.20	0.00	-0.20	-99.8	
EU	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Brazil)	0.04	0.01	-0.03	-76.9	calculation 1)
EU	fresh beef, other quality (from Uruguay)	frozen beef (from Brazil)	0.20	0.07	-0.13	-65.8	
EU	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Uruguay)	0.04	0.00	-0.03	-95.5	calculation 1)
EU	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Uruguay)	-0.50	-0.50	0.00	0.0	
EU	fresh beef, other quality (from Uruguay)	frozen beef (from Uruguay)	0.20	0.01	-0.19	-92.9	
EU	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Rest-of-World)	0.04	0.00	-0.03	-93.1	calculation 1)
EU	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Rest-of-World)	0.66	0.63	-0.03	-4.6	calculation 2)
EU	fresh beef, other quality (from Uruguay)	frozen beef (from Rest-of-World)	0.20	0.00	-0.20	-99.9	
EU	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from the EU)	0.04	0.05	0.01	39.1	calculation 1)
EU	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from the EU)	0.66	0.52	-0.14	-20.8	calculation 2)
EU	fresh beef, other quality (from Uruguay)	frozen beef (from the EU)	0.20	0.06	-0.14	-68.2	
EU	fresh beef, other quality (from Uruguay)	other meat (from Argentina)	0.19	0.08	-0.11	-57.1	WFM 1)
EU	fresh beef, other quality (from Uruguay)	other meat (from Brazil)	0.19	0.10	-0.09	-46.1	WFM 1)
EU	fresh beef, other quality (from Uruguay)	other meat (from Uruguay)	0.19	0.02	-0.17	-91.6	WFM 1)
EU	fresh beef, other quality (from Uruguay)	other meat (from Rest-of-World)	0.19	0.07	-0.12	-60.9	WFM 1)
EU	fresh beef, other quality (from Uruguay)	other meat (from the EU)	0.19	0.42	0.23	119.4	WFM 1)
EU	frozen beef (from Uruguay)	fresh beef, high quality (from Argentina)	0.04	0.01	-0.03	-85.5	calculation 1)
EU	frozen beef (from Uruguay)	frozen beef (from Argentina)	0.66	0.27	-0.39	-59.5	calculation 2)
EU	frozen beef (from Uruguay)	fresh beef, high quality (from Brazil)	0.04	0.01	-0.03	-81.8	calculation 1)
EU	frozen beef (from Uruguay)	frozen beef (from Brazil)	0.66	0.37	-0.29	-43.4	calculation 2)
EU	frozen beef (from Uruguay)	fresh beef, high quality (from Uruguay)	0.04	0.00	-0.03	-96.5	calculation 1)
EU	frozen beef (from Uruguay)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-97.8	

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
EU	frozen beef (from Uruguay)	frozen beef (from Uruguay)	-0.66	-0.66	0.00	0.0	WFM
EU	frozen beef (from Uruguay)	fresh beef, high quality (from Rest-of-World)	0.04	0.00	-0.03	-94.6	calculation 1)
EU	frozen beef (from Uruguay)	fresh beef, other quality (from Rest-of-World)	0.20	0.01	-0.19	-93.6	
EU	frozen beef (from Uruguay)	frozen beef (from Rest-of-World)	0.66	0.20	-0.46	-69.7	calculation 2)
EU	frozen beef (from Uruguay)	fresh beef, high quality (from the EU)	0.04	0.04	0.00	9.4	calculation 1)
EU	frozen beef (from Uruguay)	fresh beef, other quality (from the EU)	0.20	0.34	0.14	68.6	
EU	frozen beef (from Uruguay)	frozen beef (from the EU)	0.66	0.32	-0.34	-50.8	calculation 2)
EU	frozen beef (from Uruguay)	other meat (from Argentina)	0.19	0.02	-0.17	-89.2	WFM 1)
EU	frozen beef (from Uruguay)	other meat (from Brazil)	0.19	0.02	-0.17	-89.6	WFM 1)
EU	frozen beef (from Uruguay)	other meat (from Uruguay)	0.19	0.00	-0.18	-97.6	WFM 1)
EU	frozen beef (from Uruguay)	other meat (from Rest-of-World)	0.19	0.00	-0.19	-99.4	WFM 1)
EU	frozen beef (from Uruguay)	other meat (from the EU)	0.19	0.34	0.15	78.2	WFM 1)
EU	fresh beef, high quality (from Rest-of-World)	fresh beef, high quality (from Argentina)	0.66	0.43	-0.23	-35.3	calculation 2)
EU	fresh beef, high quality (from Rest-of-World)	frozen beef (from Argentina)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Rest-of-World)	fresh beef, high quality (from Brazil)	0.66	0.44	-0.22	-33.5	calculation 2)
EU	fresh beef, high quality (from Rest-of-World)	frozen beef (from Brazil)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Rest-of-World)	fresh beef, high quality (from Uruguay)	0.66	0.23	-0.43	-65.7	calculation 2)
EU	fresh beef, high quality (from Rest-of-World)	fresh beef, other quality (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Rest-of-World)	frozen beef (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Rest-of-World)	fresh beef, high quality (from Rest-of-World)	-0.66	-0.66	0.00	0.0	WFM
EU	fresh beef, high quality (from Rest-of-World)	fresh beef, other quality (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Rest-of-World)	frozen beef (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Rest-of-World)	fresh beef, high quality (from the EU)	0.66	0.34	-0.32	-49.2	calculation 2)
EU	fresh beef, high quality (from Rest-of-World)	fresh beef, other quality (from the EU)	0.04	0.05	0.01	17.9	calculation 1)
EU	fresh beef, high quality (from Rest-of-World)	frozen beef (from the EU)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from Rest-of-World)	other meat (from Argentina)	0.19	0.01	-0.18	-95.7	WFM 1)
EU	fresh beef, high quality (from Rest-of-World)	other meat (from Brazil)	0.19	0.03	-0.16	-84.2	WFM 1)
EU	fresh beef, high quality (from Rest-of-World)	other meat (from Uruguay)	0.19	0.00	-0.19	-99.3	WFM 1)
EU	fresh beef, high quality (from Rest-of-World)	other meat (from Rest-of-World)	0.19	0.04	-0.15	-80.2	WFM 1)
EU	fresh beef, high quality (from Rest-of-World)	other meat (from the EU)	0.19	0.05	-0.14	-73.6	WFM 1)
EU	fresh beef, other quality (from Rest-of-World)	fresh beef, high quality (from Argentina)	0.04	0.01	-0.03	-81.6	calculation 1)
EU	fresh beef, other quality (from Rest-of-World)	frozen beef (from Argentina)	0.20	0.00	-0.20	-98.5	
EU	fresh beef, other quality (from Rest-of-World)	fresh beef, high quality (from Brazil)	0.04	0.01	-0.03	-76.9	calculation 1)
EU	fresh beef, other quality (from Rest-of-World)	frozen beef (from Brazil)	0.20	0.12	-0.08	-42.0	
EU	fresh beef, other quality (from Rest-of-World)	fresh beef, high quality (from Uruguay)	0.04	0.00	-0.03	-95.5	calculation 1)
EU	fresh beef, other quality (from Rest-of-World)	fresh beef, other quality (from Uruguay)	0.66	0.40	-0.26	-40.1	calculation 2)
EU	fresh beef, other quality (from Rest-of-World)	frozen beef (from Uruguay)	0.20	0.03	-0.17	-87.1	
EU	fresh beef, other quality (from Rest-of-World)	fresh beef, high quality (from Rest-of-World)	0.04	0.00	-0.03	-93.2	calculation 1)
EU	fresh beef, other quality (from Rest-of-World)	fresh beef, other quality (from Rest-of-World)	-0.50	-0.50	0.00	0.0	

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
EU	fresh beef, other quality (from Rest-of-World)	frozen beef (from Rest-of-World)	0.20	0.00	-0.20	-99.9	
EU	fresh beef, other quality (from Rest-of-World)	fresh beef, high quality (from the EU)	0.04	0.05	0.01	38.8	calculation 1)
EU	fresh beef, other quality (from Rest-of-World)	fresh beef, other quality (from the EU)	0.66	0.57	-0.09	-14.1	calculation 2)
EU	fresh beef, other quality (from Rest-of-World)	frozen beef (from the EU)	0.20	0.11	-0.09	-45.8	
EU	fresh beef, other quality (from Rest-of-World)	other meat (from Argentina)	0.19	0.07	-0.12	-63.9	WFM 1)
EU	fresh beef, other quality (from Rest-of-World)	other meat (from Brazil)	0.19	0.15	-0.04	-22.8	WFM 1)
EU	fresh beef, other quality (from Rest-of-World)	other meat (from Uruguay)	0.19	0.01	-0.18	-94.6	WFM 1)
EU	fresh beef, other quality (from Rest-of-World)	other meat (from Rest-of-World)	0.19	0.13	-0.06	-31.6	WFM 1)
EU	fresh beef, other quality (from Rest-of-World)	other meat (from the EU)	0.19	0.41	0.23	118.9	WFM 1)
EU	frozen beef (from Rest-of-World)	fresh beef, high quality (from Argentina)	0.04	0.00	-0.03	-85.8	calculation 1)
EU	frozen beef (from Rest-of-World)	frozen beef (from Argentina)	0.66	0.31	-0.35	-53.2	calculation 2)
EU	frozen beef (from Rest-of-World)	fresh beef, high quality (from Brazil)	0.04	0.01	-0.03	-82.2	calculation 1)
EU	frozen beef (from Rest-of-World)	frozen beef (from Brazil)	0.66	0.30	-0.36	-54.3	calculation 2)
EU	frozen beef (from Rest-of-World)	fresh beef, high quality (from Uruguay)	0.04	0.00	-0.03	-96.6	calculation 1)
EU	frozen beef (from Rest-of-World)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-99.9	
EU	frozen beef (from Rest-of-World)	frozen beef (from Uruguay)	0.66	0.33	-0.33	-50.1	calculation 2)
EU	frozen beef (from Rest-of-World)	fresh beef, high quality (from Rest-of-World)	0.04	0.00	-0.03	-94.7	calculation 1)
EU	frozen beef (from Rest-of-World)	fresh beef, other quality (from Rest-of-World)	0.20	0.00	-0.20	-99.9	
EU	frozen beef (from Rest-of-World)	frozen beef (from Rest-of-World)	-0.66	-0.66	0.00	0.0	WFM
EU	frozen beef (from Rest-of-World)	fresh beef, high quality (from the EU)	0.04	0.04	0.00	7.2	calculation 1)
EU	frozen beef (from Rest-of-World)	fresh beef, other quality (from the EU)	0.20	0.33	0.13	65.8	
EU	frozen beef (from Rest-of-World)	frozen beef (from the EU)	0.66	0.27	-0.39	-58.9	calculation 2)
EU	frozen beef (from Rest-of-World)	other meat (from Argentina)	0.19	0.02	-0.17	-91.7	WFM 1)
EU	frozen beef (from Rest-of-World)	other meat (from Brazil)	0.19	0.00	-0.19	-99.9	WFM 1)
EU	frozen beef (from Rest-of-World)	other meat (from Uruguay)	0.19	0.01	-0.18	-96.4	WFM 1)
EU	frozen beef (from Rest-of-World)	other meat (from Rest-of-World)	0.19	0.00	-0.19	-99.5	WFM 1)
EU	frozen beef (from Rest-of-World)	other meat (from the EU)	0.19	0.33	0.14	75.2	WFM 1)
EU	fresh beef, high quality (from the EU)	fresh beef, high quality (from Argentina)	0.66	0.07	-0.59	-88.6	calculation 2)
EU	fresh beef, high quality (from the EU)	frozen beef (from Argentina)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from the EU)	fresh beef, high quality (from Brazil)	0.66	0.11	-0.55	-83.0	calculation 2)
EU	fresh beef, high quality (from the EU)	frozen beef (from Brazil)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from the EU)	fresh beef, high quality (from Uruguay)	0.66	0.01	-0.65	-98.5	calculation 2)
EU	fresh beef, high quality (from the EU)	fresh beef, other quality (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from the EU)	frozen beef (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from the EU)	fresh beef, high quality (from Rest-of-World)	0.66	0.02	-0.64	-97.5	calculation 2)
EU	fresh beef, high quality (from the EU)	fresh beef, other quality (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from the EU)	frozen beef (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, high quality (from the EU)	fresh beef, high quality (from the EU)	-0.66	-0.66	0.00	0.0	WFM
EU	fresh beef, high quality (from the EU)	fresh beef, other quality (from the EU)	0.04	0.05	0.01	17.9	calculation 1)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
EU	fresh beef, high quality (from the EU)	frozen beef (from the EU)	0.04	0.01	-0.04	-83.3	calculation 1)
EU	fresh beef, high quality (from the EU)	other meat (from Argentina)	0.19	0.00	-0.19	-99.8	WFM 1)
EU	fresh beef, high quality (from the EU)	other meat (from Brazil)	0.19	0.00	-0.19	-99.1	WFM 1)
EU	fresh beef, high quality (from the EU)	other meat (from Uruguay)	0.19	0.00	-0.19	-100.0	WFM 1)
EU	fresh beef, high quality (from the EU)	other meat (from Rest-of-World)	0.19	0.01	-0.18	-94.8	WFM 1)
EU	fresh beef, high quality (from the EU)	other meat (from the EU)	0.19	0.20	0.01	4.8	WFM 1)
EU	fresh beef, other quality (from the EU)	fresh beef, high quality (from Argentina)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, other quality (from the EU)	frozen beef (from Argentina)	0.20	0.00	-0.20	-100.0	
EU	fresh beef, other quality (from the EU)	fresh beef, high quality (from Brazil)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, other quality (from the EU)	frozen beef (from Brazil)	0.20	0.00	-0.20	-100.0	
EU	fresh beef, other quality (from the EU)	fresh beef, high quality (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, other quality (from the EU)	fresh beef, other quality (from Uruguay)	0.66	0.00	-0.66	-100.0	calculation 2)
EU	fresh beef, other quality (from the EU)	frozen beef (from Uruguay)	0.20	0.00	-0.20	-100.0	
EU	fresh beef, other quality (from the EU)	fresh beef, high quality (from Rest-of-World)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, other quality (from the EU)	fresh beef, other quality (from Rest-of-World)	0.66	0.00	-0.66	-100.0	calculation 2)
EU	fresh beef, other quality (from the EU)	frozen beef (from Rest-of-World)	0.20	0.00	-0.20	-100.0	
EU	fresh beef, other quality (from the EU)	fresh beef, high quality (from the EU)	0.04	0.00	-0.04	-100.0	calculation 1)
EU	fresh beef, other quality (from the EU)	fresh beef, other quality (from the EU)	-0.66	-0.66	0.00	0.0	WFM
EU	fresh beef, other quality (from the EU)	frozen beef (from the EU)	0.20	0.00	-0.20	-100.0	
EU	fresh beef, other quality (from the EU)	other meat (from Argentina)	0.19	0.00	-0.19	-100.0	WFM 1)
EU	fresh beef, other quality (from the EU)	other meat (from Brazil)	0.19	0.00	-0.19	-100.0	WFM 1)
EU	fresh beef, other quality (from the EU)	other meat (from Uruguay)	0.19	0.00	-0.19	-100.0	WFM 1)
EU	fresh beef, other quality (from the EU)	other meat (from Rest-of-World)	0.19	0.00	-0.19	-100.0	WFM 1)
EU	fresh beef, other quality (from the EU)	other meat (from the EU)	0.19	0.14	-0.05	-26.7	WFM 1)
EU	frozen beef (from the EU)	fresh beef, high quality (from Argentina)	0.04	0.01	-0.03	-85.0	calculation 1)
EU	frozen beef (from the EU)	frozen beef (from Argentina)	0.66	0.01	-0.65	-99.2	calculation 2)
EU	frozen beef (from the EU)	fresh beef, high quality (from Brazil)	0.04	0.01	-0.03	-81.2	calculation 1)
EU	frozen beef (from the EU)	frozen beef (from Brazil)	0.66	0.16	-0.50	-75.1	calculation 2)
EU	frozen beef (from the EU)	fresh beef, high quality (from Uruguay)	0.04	0.00	-0.03	-96.4	calculation 1)
EU	frozen beef (from the EU)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-99.8	
EU	frozen beef (from the EU)	frozen beef (from Uruguay)	0.66	0.01	-0.65	-98.9	calculation 2)
EU	frozen beef (from the EU)	fresh beef, high quality (from Rest-of-World)	0.04	0.00	-0.03	-94.4	calculation 1)
EU	frozen beef (from the EU)	fresh beef, other quality (from Rest-of-World)	0.20	0.00	-0.20	-99.4	
EU	frozen beef (from the EU)	frozen beef (from Rest-of-World)	0.66	0.00	-0.66	-99.5	calculation 2)
EU	frozen beef (from the EU)	fresh beef, high quality (from the EU)	0.04	0.05	0.01	42.7	calculation 1)
EU	frozen beef (from the EU)	fresh beef, other quality (from the EU)	0.20	0.35	0.15	73.5	
EU	frozen beef (from the EU)	frozen beef (from the EU)	-0.66	-0.66	0.00	0.0	WFM
EU	frozen beef (from the EU)	other meat (from Argentina)	0.19	0.00	-0.19	-99.6	WFM 1)
EU	frozen beef (from the EU)	other meat (from Brazil)	0.19	0.00	-0.19	-98.3	WFM 1)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
EU	frozen beef (from the EU)	other meat (from Uruguay)	0.19	0.00	-0.19	-99.9	WFM 1)
EU	frozen beef (from the EU)	other meat (from Rest-of-World)	0.19	0.02	-0.17	-90.9	WFM 1)
EU	frozen beef (from the EU)	other meat (from the EU)	0.19	0.35	0.16	83.3	WFM 1)
EU	other meat (from Argentina)	fresh beef, high quality (from Argentina)	0.33	0.13	-0.21	-61.5	WFM 1)
EU	other meat (from Argentina)	frozen beef (from Argentina)	0.33	0.07	-0.26	-79.1	WFM 1)
EU	other meat (from Argentina)	fresh beef, high quality (from Brazil)	0.33	0.13	-0.20	-60.9	WFM 1)
EU	other meat (from Argentina)	frozen beef (from Brazil)	0.33	0.13	-0.20	-60.3	WFM 1)
EU	other meat (from Argentina)	fresh beef, high quality (from Uruguay)	0.33	0.11	-0.23	-67.7	WFM 1)
EU	other meat (from Argentina)	fresh beef, other quality (from Uruguay)	0.33	0.11	-0.23	-68.4	WFM 1)
EU	other meat (from Argentina)	frozen beef (from Uruguay)	0.33	0.09	-0.25	-74.5	WFM 1)
EU	other meat (from Argentina)	fresh beef, high quality (from Rest-of-World)	0.33	0.12	-0.22	-65.4	WFM 1)
EU	other meat (from Argentina)	fresh beef, other quality (from Rest-of-World)	0.33	0.14	-0.19	-57.7	WFM 1)
EU	other meat (from Argentina)	frozen beef (from Rest-of-World)	0.33	0.04	-0.29	-88.1	WFM 1)
EU	other meat (from Argentina)	fresh beef, high quality (from the EU)	0.33	0.13	-0.21	-61.4	WFM 1)
EU	other meat (from Argentina)	fresh beef, other quality (from the EU)	0.33	0.29	-0.04	-12.5	WFM 1)
EU	other meat (from Argentina)	frozen beef (from the EU)	0.33	0.13	-0.21	-61.3	WFM 1)
EU	other meat (from Argentina)	other meat (from Argentina)	-0.58	-0.58	0.00	0.0	WFM 1)
EU	other meat (from Argentina)	other meat (from Brazil)	0.20	0.00	-0.20	-97.9	
EU	other meat (from Argentina)	other meat (from Uruguay)	0.20	0.00	-0.20	-100.0	
EU	other meat (from Argentina)	other meat (from Rest-of-World)	0.20	0.00	-0.20	-99.3	
EU	other meat (from Argentina)	other meat (from the EU)	0.20	0.29	0.09	46.5	
EU	other meat (from Brazil)	fresh beef, high quality (from Argentina)	0.33	0.17	-0.16	-48.6	WFM 1)
EU	other meat (from Brazil)	frozen beef (from Argentina)	0.33	0.00	-0.33	-99.9	WFM 1)
EU	other meat (from Brazil)	fresh beef, high quality (from Brazil)	0.33	0.18	-0.16	-46.4	WFM 1)
EU	other meat (from Brazil)	frozen beef (from Brazil)	0.33	0.19	-0.15	-44.4	WFM 1)
EU	other meat (from Brazil)	fresh beef, high quality (from Uruguay)	0.33	0.09	-0.24	-72.2	WFM 1)
EU	other meat (from Brazil)	fresh beef, other quality (from Uruguay)	0.33	0.04	-0.30	-88.4	WFM 1)
EU	other meat (from Brazil)	frozen beef (from Uruguay)	0.33	0.02	-0.31	-92.8	WFM 1)
EU	other meat (from Brazil)	fresh beef, high quality (from Rest-of-World)	0.33	0.12	-0.21	-63.2	WFM 1)
EU	other meat (from Brazil)	fresh beef, other quality (from Rest-of-World)	0.33	0.09	-0.25	-73.6	WFM 1)
EU	other meat (from Brazil)	frozen beef (from Rest-of-World)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from Brazil)	fresh beef, high quality (from the EU)	0.33	0.17	-0.16	-48.0	WFM 1)
EU	other meat (from Brazil)	fresh beef, other quality (from the EU)	0.33	0.30	-0.04	-11.6	WFM 1)
EU	other meat (from Brazil)	frozen beef (from the EU)	0.33	0.18	-0.16	-47.7	WFM 1)
EU	other meat (from Brazil)	other meat (from Argentina)	0.20	0.00	-0.20	-99.4	
EU	other meat (from Brazil)	other meat (from Brazil)	-0.58	-0.58	0.00	0.0	WFM 1)
EU	other meat (from Brazil)	other meat (from Uruguay)	0.20	0.00	-0.20	-100.0	
EU	other meat (from Brazil)	other meat (from Rest-of-World)	0.20	0.06	-0.14	-70.4	
EU	other meat (from Brazil)	other meat (from the EU)	0.20	0.30	0.10	48.0	

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
EU	other meat (from Uruguay)	fresh beef, high quality (from Argentina)	0.33	0.11	-0.22	-65.7	WFM 1)
EU	other meat (from Uruguay)	frozen beef (from Argentina)	0.33	0.11	-0.23	-68.5	WFM 1)
EU	other meat (from Uruguay)	fresh beef, high quality (from Brazil)	0.33	0.12	-0.22	-65.6	WFM 1)
EU	other meat (from Uruguay)	frozen beef (from Brazil)	0.33	0.12	-0.22	-65.5	WFM 1)
EU	other meat (from Uruguay)	fresh beef, high quality (from Uruguay)	0.33	0.11	-0.22	-66.7	WFM 1)
EU	other meat (from Uruguay)	fresh beef, other quality (from Uruguay)	0.33	0.12	-0.22	-64.3	WFM 1)
EU	other meat (from Uruguay)	frozen beef (from Uruguay)	0.33	0.11	-0.23	-67.8	WFM 1)
EU	other meat (from Uruguay)	fresh beef, high quality (from Rest-of-World)	0.33	0.11	-0.22	-66.3	WFM 1)
EU	other meat (from Uruguay)	fresh beef, other quality (from Rest-of-World)	0.33	0.12	-0.21	-63.6	WFM 1)
EU	other meat (from Uruguay)	frozen beef (from Rest-of-World)	0.33	0.10	-0.23	-70.1	WFM 1)
EU	other meat (from Uruguay)	fresh beef, high quality (from the EU)	0.33	0.11	-0.22	-65.7	WFM 1)
EU	other meat (from Uruguay)	fresh beef, other quality (from the EU)	0.33	0.30	-0.04	-10.7	WFM 1)
EU	other meat (from Uruguay)	frozen beef (from the EU)	0.33	0.11	-0.22	-65.7	WFM 1)
EU	other meat (from Uruguay)	other meat (from Argentina)	0.20	0.00	-0.20	-100.0	
EU	other meat (from Uruguay)	other meat (from Brazil)	0.20	0.00	-0.20	-99.9	
EU	other meat (from Uruguay)	other meat (from Uruguay)	-0.58	-0.58	0.00	0.0	WFM 1)
EU	other meat (from Uruguay)	other meat (from Rest-of-World)	0.20	0.00	-0.20	-99.6	
EU	other meat (from Uruguay)	other meat (from the EU)	0.20	0.30	0.10	49.6	
EU	other meat (from Rest-of-World)	fresh beef, high quality (from Argentina)	0.33	0.22	-0.12	-35.7	WFM 1)
EU	other meat (from Rest-of-World)	frozen beef (from Argentina)	0.33	0.00	-0.33	-99.9	WFM 1)
EU	other meat (from Rest-of-World)	fresh beef, high quality (from Brazil)	0.33	0.25	-0.09	-25.9	WFM 1)
EU	other meat (from Rest-of-World)	frozen beef (from Brazil)	0.33	0.27	-0.07	-20.0	WFM 1)
EU	other meat (from Rest-of-World)	fresh beef, high quality (from Uruguay)	0.33	0.00	-0.33	-99.7	WFM 1)
EU	other meat (from Rest-of-World)	fresh beef, other quality (from Uruguay)	0.33	0.01	-0.33	-97.8	WFM 1)
EU	other meat (from Rest-of-World)	frozen beef (from Uruguay)	0.33	0.00	-0.33	-99.9	WFM 1)
EU	other meat (from Rest-of-World)	fresh beef, high quality (from Rest-of-World)	0.33	0.04	-0.29	-87.6	WFM 1)
EU	other meat (from Rest-of-World)	fresh beef, other quality (from Rest-of-World)	0.33	0.02	-0.31	-93.9	WFM 1)
EU	other meat (from Rest-of-World)	frozen beef (from Rest-of-World)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from Rest-of-World)	fresh beef, high quality (from the EU)	0.33	0.24	-0.09	-27.4	WFM 1)
EU	other meat (from Rest-of-World)	fresh beef, other quality (from the EU)	0.33	0.30	-0.03	-10.2	WFM 1)
EU	other meat (from Rest-of-World)	frozen beef (from the EU)	0.33	0.25	-0.09	-26.4	WFM 1)
EU	other meat (from Rest-of-World)	other meat (from Argentina)	0.20	0.00	-0.20	-99.9	
EU	other meat (from Rest-of-World)	other meat (from Brazil)	0.20	0.02	-0.18	-92.3	
EU	other meat (from Rest-of-World)	other meat (from Uruguay)	0.20	0.00	-0.20	-100.0	
EU	other meat (from Rest-of-World)	other meat (from Rest-of-World)	-0.58	-0.58	0.00	0.0	WFM 1)
EU	other meat (from Rest-of-World)	other meat (from the EU)	0.20	0.30	0.10	50.3	
EU	other meat (from the EU)	fresh beef, high quality (from Argentina)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	frozen beef (from Argentina)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	fresh beef, high quality (from Brazil)	0.33	0.00	-0.33	-99.6	WFM 1)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
EU	other meat (from the EU)	frozen beef (from Brazil)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	fresh beef, high quality (from Uruguay)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	fresh beef, other quality (from Uruguay)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	frozen beef (from Uruguay)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	fresh beef, high quality (from Rest-of-World)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	fresh beef, other quality (from Rest-of-World)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	frozen beef (from Rest-of-World)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	fresh beef, high quality (from the EU)	0.33	0.02	-0.31	-94.1	WFM 1)
EU	other meat (from the EU)	fresh beef, other quality (from the EU)	0.33	0.14	-0.20	-58.5	WFM 1)
EU	other meat (from the EU)	frozen beef (from the EU)	0.33	0.00	-0.33	-100.0	WFM 1)
EU	other meat (from the EU)	other meat (from Argentina)	0.20	0.00	-0.20	-100.0	
EU	other meat (from the EU)	other meat (from Brazil)	0.20	0.00	-0.20	-100.0	
EU	other meat (from the EU)	other meat (from Uruguay)	0.20	0.00	-0.20	-100.0	
EU	other meat (from the EU)	other meat (from Rest-of-World)	0.20	0.00	-0.20	-100.0	
EU	other meat (from the EU)	other meat (from the EU)	-0.58	-0.58	0.00	0.0	WFM 1)
Uruguay	fresh beef, high quality (from Brazil)	fresh beef, high quality (from Brazil)	-0.82	-0.82	0.00	0.0	Cap et al. (2007)
Uruguay	fresh beef, high quality (from Brazil)	fresh beef, high quality (from Uruguay)	0.82	0.86	0.04	5.3	calculation 3)
Uruguay	fresh beef, high quality (from Brazil)	fresh beef, other quality (from Uruguay)	0.05	0.49	0.44	839.9	calculation 1)
Uruguay	fresh beef, high quality (from Brazil)	other meat (from Brazil)	0.02	0.08	0.06	305.1	WFM 2)
Uruguay	fresh beef, high quality (from Brazil)	other meat (from Uruguay)	0.02	0.04	0.02	116.2	WFM 2)
Uruguay	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from Brazil)	0.82	0.05	-0.77	-94.5	calculation 3)
Uruguay	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from Uruguay)	-0.82	-0.82	0.00	0.0	Cap et al. (2007)
Uruguay	fresh beef, high quality (from Uruguay)	fresh beef, other quality (from Uruguay)	0.05	0.26	0.21	396.0	calculation 1)
Uruguay	fresh beef, high quality (from Uruguay)	other meat (from Brazil)	0.02	0.00	-0.02	-85.7	WFM 2)
Uruguay	fresh beef, high quality (from Uruguay)	other meat (from Uruguay)	0.02	0.10	0.08	383.2	WFM 2)
Uruguay	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Brazil)	0.04	0.00	-0.04	-100.0	calculation 3)
Uruguay	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Uruguay)	0.04	0.00	-0.04	-100.0	calculation 3)
Uruguay	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Uruguay)	-0.80	-0.80	0.00	0.0	Cap et al. (2007)a
Uruguay	fresh beef, other quality (from Uruguay)	other meat (from Brazil)	0.02	0.00	-0.02	-100.0	WFM 2)
Uruguay	fresh beef, other quality (from Uruguay)	other meat (from Uruguay)	0.02	0.00	-0.02	-100.0	WFM 2)
Uruguay	other meat (from Brazil)	fresh beef, high quality (from Brazil)	0.22	0.19	-0.03	-11.9	WFM 2)
Uruguay	other meat (from Brazil)	fresh beef, high quality (from Uruguay)	0.22	0.22	0.00	0.2	WFM 2)
Uruguay	other meat (from Brazil)	fresh beef, other quality (from Uruguay)	0.22	0.59	0.38	171.0	WFM 2)
Uruguay	other meat (from Brazil)	other meat (from Brazil)	-0.63	-0.63	0.00	0.0	WFM 2)
Uruguay	other meat (from Brazil)	other meat (from Uruguay)	0.20	0.21	0.01	2.8	
Uruguay	other meat (from Uruguay)	fresh beef, high quality (from Brazil)	0.22	0.00	-0.22	-99.5	WFM 2)
Uruguay	other meat (from Uruguay)	fresh beef, high quality (from Uruguay)	0.22	0.15	-0.07	-29.7	WFM 2)
Uruguay	other meat (from Uruguay)	fresh beef, other quality (from Uruguay)	0.22	0.39	0.17	79.7	WFM 2)
Uruguay	other meat (from Uruguay)	other meat (from Brazil)	0.20	0.00	-0.20	-97.8	

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Uruguay	other meat (from Uruguay)	other meat (from Uruguay)	-0.63	-0.63	0.00	0.0	WFM 2)
Argentina	fresh beef, high quality (from Argentina)	fresh beef, high quality (from Argentina)	-0.36	-0.36	0.00	0.0	Cap et al. (2007)b
Argentina	fresh beef, high quality (from Argentina)	fresh beef, other quality (from Argentina)	0.02	0.35	0.32	1401.1	Cap et al. (2007)d
Argentina	fresh beef, high quality (from Argentina)	fresh beef, other quality (from Uruguay)	0.02	0.00	-0.02	-100.0	Cap et al. (2007)d
Argentina	fresh beef, high quality (from Argentina)	other meat (from Argentina)	0.02	0.10	0.08	351.1	WFM 1)
Argentina	fresh beef, high quality (from Argentina)	other meat (from Brazil)	0.02	0.00	-0.02	-86.9	WFM 1)
Argentina	fresh beef, high quality (from Argentina)	other meat (from Rest-of-World)	0.02	0.00	-0.02	-94.8	WFM 1)
Argentina	fresh beef, other quality (from Argentina)	fresh beef, high quality (from Argentina)	0.02	0.00	-0.02	-100.0	Cap et al. (2007)e
Argentina	fresh beef, other quality (from Argentina)	fresh beef, other quality (from Argentina)	-0.37	-0.37	0.00	0.0	Cap et al. (2007)c
Argentina	fresh beef, other quality (from Argentina)	fresh beef, other quality (from Uruguay)	0.37	0.00	-0.37	-100.0	Calculation 4)
Argentina	fresh beef, other quality (from Argentina)	other meat (from Argentina)	0.02	0.02	0.00	11.3	WFM 1)
Argentina	fresh beef, other quality (from Argentina)	other meat (from Brazil)	0.02	0.00	-0.02	-100.0	WFM 1)
Argentina	fresh beef, other quality (from Argentina)	other meat (from Rest-of-World)	0.02	0.00	-0.02	-100.0	WFM 1)
Argentina	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Argentina)	0.02	0.02	0.00	3.4	Cap et al. (2007)e
Argentina	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Argentina)	0.37	0.52	0.15	41.2	Calculation 4)
Argentina	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Uruguay)	-0.50	-0.50	0.00	0.0	
Argentina	fresh beef, other quality (from Uruguay)	other meat (from Argentina)	0.02	0.11	0.09	420.0	WFM 1)
Argentina	fresh beef, other quality (from Uruguay)	other meat (from Brazil)	0.02	0.14	0.12	533.7	WFM 1)
Argentina	fresh beef, other quality (from Uruguay)	other meat (from Rest-of-World)	0.02	0.11	0.09	392.5	WFM 1)
Argentina	other meat (from Argentina)	fresh beef, high quality (from Argentina)	0.26	0.01	-0.25	-94.5	calculation 1)
Argentina	other meat (from Argentina)	fresh beef, other quality (from Argentina)	0.26	0.26	0.00	-0.3	calculation 1)
Argentina	other meat (from Argentina)	fresh beef, other quality (from Uruguay)	0.26	0.00	-0.26	-100.0	calculation 1)
Argentina	other meat (from Argentina)	other meat (from Argentina)	-0.25	-0.25	0.00	0.0	calculation 1)
Argentina	other meat (from Argentina)	other meat (from Brazil)	0.20	0.00	-0.20	-99.8	
Argentina	other meat (from Argentina)	other meat (from Rest-of-World)	0.20	0.00	-0.20	-99.9	
Argentina	other meat (from Brazil)	fresh beef, high quality (from Argentina)	0.26	0.26	0.00	0.1	calculation 1)
Argentina	other meat (from Brazil)	fresh beef, other quality (from Argentina)	0.26	0.42	0.16	62.4	calculation 1)
Argentina	other meat (from Brazil)	fresh beef, other quality (from Uruguay)	0.26	0.11	-0.15	-57.7	calculation 1)
Argentina	other meat (from Brazil)	other meat (from Argentina)	0.20	0.20	0.00	0.4	
Argentina	other meat (from Brazil)	other meat (from Brazil)	-0.25	-0.25	0.00	0.0	calculation 1)
Argentina	other meat (from Brazil)	other meat (from Rest-of-World)	0.20	0.10	-0.10	-52.3	
Argentina	other meat (from Rest-of-World)	fresh beef, high quality (from Argentina)	0.26	0.26	0.00	0.0	calculation 1)
Argentina	other meat (from Rest-of-World)	fresh beef, other quality (from Argentina)	0.26	0.42	0.16	62.9	calculation 1)
Argentina	other meat (from Rest-of-World)	fresh beef, other quality (from Uruguay)	0.26	0.22	-0.04	-16.8	calculation 1)
Argentina	other meat (from Rest-of-World)	other meat (from Argentina)	0.20	0.20	0.00	0.1	
Argentina	other meat (from Rest-of-World)	other meat (from Brazil)	0.20	0.24	0.04	20.7	
Argentina	other meat (from Rest-of-World)	other meat (from Rest-of-World)	-0.25	-0.25	0.00	0.0	calculation 1)
Brazil	fresh beef, high quality (from Argentina)	fresh beef, high quality (from Argentina)	-1.03	-1.03	0.00	0.0	-calculation 4)
Brazil	fresh beef, high quality (from Argentina)	fresh beef, other quality (from Argentina)	0.07	0.01	-0.05	-79.5	calculation 3)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Brazil	fresh beef, high quality (from Argentina)	frozen beef (from Argentina)	0.07	0.00	-0.06	-92.6	calculation 3)
Brazil	fresh beef, high quality (from Argentina)	fresh beef, high quality (from Brazil)	1.03	0.89	-0.14	-13.9	calculation 4)
Brazil	fresh beef, high quality (from Argentina)	fresh beef, other quality (from Brazil)	0.07	0.28	0.21	315.8	calculation 3)
Brazil	fresh beef, high quality (from Argentina)	fresh beef, high quality (from Uruguay)	1.03	0.67	-0.36	-34.9	calculation 4)
Brazil	fresh beef, high quality (from Argentina)	fresh beef, other quality (from Uruguay)	0.07	0.01	-0.06	-86.6	calculation 3)
Brazil	fresh beef, high quality (from Argentina)	frozen beef (from Uruguay)	0.07	0.01	-0.06	-91.8	calculation 3)
Brazil	fresh beef, high quality (from Argentina)	other meat (from Brazil)	0.03	0.04	0.01	27.3	0.03
Brazil	fresh beef, high quality (from Argentina)	other meat (from Uruguay)	0.03	0.02	-0.01	-47.8	0.03
Brazil	fresh beef, other quality (from Argentina)	fresh beef, high quality (from Argentina)	0.05	0.01	-0.04	-76.8	calculation 3)
Brazil	fresh beef, other quality (from Argentina)	fresh beef, other quality (from Argentina)	-0.50	-0.50	0.00	0.0	
Brazil	fresh beef, other quality (from Argentina)	frozen beef (from Argentina)	0.20	0.10	-0.10	-49.2	
Brazil	fresh beef, other quality (from Argentina)	fresh beef, high quality (from Brazil)	0.05	0.04	-0.01	-21.8	calculation 3)
Brazil	fresh beef, other quality (from Argentina)	fresh beef, other quality (from Brazil)	1.03	1.02	-0.01	-1.1	calculation 4)
Brazil	fresh beef, other quality (from Argentina)	fresh beef, high quality (from Uruguay)	0.05	0.01	-0.05	-82.6	calculation 3)
Brazil	fresh beef, other quality (from Argentina)	fresh beef, other quality (from Uruguay)	1.03	0.69	-0.34	-33.2	calculation 4)
Brazil	fresh beef, other quality (from Argentina)	frozen beef (from Uruguay)	0.20	0.09	-0.11	-55.2	
Brazil	fresh beef, other quality (from Argentina)	other meat (from Brazil)	0.03	0.07	0.04	139.6	0.03
Brazil	fresh beef, other quality (from Argentina)	other meat (from Uruguay)	0.03	0.02	-0.01	-25.4	0.03
Brazil	frozen beef (from Argentina)	fresh beef, high quality (from Argentina)	0.05	0.01	-0.04	-80.7	calculation 3)
Brazil	frozen beef (from Argentina)	fresh beef, other quality (from Argentina)	0.20	0.24	0.04	18.3	
Brazil	frozen beef (from Argentina)	frozen beef (from Argentina)	-1.03	-1.03	0.00	0.0	-calculation 4)
Brazil	frozen beef (from Argentina)	fresh beef, high quality (from Brazil)	0.05	0.06	0.00	1.0	calculation 3)
Brazil	frozen beef (from Argentina)	fresh beef, other quality (from Brazil)	0.20	0.34	0.14	71.0	
Brazil	frozen beef (from Argentina)	fresh beef, high quality (from Uruguay)	0.05	0.01	-0.05	-82.4	calculation 3)
Brazil	frozen beef (from Argentina)	fresh beef, other quality (from Uruguay)	0.20	0.13	-0.07	-35.5	
Brazil	frozen beef (from Argentina)	frozen beef (from Uruguay)	1.03	0.96	-0.07	-6.7	calculation 4)
Brazil	frozen beef (from Argentina)	other meat (from Brazil)	0.03	0.05	0.02	76.8	0.03
Brazil	frozen beef (from Argentina)	other meat (from Uruguay)	0.03	0.05	0.02	59.3	0.03
Brazil	fresh beef, high quality (from Brazil)	fresh beef, high quality (from Argentina)	1.03	0.02	-1.02	-98.5	calculation 4)
Brazil	fresh beef, high quality (from Brazil)	fresh beef, other quality (from Argentina)	0.07	0.00	-0.07	-99.1	calculation 3)
Brazil	fresh beef, high quality (from Brazil)	frozen beef (from Argentina)	0.07	0.00	-0.07	-99.4	calculation 3)
Brazil	fresh beef, high quality (from Brazil)	fresh beef, high quality (from Brazil)	-1.03	-1.03	0.00	0.0	-calculation 4)
Brazil	fresh beef, high quality (from Brazil)	fresh beef, other quality (from Brazil)	0.07	0.29	0.23	339.5	calculation 3)
Brazil	fresh beef, high quality (from Brazil)	fresh beef, high quality (from Uruguay)	1.03	0.01	-1.02	-99.0	calculation 4)
Brazil	fresh beef, high quality (from Brazil)	fresh beef, other quality (from Uruguay)	0.07	0.00	-0.07	-99.8	calculation 3)
Brazil	fresh beef, high quality (from Brazil)	frozen beef (from Uruguay)	0.07	0.00	-0.07	-99.5	calculation 3)
Brazil	fresh beef, high quality (from Brazil)	other meat (from Brazil)	0.03	0.06	0.03	88.3	0.03
Brazil	fresh beef, high quality (from Brazil)	other meat (from Uruguay)	0.03	0.00	-0.03	-98.7	0.03
Brazil	fresh beef, other quality (from Brazil)	fresh beef, high quality (from Argentina)	0.05	0.00	-0.05	-99.8	calculation 3)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Brazil	fresh beef, other quality (from Brazil)	fresh beef, other quality (from Argentina)	1.03	0.00	-1.03	-99.9	calculation 4)
Brazil	fresh beef, other quality (from Brazil)	frozen beef (from Argentina)	0.20	0.00	-0.20	-100.0	
Brazil	fresh beef, other quality (from Brazil)	fresh beef, high quality (from Brazil)	0.05	0.01	-0.05	-85.0	calculation 3)
Brazil	fresh beef, other quality (from Brazil)	fresh beef, other quality (from Brazil)	-1.03	-1.03	0.00	0.0	-calculation 4)
Brazil	fresh beef, other quality (from Brazil)	fresh beef, high quality (from Uruguay)	0.05	0.00	-0.05	-99.9	calculation 3)
Brazil	fresh beef, other quality (from Brazil)	fresh beef, other quality (from Uruguay)	1.03	0.00	-1.03	-100.0	calculation 4)
Brazil	fresh beef, other quality (from Brazil)	frozen beef (from Uruguay)	0.20	0.00	-0.20	-100.0	
Brazil	fresh beef, other quality (from Brazil)	other meat (from Brazil)	0.03	0.03	0.00	3.4	0.03
Brazil	fresh beef, other quality (from Brazil)	other meat (from Uruguay)	0.03	0.00	-0.03	-99.9	0.03
Brazil	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from Argentina)	1.03	0.86	-0.17	-16.5	calculation 4)
Brazil	fresh beef, high quality (from Uruguay)	fresh beef, other quality (from Argentina)	0.07	0.01	-0.05	-80.3	calculation 3)
Brazil	fresh beef, high quality (from Uruguay)	frozen beef (from Argentina)	0.07	0.01	-0.06	-91.4	calculation 3)
Brazil	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from Brazil)	1.03	0.72	-0.31	-30.1	calculation 4)
Brazil	fresh beef, high quality (from Uruguay)	fresh beef, other quality (from Brazil)	0.07	0.26	0.19	290.9	calculation 3)
Brazil	fresh beef, high quality (from Uruguay)	fresh beef, high quality (from Uruguay)	-1.03	-1.03	0.00	0.0	-calculation 4)
Brazil	fresh beef, high quality (from Uruguay)	fresh beef, other quality (from Uruguay)	0.07	0.01	-0.06	-85.8	calculation 3)
Brazil	fresh beef, high quality (from Uruguay)	frozen beef (from Uruguay)	0.07	0.00	-0.06	-92.6	calculation 3)
Brazil	fresh beef, high quality (from Uruguay)	other meat (from Brazil)	0.03	0.03	0.00	14.8	0.03
Brazil	fresh beef, high quality (from Uruguay)	other meat (from Uruguay)	0.03	0.00	-0.03	-91.1	0.03
Brazil	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Argentina)	0.05	0.01	-0.04	-77.3	calculation 3)
Brazil	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Argentina)	1.03	1.03	-0.01	-0.7	calculation 4)
Brazil	fresh beef, other quality (from Uruguay)	frozen beef (from Argentina)	0.20	0.08	-0.12	-58.8	
Brazil	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Brazil)	0.05	0.03	-0.02	-43.4	calculation 3)
Brazil	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Brazil)	1.03	0.81	-0.23	-22.0	calculation 4)
Brazil	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Uruguay)	0.05	0.01	-0.04	-81.2	calculation 3)
Brazil	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Uruguay)	-0.50	-0.50	0.00	0.0	
Brazil	fresh beef, other quality (from Uruguay)	frozen beef (from Uruguay)	0.20	0.08	-0.12	-60.7	
Brazil	fresh beef, other quality (from Uruguay)	other meat (from Brazil)	0.03	0.09	0.06	198.9	0.03
Brazil	fresh beef, other quality (from Uruguay)	other meat (from Uruguay)	0.03	0.01	-0.02	-66.5	0.03
Brazil	frozen beef (from Uruguay)	fresh beef, high quality (from Argentina)	0.05	0.01	-0.04	-75.6	calculation 3)
Brazil	frozen beef (from Uruguay)	fresh beef, other quality (from Argentina)	0.20	0.24	0.04	18.4	
Brazil	frozen beef (from Uruguay)	frozen beef (from Argentina)	1.03	1.09	0.06	5.9	calculation 4)
Brazil	frozen beef (from Uruguay)	fresh beef, high quality (from Brazil)	0.05	0.06	0.00	0.9	calculation 3)
Brazil	frozen beef (from Uruguay)	fresh beef, other quality (from Brazil)	0.20	0.34	0.14	71.0	
Brazil	frozen beef (from Uruguay)	fresh beef, high quality (from Uruguay)	0.05	0.01	-0.05	-82.8	calculation 3)
Brazil	frozen beef (from Uruguay)	fresh beef, other quality (from Uruguay)	0.20	0.14	-0.06	-30.2	
Brazil	frozen beef (from Uruguay)	frozen beef (from Uruguay)	-1.03	-1.03	0.00	0.0	-calculation 4)
Brazil	frozen beef (from Uruguay)	other meat (from Brazil)	0.03	0.05	0.02	76.9	0.03
Brazil	frozen beef (from Uruguay)	other meat (from Uruguay)	0.03	0.05	0.02	73.2	0.03

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Brazil	other meat (from Brazil)	fresh beef, high quality (from Argentina)	0.10	0.00	-0.10	-99.7	WFM 1)
Brazil	other meat (from Brazil)	fresh beef, other quality (from Argentina)	0.10	0.00	-0.10	-99.7	WFM 1)
Brazil	other meat (from Brazil)	frozen beef (from Argentina)	0.10	0.00	-0.10	-99.9	WFM 1)
Brazil	other meat (from Brazil)	fresh beef, high quality (from Brazil)	0.10	0.02	-0.08	-75.5	WFM 1)
Brazil	other meat (from Brazil)	fresh beef, other quality (from Brazil)	0.10	0.38	0.28	284.2	WFM 1)
Brazil	other meat (from Brazil)	fresh beef, high quality (from Uruguay)	0.10	0.00	-0.10	-99.8	WFM 1)
Brazil	other meat (from Brazil)	fresh beef, other quality (from Uruguay)	0.10	0.00	-0.10	-99.8	WFM 1)
Brazil	other meat (from Brazil)	frozen beef (from Uruguay)	0.10	0.00	-0.10	-99.9	WFM 1)
Brazil	other meat (from Brazil)	other meat (from Brazil)	-0.84	-0.84	0.00	0.0	WFM 1)
Brazil	other meat (from Brazil)	other meat (from Uruguay)	0.20	0.00	-0.20	-99.9	
Brazil	other meat (from Uruguay)	fresh beef, high quality (from Argentina)	0.10	0.06	-0.04	-36.3	WFM 1)
Brazil	other meat (from Uruguay)	fresh beef, other quality (from Argentina)	0.10	0.10	0.00	-1.3	WFM 1)
Brazil	other meat (from Uruguay)	frozen beef (from Argentina)	0.10	0.09	-0.01	-9.4	WFM 1)
Brazil	other meat (from Uruguay)	fresh beef, high quality (from Brazil)	0.10	0.10	0.00	0.1	WFM 1)
Brazil	other meat (from Uruguay)	fresh beef, other quality (from Brazil)	0.10	0.41	0.31	306.5	WFM 1)
Brazil	other meat (from Uruguay)	fresh beef, high quality (from Uruguay)	0.10	0.01	-0.09	-91.4	WFM 1)
Brazil	other meat (from Uruguay)	fresh beef, other quality (from Uruguay)	0.10	0.03	-0.07	-70.3	WFM 1)
Brazil	other meat (from Uruguay)	frozen beef (from Uruguay)	0.10	0.09	-0.01	-13.1	WFM 1)
Brazil	other meat (from Uruguay)	other meat (from Brazil)	0.20	0.20	0.00	0.2	
Brazil	other meat (from Uruguay)	other meat (from Uruguay)	-0.84	-0.84	0.00	0.0	WFM 1)
Rest-of-World	fresh beef, other quality (from Argentina)	fresh beef, other quality (from Argentina)	-0.70	-0.70	0.00	0.0	
Rest-of-World	fresh beef, other quality (from Argentina)	frozen beef (from Argentina)	0.20	0.00	-0.20	-98.0	
Rest-of-World	fresh beef, other quality (from Argentina)	fresh beef, other quality (from Brazil)	0.70	0.34	-0.36	-51.7	
Rest-of-World	fresh beef, other quality (from Argentina)	frozen beef (from Brazil)	0.20	0.01	-0.19	-93.5	
Rest-of-World	fresh beef, other quality (from Argentina)	fresh beef, other quality (from Uruguay)	0.70	0.05	-0.65	-93.5	
Rest-of-World	fresh beef, other quality (from Argentina)	frozen beef (from Uruguay)	0.20	0.00	-0.20	-97.8	
Rest-of-World	fresh beef, other quality (from Argentina)	fresh beef, high quality (from Rest-of-World)	0.20	0.07	-0.13	-65.9	
Rest-of-World	fresh beef, other quality (from Argentina)	fresh beef, other quality (from Rest-of-World)	0.70	0.54	-0.16	-23.2	
Rest-of-World	fresh beef, other quality (from Argentina)	frozen beef (from Rest-of-World)	0.20	0.01	-0.19	-96.2	
Rest-of-World	fresh beef, other quality (from Argentina)	fresh beef, high quality (from the EU)	0.20	0.03	-0.17	-83.1	
Rest-of-World	fresh beef, other quality (from Argentina)	fresh beef, other quality (from the EU)	0.70	0.53	-0.17	-24.8	
Rest-of-World	fresh beef, other quality (from Argentina)	frozen beef (from the EU)	0.20	0.00	-0.20	-99.2	
Rest-of-World	fresh beef, other quality (from Argentina)	other meat (from Argentina)	0.15	0.03	-0.12	-83.1	WFM 1)
Rest-of-World	fresh beef, other quality (from Argentina)	other meat (from Brazil)	0.15	0.00	-0.15	-98.7	WFM 1)
Rest-of-World	fresh beef, other quality (from Argentina)	other meat (from Uruguay)	0.15	0.00	-0.15	-99.2	WFM 1)
Rest-of-World	fresh beef, other quality (from Argentina)	other meat (from Rest-of-World)	0.15	0.38	0.23	155.7	WFM 1)
Rest-of-World	fresh beef, other quality (from Argentina)	other meat (from the EU)	0.15	0.00	-0.15	-96.8	WFM 1)
Rest-of-World	frozen beef (from Argentina)	fresh beef, other quality (from Argentina)	0.20	0.00	-0.20	-99.8	
Rest-of-World	frozen beef (from Argentina)	frozen beef (from Argentina)	-0.70	-0.70	0.00	0.0	

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Rest-of-World	frozen beef (from Argentina)	fresh beef, other quality (from Brazil)	0.20	0.00	-0.20	-99.8	
Rest-of-World	frozen beef (from Argentina)	frozen beef (from Brazil)	0.70	0.40	-0.30	-43.1	
Rest-of-World	frozen beef (from Argentina)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	frozen beef (from Argentina)	frozen beef (from Uruguay)	0.70	0.24	-0.46	-66.3	
Rest-of-World	frozen beef (from Argentina)	fresh beef, high quality (from Rest-of-World)	0.20	0.05	-0.15	-77.0	
Rest-of-World	frozen beef (from Argentina)	fresh beef, other quality (from Rest-of-World)	0.20	0.40	0.20	99.6	
Rest-of-World	frozen beef (from Argentina)	frozen beef (from Rest-of-World)	0.70	0.31	-0.39	-55.9	
Rest-of-World	frozen beef (from Argentina)	fresh beef, high quality (from the EU)	0.20	0.02	-0.18	-91.2	
Rest-of-World	frozen beef (from Argentina)	fresh beef, other quality (from the EU)	0.20	0.00	-0.20	-99.7	
Rest-of-World	frozen beef (from Argentina)	frozen beef (from the EU)	0.70	0.10	-0.60	-85.4	
Rest-of-World	frozen beef (from Argentina)	other meat (from Argentina)	0.15	0.01	-0.14	-95.8	WFM 1)
Rest-of-World	frozen beef (from Argentina)	other meat (from Brazil)	0.15	0.03	-0.12	-80.5	WFM 1)
Rest-of-World	frozen beef (from Argentina)	other meat (from Uruguay)	0.15	0.00	-0.15	-99.8	WFM 1)
Rest-of-World	frozen beef (from Argentina)	other meat (from Rest-of-World)	0.15	0.28	0.13	90.0	WFM 1)
Rest-of-World	frozen beef (from Argentina)	other meat (from the EU)	0.15	0.00	-0.15	-98.0	WFM 1)
Rest-of-World	fresh beef, other quality (from Brazil)	fresh beef, other quality (from Argentina)	0.70	0.42	-0.28	-40.1	
Rest-of-World	fresh beef, other quality (from Brazil)	frozen beef (from Argentina)	0.20	0.00	-0.20	-98.1	
Rest-of-World	fresh beef, other quality (from Brazil)	fresh beef, other quality (from Brazil)	-0.70	-0.70	0.00	0.0	
Rest-of-World	fresh beef, other quality (from Brazil)	frozen beef (from Brazil)	0.20	0.01	-0.19	-93.7	
Rest-of-World	fresh beef, other quality (from Brazil)	fresh beef, other quality (from Uruguay)	0.70	0.06	-0.64	-92.0	
Rest-of-World	fresh beef, other quality (from Brazil)	frozen beef (from Uruguay)	0.20	0.00	-0.20	-97.9	
Rest-of-World	fresh beef, other quality (from Brazil)	fresh beef, high quality (from Rest-of-World)	0.20	0.07	-0.13	-66.9	
Rest-of-World	fresh beef, other quality (from Brazil)	fresh beef, other quality (from Rest-of-World)	0.70	0.53	-0.17	-25.0	
Rest-of-World	fresh beef, other quality (from Brazil)	frozen beef (from Rest-of-World)	0.20	0.01	-0.19	-96.3	
Rest-of-World	fresh beef, other quality (from Brazil)	fresh beef, high quality (from the EU)	0.20	0.00	-0.20	-99.6	
Rest-of-World	fresh beef, other quality (from Brazil)	fresh beef, other quality (from the EU)	0.70	0.49	-0.21	-30.2	
Rest-of-World	fresh beef, other quality (from Brazil)	frozen beef (from the EU)	0.20	0.00	-0.20	-99.3	
Rest-of-World	fresh beef, other quality (from Brazil)	other meat (from Argentina)	0.15	0.02	-0.13	-88.7	WFM 1)
Rest-of-World	fresh beef, other quality (from Brazil)	other meat (from Brazil)	0.15	0.00	-0.15	-98.7	WFM 1)
Rest-of-World	fresh beef, other quality (from Brazil)	other meat (from Uruguay)	0.15	0.00	-0.15	-99.0	WFM 1)
Rest-of-World	fresh beef, other quality (from Brazil)	other meat (from Rest-of-World)	0.15	0.37	0.22	149.9	WFM 1)
Rest-of-World	fresh beef, other quality (from Brazil)	other meat (from the EU)	0.15	0.00	-0.15	-96.9	WFM 1)
Rest-of-World	frozen beef (from Brazil)	fresh beef, other quality (from Argentina)	0.20	0.00	-0.20	-99.7	
Rest-of-World	frozen beef (from Brazil)	frozen beef (from Argentina)	0.70	0.12	-0.58	-82.6	
Rest-of-World	frozen beef (from Brazil)	fresh beef, other quality (from Brazil)	0.20	0.00	-0.20	-99.8	
Rest-of-World	frozen beef (from Brazil)	frozen beef (from Brazil)	-0.70	-0.70	0.00	0.0	
Rest-of-World	frozen beef (from Brazil)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	frozen beef (from Brazil)	frozen beef (from Uruguay)	0.70	0.14	-0.56	-79.7	
Rest-of-World	frozen beef (from Brazil)	fresh beef, high quality (from Rest-of-World)	0.20	0.23	0.03	16.5	

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Rest-of-World	frozen beef (from Brazil)	fresh beef, other quality (from Rest-of-World)	0.20	0.44	0.24	117.5	
Rest-of-World	frozen beef (from Brazil)	frozen beef (from Rest-of-World)	0.70	0.32	-0.38	-53.9	
Rest-of-World	frozen beef (from Brazil)	fresh beef, high quality (from the EU)	0.20	0.01	-0.19	-95.1	
Rest-of-World	frozen beef (from Brazil)	fresh beef, other quality (from the EU)	0.20	0.00	-0.20	-98.5	
Rest-of-World	frozen beef (from Brazil)	frozen beef (from the EU)	0.70	0.04	-0.66	-95.0	
Rest-of-World	frozen beef (from Brazil)	other meat (from Argentina)	0.15	0.00	-0.15	-98.5	WFM 1)
Rest-of-World	frozen beef (from Brazil)	other meat (from Brazil)	0.15	0.04	-0.11	-73.2	WFM 1)
Rest-of-World	frozen beef (from Brazil)	other meat (from Uruguay)	0.15	0.00	-0.15	-100.0	WFM 1)
Rest-of-World	frozen beef (from Brazil)	other meat (from Rest-of-World)	0.15	0.31	0.16	107.0	WFM 1)
Rest-of-World	frozen beef (from Brazil)	other meat (from the EU)	0.15	0.12	-0.03	-21.6	WFM 1)
Rest-of-World	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Argentina)	0.70	0.33	-0.37	-52.5	
Rest-of-World	fresh beef, other quality (from Uruguay)	frozen beef (from Argentina)	0.20	0.00	-0.20	-98.1	
Rest-of-World	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Brazil)	0.70	0.33	-0.37	-52.8	
Rest-of-World	fresh beef, other quality (from Uruguay)	frozen beef (from Brazil)	0.20	0.01	-0.19	-93.8	
Rest-of-World	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Uruguay)	-0.70	-0.70	0.00	0.0	
Rest-of-World	fresh beef, other quality (from Uruguay)	frozen beef (from Uruguay)	0.20	0.00	-0.20	-97.9	
Rest-of-World	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from Rest-of-World)	0.20	0.07	-0.13	-67.4	
Rest-of-World	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from Rest-of-World)	0.70	0.52	-0.18	-25.9	
Rest-of-World	fresh beef, other quality (from Uruguay)	frozen beef (from Rest-of-World)	0.20	0.01	-0.19	-96.4	
Rest-of-World	fresh beef, other quality (from Uruguay)	fresh beef, high quality (from the EU)	0.20	0.00	-0.20	-99.6	
Rest-of-World	fresh beef, other quality (from Uruguay)	fresh beef, other quality (from the EU)	0.70	0.33	-0.37	-52.8	
Rest-of-World	fresh beef, other quality (from Uruguay)	frozen beef (from the EU)	0.20	0.00	-0.20	-99.3	
Rest-of-World	fresh beef, other quality (from Uruguay)	other meat (from Argentina)	0.15	0.00	-0.15	-99.9	WFM 1)
Rest-of-World	fresh beef, other quality (from Uruguay)	other meat (from Brazil)	0.15	0.00	-0.15	-98.7	WFM 1)
Rest-of-World	fresh beef, other quality (from Uruguay)	other meat (from Uruguay)	0.15	0.01	-0.14	-95.0	WFM 1)
Rest-of-World	fresh beef, other quality (from Uruguay)	other meat (from Rest-of-World)	0.15	0.37	0.22	146.7	WFM 1)
Rest-of-World	fresh beef, other quality (from Uruguay)	other meat (from the EU)	0.15	0.00	-0.15	-97.0	WFM 1)
Rest-of-World	frozen beef (from Uruguay)	fresh beef, other quality (from Argentina)	0.20	0.00	-0.20	-99.8	
Rest-of-World	frozen beef (from Uruguay)	frozen beef (from Argentina)	0.70	0.21	-0.49	-69.5	
Rest-of-World	frozen beef (from Uruguay)	fresh beef, other quality (from Brazil)	0.20	0.00	-0.20	-99.8	
Rest-of-World	frozen beef (from Uruguay)	frozen beef (from Brazil)	0.70	0.42	-0.28	-40.2	
Rest-of-World	frozen beef (from Uruguay)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	frozen beef (from Uruguay)	frozen beef (from Uruguay)	-0.70	-0.70	0.00	0.0	
Rest-of-World	frozen beef (from Uruguay)	fresh beef, high quality (from Rest-of-World)	0.20	0.05	-0.15	-77.1	
Rest-of-World	frozen beef (from Uruguay)	fresh beef, other quality (from Rest-of-World)	0.20	0.40	0.20	99.4	
Rest-of-World	frozen beef (from Uruguay)	frozen beef (from Rest-of-World)	0.70	0.31	-0.39	-55.0	
Rest-of-World	frozen beef (from Uruguay)	fresh beef, high quality (from the EU)	0.20	0.02	-0.18	-91.4	
Rest-of-World	frozen beef (from Uruguay)	fresh beef, other quality (from the EU)	0.20	0.00	-0.20	-99.7	
Rest-of-World	frozen beef (from Uruguay)	frozen beef (from the EU)	0.70	0.09	-0.61	-86.7	

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Rest-of-World	frozen beef (from Uruguay)	other meat (from Argentina)	0.15	0.01	-0.14	-96.1	WFM 1)
Rest-of-World	frozen beef (from Uruguay)	other meat (from Brazil)	0.15	0.04	-0.11	-76.6	WFM 1)
Rest-of-World	frozen beef (from Uruguay)	other meat (from Uruguay)	0.15	0.00	-0.15	-99.9	WFM 1)
Rest-of-World	frozen beef (from Uruguay)	other meat (from Rest-of-World)	0.15	0.28	0.13	89.7	WFM 1)
Rest-of-World	frozen beef (from Uruguay)	other meat (from the EU)	0.15	0.00	-0.15	-98.0	WFM 1)
Rest-of-World	fresh beef, high quality (from Rest-of-World)	fresh beef, other quality (from Argentina)	0.20	0.00	-0.20	-99.9	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	frozen beef (from Argentina)	0.20	0.00	-0.20	-99.5	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	fresh beef, other quality (from Brazil)	0.20	0.00	-0.20	-99.9	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	frozen beef (from Brazil)	0.20	0.04	-0.16	-79.5	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	frozen beef (from Uruguay)	0.20	0.00	-0.20	-99.4	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	fresh beef, high quality (from Rest-of-World)	-0.70	-0.70	0.00	0.0	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	fresh beef, other quality (from Rest-of-World)	0.20	0.21	0.01	7.1	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	frozen beef (from Rest-of-World)	0.20	0.00	-0.20	-99.0	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	fresh beef, high quality (from the EU)	0.20	0.00	-0.20	-99.3	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	fresh beef, other quality (from the EU)	0.20	0.00	-0.20	-99.9	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	frozen beef (from the EU)	0.20	0.00	-0.20	-99.8	
Rest-of-World	fresh beef, high quality (from Rest-of-World)	other meat (from Argentina)	0.15	0.00	-0.15	-99.8	WFM 1)
Rest-of-World	fresh beef, high quality (from Rest-of-World)	other meat (from Brazil)	0.15	0.01	-0.14	-95.6	WFM 1)
Rest-of-World	fresh beef, high quality (from Rest-of-World)	other meat (from Uruguay)	0.15	0.00	-0.15	-100.0	WFM 1)
Rest-of-World	fresh beef, high quality (from Rest-of-World)	other meat (from Rest-of-World)	0.15	0.22	0.07	44.7	WFM 1)
Rest-of-World	fresh beef, high quality (from Rest-of-World)	other meat (from the EU)	0.15	0.02	-0.13	-86.0	WFM 1)
Rest-of-World	fresh beef, other quality (from Rest-of-World)	fresh beef, other quality (from Argentina)	0.70	0.00	-0.70	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	frozen beef (from Argentina)	0.20	0.00	-0.20	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	fresh beef, other quality (from Brazil)	0.70	0.00	-0.70	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	frozen beef (from Brazil)	0.20	0.00	-0.20	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	fresh beef, other quality (from Uruguay)	0.70	0.00	-0.70	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	frozen beef (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	fresh beef, high quality (from Rest-of-World)	0.20	0.00	-0.20	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	fresh beef, other quality (from Rest-of-World)	-0.70	-0.70	0.00	0.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	frozen beef (from Rest-of-World)	0.20	0.00	-0.20	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	fresh beef, high quality (from the EU)	0.20	0.00	-0.20	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	fresh beef, other quality (from the EU)	0.70	0.00	-0.70	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	frozen beef (from the EU)	0.20	0.00	-0.20	-100.0	
Rest-of-World	fresh beef, other quality (from Rest-of-World)	other meat (from Argentina)	0.15	0.00	-0.15	-100.0	WFM 1)
Rest-of-World	fresh beef, other quality (from Rest-of-World)	other meat (from Brazil)	0.15	0.00	-0.15	-100.0	WFM 1)
Rest-of-World	fresh beef, other quality (from Rest-of-World)	other meat (from Uruguay)	0.15	0.00	-0.15	-100.0	WFM 1)
Rest-of-World	fresh beef, other quality (from Rest-of-World)	other meat (from Rest-of-World)	0.15	0.00	-0.15	-100.0	WFM 1)
Rest-of-World	fresh beef, other quality (from Rest-of-World)	other meat (from the EU)	0.15	0.00	-0.15	-100.0	WFM 1)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Rest-of-World	frozen beef (from Rest-of-World)	fresh beef, other quality (from Argentina)	0.20	0.00	-0.20	-99.8	
Rest-of-World	frozen beef (from Rest-of-World)	frozen beef (from Argentina)	0.70	0.16	-0.54	-76.9	
Rest-of-World	frozen beef (from Rest-of-World)	fresh beef, other quality (from Brazil)	0.20	0.00	-0.20	-99.8	
Rest-of-World	frozen beef (from Rest-of-World)	frozen beef (from Brazil)	0.70	0.55	-0.15	-21.4	
Rest-of-World	frozen beef (from Rest-of-World)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	frozen beef (from Rest-of-World)	frozen beef (from Uruguay)	0.70	0.18	-0.52	-74.0	
Rest-of-World	frozen beef (from Rest-of-World)	fresh beef, high quality (from Rest-of-World)	0.20	0.05	-0.15	-76.9	
Rest-of-World	frozen beef (from Rest-of-World)	fresh beef, other quality (from Rest-of-World)	0.20	0.40	0.20	100.3	
Rest-of-World	frozen beef (from Rest-of-World)	frozen beef (from Rest-of-World)	-0.70	-0.70	0.00	0.0	
Rest-of-World	frozen beef (from Rest-of-World)	fresh beef, high quality (from the EU)	0.20	0.01	-0.19	-93.3	
Rest-of-World	frozen beef (from Rest-of-World)	fresh beef, other quality (from the EU)	0.20	0.00	-0.20	-99.7	
Rest-of-World	frozen beef (from Rest-of-World)	frozen beef (from the EU)	0.70	0.06	-0.64	-92.1	
Rest-of-World	frozen beef (from Rest-of-World)	other meat (from Argentina)	0.15	0.00	-0.15	-97.5	WFM 1)
Rest-of-World	frozen beef (from Rest-of-World)	other meat (from Brazil)	0.15	0.05	-0.10	-69.9	WFM 1)
Rest-of-World	frozen beef (from Rest-of-World)	other meat (from Uruguay)	0.15	0.00	-0.15	-99.9	WFM 1)
Rest-of-World	frozen beef (from Rest-of-World)	other meat (from Rest-of-World)	0.15	0.29	0.14	90.6	WFM 1)
Rest-of-World	frozen beef (from Rest-of-World)	other meat (from the EU)	0.15	0.08	-0.07	-48.7	WFM 1)
Rest-of-World	fresh beef, high quality (from the EU)	fresh beef, other quality (from Argentina)	0.20	0.03	-0.17	-84.3	
Rest-of-World	fresh beef, high quality (from the EU)	frozen beef (from Argentina)	0.20	0.09	-0.11	-56.1	
Rest-of-World	fresh beef, high quality (from the EU)	fresh beef, other quality (from Brazil)	0.20	0.00	-0.20	-99.7	
Rest-of-World	fresh beef, high quality (from the EU)	frozen beef (from Brazil)	0.20	0.16	-0.04	-20.2	
Rest-of-World	fresh beef, high quality (from the EU)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	fresh beef, high quality (from the EU)	frozen beef (from Uruguay)	0.20	0.10	-0.10	-52.4	
Rest-of-World	fresh beef, high quality (from the EU)	fresh beef, high quality (from Rest-of-World)	0.20	0.15	-0.05	-24.8	
Rest-of-World	fresh beef, high quality (from the EU)	fresh beef, other quality (from Rest-of-World)	0.20	0.48	0.28	138.9	
Rest-of-World	fresh beef, high quality (from the EU)	frozen beef (from Rest-of-World)	0.20	0.13	-0.07	-35.8	
Rest-of-World	fresh beef, high quality (from the EU)	fresh beef, high quality (from the EU)	-0.70	-0.70	0.00	0.0	
Rest-of-World	fresh beef, high quality (from the EU)	fresh beef, other quality (from the EU)	0.20	0.10	-0.10	-48.5	
Rest-of-World	fresh beef, high quality (from the EU)	frozen beef (from the EU)	0.20	0.00	-0.20	-99.3	
Rest-of-World	fresh beef, high quality (from the EU)	other meat (from Argentina)	0.15	0.04	-0.11	-72.1	WFM 1)
Rest-of-World	fresh beef, high quality (from the EU)	other meat (from Brazil)	0.15	0.17	0.02	11.5	WFM 1)
Rest-of-World	fresh beef, high quality (from the EU)	other meat (from Uruguay)	0.15	0.00	-0.15	-99.2	WFM 1)
Rest-of-World	fresh beef, high quality (from the EU)	other meat (from Rest-of-World)	0.15	0.34	0.19	127.3	WFM 1)
Rest-of-World	fresh beef, high quality (from the EU)	other meat (from the EU)	0.15	0.15	0.00	-2.4	WFM 1)
Rest-of-World	fresh beef, other quality (from the EU)	fresh beef, other quality (from Argentina)	0.70	0.39	-0.31	-44.2	
Rest-of-World	fresh beef, other quality (from the EU)	frozen beef (from Argentina)	0.20	0.00	-0.20	-98.0	
Rest-of-World	fresh beef, other quality (from the EU)	fresh beef, other quality (from Brazil)	0.70	0.29	-0.41	-58.2	
Rest-of-World	fresh beef, other quality (from the EU)	frozen beef (from Brazil)	0.20	0.04	-0.16	-79.2	
Rest-of-World	fresh beef, other quality (from the EU)	fresh beef, other quality (from Uruguay)	0.70	0.03	-0.67	-95.2	

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Rest-of-World	fresh beef, other quality (from the EU)	frozen beef (from Uruguay)	0.20	0.00	-0.20	-97.8	
Rest-of-World	fresh beef, other quality (from the EU)	fresh beef, high quality (from Rest-of-World)	0.20	0.07	-0.13	-65.6	
Rest-of-World	fresh beef, other quality (from the EU)	fresh beef, other quality (from Rest-of-World)	0.70	0.54	-0.16	-22.7	
Rest-of-World	fresh beef, other quality (from the EU)	frozen beef (from Rest-of-World)	0.20	0.01	-0.19	-96.2	
Rest-of-World	fresh beef, other quality (from the EU)	fresh beef, high quality (from the EU)	0.20	0.08	-0.12	-58.8	
Rest-of-World	fresh beef, other quality (from the EU)	fresh beef, other quality (from the EU)	-0.70	-0.70	0.00	0.0	
Rest-of-World	fresh beef, other quality (from the EU)	frozen beef (from the EU)	0.20	0.00	-0.20	-99.2	
Rest-of-World	fresh beef, other quality (from the EU)	other meat (from Argentina)	0.15	0.03	-0.12	-82.0	WFM 1)
Rest-of-World	fresh beef, other quality (from the EU)	other meat (from Brazil)	0.15	0.08	-0.07	-48.7	WFM 1)
Rest-of-World	fresh beef, other quality (from the EU)	other meat (from Uruguay)	0.15	0.00	-0.15	-99.4	WFM 1)
Rest-of-World	fresh beef, other quality (from the EU)	other meat (from Rest-of-World)	0.15	0.39	0.24	157.4	WFM 1)
Rest-of-World	fresh beef, other quality (from the EU)	other meat (from the EU)	0.15	0.04	-0.11	-73.0	WFM 1)
Rest-of-World	frozen beef (from the EU)	fresh beef, other quality (from Argentina)	0.20	0.00	-0.20	-99.8	
Rest-of-World	frozen beef (from the EU)	frozen beef (from Argentina)	0.70	0.26	-0.44	-62.7	
Rest-of-World	frozen beef (from the EU)	fresh beef, other quality (from Brazil)	0.20	0.00	-0.20	-99.8	
Rest-of-World	frozen beef (from the EU)	frozen beef (from Brazil)	0.70	0.29	-0.41	-58.0	
Rest-of-World	frozen beef (from the EU)	fresh beef, other quality (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	frozen beef (from the EU)	frozen beef (from Uruguay)	0.70	0.26	-0.44	-62.4	
Rest-of-World	frozen beef (from the EU)	fresh beef, high quality (from Rest-of-World)	0.20	0.05	-0.15	-76.2	
Rest-of-World	frozen beef (from the EU)	fresh beef, other quality (from Rest-of-World)	0.20	0.41	0.21	104.8	
Rest-of-World	frozen beef (from the EU)	frozen beef (from Rest-of-World)	0.70	0.27	-0.43	-61.4	
Rest-of-World	frozen beef (from the EU)	fresh beef, high quality (from the EU)	0.20	0.00	-0.20	-99.7	
Rest-of-World	frozen beef (from the EU)	fresh beef, other quality (from the EU)	0.20	0.00	-0.20	-99.7	
Rest-of-World	frozen beef (from the EU)	frozen beef (from the EU)	-0.70	-0.70	0.00	0.0	
Rest-of-World	frozen beef (from the EU)	other meat (from Argentina)	0.15	0.01	-0.14	-92.4	WFM 1)
Rest-of-World	frozen beef (from the EU)	other meat (from Brazil)	0.15	0.00	-0.15	-99.1	WFM 1)
Rest-of-World	frozen beef (from the EU)	other meat (from Uruguay)	0.15	0.00	-0.15	-99.6	WFM 1)
Rest-of-World	frozen beef (from the EU)	other meat (from Rest-of-World)	0.15	0.29	0.14	94.9	WFM 1)
Rest-of-World	frozen beef (from the EU)	other meat (from the EU)	0.15	0.00	-0.15	-97.9	WFM 1)
Rest-of-World	other meat (from Argentina)	fresh beef, other quality (from Argentina)	0.31	0.08	-0.23	-73.9	WFM 1)
Rest-of-World	other meat (from Argentina)	frozen beef (from Argentina)	0.31	0.11	-0.20	-65.2	WFM 1)
Rest-of-World	other meat (from Argentina)	fresh beef, other quality (from Brazil)	0.31	0.04	-0.27	-85.9	WFM 1)
Rest-of-World	other meat (from Argentina)	frozen beef (from Brazil)	0.31	0.13	-0.18	-58.0	WFM 1)
Rest-of-World	other meat (from Argentina)	fresh beef, other quality (from Uruguay)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Argentina)	frozen beef (from Uruguay)	0.31	0.11	-0.20	-64.4	WFM 1)
Rest-of-World	other meat (from Argentina)	fresh beef, high quality (from Rest-of-World)	0.31	0.13	-0.18	-58.6	WFM 1)
Rest-of-World	other meat (from Argentina)	fresh beef, other quality (from Rest-of-World)	0.31	0.48	0.17	54.4	WFM 1)
Rest-of-World	other meat (from Argentina)	frozen beef (from Rest-of-World)	0.31	0.12	-0.19	-61.0	WFM 1)
Rest-of-World	other meat (from Argentina)	fresh beef, high quality (from the EU)	0.31	0.14	-0.17	-53.6	WFM 1)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Rest-of-World	other meat (from Argentina)	fresh beef, other quality (from the EU)	0.31	0.12	-0.19	-62.6	WFM 1)
Rest-of-World	other meat (from Argentina)	frozen beef (from the EU)	0.31	0.08	-0.24	-75.6	WFM 1)
Rest-of-World	other meat (from Argentina)	other meat (from Argentina)	-0.55	-0.55	0.00	0.0	WFM 1)
Rest-of-World	other meat (from Argentina)	other meat (from Brazil)	0.20	0.03	-0.17	-84.3	
Rest-of-World	other meat (from Argentina)	other meat (from Uruguay)	0.20	0.00	-0.20	-99.9	
Rest-of-World	other meat (from Argentina)	other meat (from Rest-of-World)	0.20	0.34	0.14	71.4	
Rest-of-World	other meat (from Argentina)	other meat (from the EU)	0.20	0.03	-0.17	-86.6	
Rest-of-World	other meat (from Brazil)	fresh beef, other quality (from Argentina)	0.31	0.00	-0.31	-99.8	WFM 1)
Rest-of-World	other meat (from Brazil)	frozen beef (from Argentina)	0.31	0.06	-0.25	-81.3	WFM 1)
Rest-of-World	other meat (from Brazil)	fresh beef, other quality (from Brazil)	0.31	0.00	-0.31	-99.8	WFM 1)
Rest-of-World	other meat (from Brazil)	frozen beef (from Brazil)	0.31	0.26	-0.05	-16.9	WFM 1)
Rest-of-World	other meat (from Brazil)	fresh beef, other quality (from Uruguay)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Brazil)	frozen beef (from Uruguay)	0.31	0.08	-0.23	-75.3	WFM 1)
Rest-of-World	other meat (from Brazil)	fresh beef, high quality (from Rest-of-World)	0.31	0.25	-0.07	-20.9	WFM 1)
Rest-of-World	other meat (from Brazil)	fresh beef, other quality (from Rest-of-World)	0.31	0.49	0.17	56.2	WFM 1)
Rest-of-World	other meat (from Brazil)	frozen beef (from Rest-of-World)	0.31	0.17	-0.14	-45.3	WFM 1)
Rest-of-World	other meat (from Brazil)	fresh beef, high quality (from the EU)	0.31	0.07	-0.24	-78.7	WFM 1)
Rest-of-World	other meat (from Brazil)	fresh beef, other quality (from the EU)	0.31	0.04	-0.27	-87.8	WFM 1)
Rest-of-World	other meat (from Brazil)	frozen beef (from the EU)	0.31	0.00	-0.31	-99.6	WFM 1)
Rest-of-World	other meat (from Brazil)	other meat (from Argentina)	0.20	0.00	-0.20	-98.2	
Rest-of-World	other meat (from Brazil)	other meat (from Brazil)	-0.55	-0.55	0.00	0.0	WFM 1)
Rest-of-World	other meat (from Brazil)	other meat (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	other meat (from Brazil)	other meat (from Rest-of-World)	0.20	0.35	0.15	73.4	
Rest-of-World	other meat (from Brazil)	other meat (from the EU)	0.20	0.18	-0.02	-8.8	
Rest-of-World	other meat (from Uruguay)	fresh beef, other quality (from Argentina)	0.31	0.11	-0.20	-63.8	WFM 1)
Rest-of-World	other meat (from Uruguay)	frozen beef (from Argentina)	0.31	0.11	-0.20	-63.6	WFM 1)
Rest-of-World	other meat (from Uruguay)	fresh beef, other quality (from Brazil)	0.31	0.11	-0.20	-64.3	WFM 1)
Rest-of-World	other meat (from Uruguay)	frozen beef (from Brazil)	0.31	0.11	-0.20	-63.4	WFM 1)
Rest-of-World	other meat (from Uruguay)	fresh beef, other quality (from Uruguay)	0.31	0.09	-0.22	-70.7	WFM 1)
Rest-of-World	other meat (from Uruguay)	frozen beef (from Uruguay)	0.31	0.11	-0.20	-63.6	WFM 1)
Rest-of-World	other meat (from Uruguay)	fresh beef, high quality (from Rest-of-World)	0.31	0.11	-0.20	-63.4	WFM 1)
Rest-of-World	other meat (from Uruguay)	fresh beef, other quality (from Rest-of-World)	0.31	0.51	0.20	64.9	WFM 1)
Rest-of-World	other meat (from Uruguay)	frozen beef (from Rest-of-World)	0.31	0.11	-0.20	-63.5	WFM 1)
Rest-of-World	other meat (from Uruguay)	fresh beef, high quality (from the EU)	0.31	0.11	-0.20	-63.1	WFM 1)
Rest-of-World	other meat (from Uruguay)	fresh beef, other quality (from the EU)	0.31	0.11	-0.20	-63.5	WFM 1)
Rest-of-World	other meat (from Uruguay)	frozen beef (from the EU)	0.31	0.11	-0.20	-64.0	WFM 1)
Rest-of-World	other meat (from Uruguay)	other meat (from Argentina)	0.20	0.00	-0.20	-98.3	
Rest-of-World	other meat (from Uruguay)	other meat (from Brazil)	0.20	0.00	-0.20	-98.3	
Rest-of-World	other meat (from Uruguay)	other meat (from Uruguay)	-0.55	-0.55	0.00	0.0	WFM 1)

			Raw data	Calibrated data	Absolute difference	Percentage difference	Source
Rest-of-World	other meat (from Uruguay)	other meat (from Rest-of-World)	0.20	0.37	0.17	83.1	
Rest-of-World	other meat (from Uruguay)	other meat (from the EU)	0.20	0.00	-0.20	-97.8	
Rest-of-World	other meat (from Rest-of-World)	fresh beef, other quality (from Argentina)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	frozen beef (from Argentina)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	fresh beef, other quality (from Brazil)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	frozen beef (from Brazil)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	fresh beef, other quality (from Uruguay)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	frozen beef (from Uruguay)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	fresh beef, high quality (from Rest-of-World)	0.31	0.01	-0.30	-95.3	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	fresh beef, other quality (from Rest-of-World)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	frozen beef (from Rest-of-World)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	fresh beef, high quality (from the EU)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	fresh beef, other quality (from the EU)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	frozen beef (from the EU)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	other meat (from Argentina)	0.20	0.00	-0.20	-100.0	
Rest-of-World	other meat (from Rest-of-World)	other meat (from Brazil)	0.20	0.00	-0.20	-100.0	
Rest-of-World	other meat (from Rest-of-World)	other meat (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	other meat (from Rest-of-World)	other meat (from Rest-of-World)	-0.55	-0.55	0.00	0.0	WFM 1)
Rest-of-World	other meat (from Rest-of-World)	other meat (from the EU)	0.20	0.00	-0.20	-100.0	
Rest-of-World	other meat (from the EU)	fresh beef, other quality (from Argentina)	0.31	0.00	-0.31	-99.8	WFM 1)
Rest-of-World	other meat (from the EU)	frozen beef (from Argentina)	0.31	0.00	-0.31	-98.9	WFM 1)
Rest-of-World	other meat (from the EU)	fresh beef, other quality (from Brazil)	0.31	0.00	-0.31	-99.8	WFM 1)
Rest-of-World	other meat (from the EU)	frozen beef (from Brazil)	0.31	0.32	0.01	3.8	WFM 1)
Rest-of-World	other meat (from the EU)	fresh beef, other quality (from Uruguay)	0.31	0.00	-0.31	-100.0	WFM 1)
Rest-of-World	other meat (from the EU)	frozen beef (from Uruguay)	0.31	0.00	-0.31	-98.8	WFM 1)
Rest-of-World	other meat (from the EU)	fresh beef, high quality (from Rest-of-World)	0.31	0.32	0.01	3.1	WFM 1)
Rest-of-World	other meat (from the EU)	fresh beef, other quality (from Rest-of-World)	0.31	0.48	0.17	55.6	WFM 1)
Rest-of-World	other meat (from the EU)	frozen beef (from Rest-of-World)	0.31	0.12	-0.19	-59.9	WFM 1)
Rest-of-World	other meat (from the EU)	fresh beef, high quality (from the EU)	0.31	0.02	-0.29	-92.0	WFM 1)
Rest-of-World	other meat (from the EU)	fresh beef, other quality (from the EU)	0.31	0.01	-0.30	-97.3	WFM 1)
Rest-of-World	other meat (from the EU)	frozen beef (from the EU)	0.31	0.00	-0.31	-99.6	WFM 1)
Rest-of-World	other meat (from the EU)	other meat (from Argentina)	0.20	0.00	-0.20	-99.3	
Rest-of-World	other meat (from the EU)	other meat (from Brazil)	0.20	0.08	-0.12	-60.9	
Rest-of-World	other meat (from the EU)	other meat (from Uruguay)	0.20	0.00	-0.20	-100.0	
Rest-of-World	other meat (from the EU)	other meat (from Rest-of-World)	0.20	0.35	0.15	72.7	
Rest-of-World	other meat (from the EU)	other meat (from the EU)	-0.55	-0.55	0.00	0.0	WFM 1)

Legend: see next page

calculation 1): The ratio of demand elasticities for beef of high and other quality from Argentina applied to the demand elasticity taken from the WFM
calculation 2): The inverse of the elasticity taken from the WFM
Calculation 3): The ratio of demand elasticities for beef of high and other quality from Argentina applied to the demand elasticity taken from the Cap et al. (2007)
Calculation 4): The inverse of the elasticity taken from Cap et al.
WFM 1): Weighted average of cross price elasticities for pork and poultry taken from the WFM
WFM 2): Weighted average of cross price elasticities for pork, sheep and poultry
Cap et al. (2007): Demand elasticity for boneless hind quarters
Cap et al. (2007) a: Average of elasticities of ground beef and forequarters
Cap et al. (2007) b: Elasticity for "beef A"
Cap et al. (2007) c: Elasticity for "beef B"
Cap et al. (2007) d: Cross price elasticity for "beef A" and "beef B"
Cap et al. (2007) e: Cross price elasticity for "beef B" and "beef A"

Table A 10 Demand elasticity for product group meat

	Raw data	Balanced data	Absolute difference	Source
EU	-0.30	-0.30	0.0	Own calculation based on Seale et al. (2003) and Eurostat (n.d.b)
Uruguay	-0.48	-0.48	0.0	Seale et al. (2003)
Argentina	-0.44	-0.44	0.0	Seale et al. (2003)
Brazil	-0.54	-0.54	0.0	Seale et al. (2003)
Rest-of-World	-0.33	-0.33	0.0	Richards et al. (1999); Seale et al. (2003);You et al. (1996)

Table A 11 Income elasticity for product group meat

Raw data	Balanced data	Absolute difference	Percentage difference	Source
0.38	0.30	-0.07	-19	Own calculation based on Seale et al. (2003) and Eurostat (n.d.b)
0.60	0.48	-0.11	-19	Seale et al. (2003)
0.55	0.44	-0.11	-19	Seale et al. (2003)
0.66	0.54	-0.13	-19	Seale et al. (2003)
0.10	0.35	0.25	352	Richards et al (1999); Seale et al.(2003);You et al. (1996)

Table A 12 Leontief coefficient

		fresh beef, high quality	fresh beef, other quality
EU	live cattle, high quality	0.09	0.91
	live cattle, other quality	0.00	1.00
Uruguay	live cattle, high quality	0.11	0.89
	live cattle, other quality	0.00	1.00
Argentina	live cattle, high quality	0.11	0.89
	live cattle, other quality	0.00	1.00
Brazil	live cattle, high quality	0.10	0.90
	live cattle, other quality	0.00	1.00
Rest-of-World	live cattle, high quality	0.10	0.90
	live cattle, other quality	0.00	1.00

Source: Own compilation

Table A 13 Transport costs

Euro/Tonne		Uruguay	Argentina	Brazil
EU	fresh beef	313	289	481
	frozen beef	249	465	481

Source: Own compilation

ANNEX II SCENARIO ANALYSIS

```
*****************************************************************************************************
*                                                                                                   *
*   Model code for EU-Mercosur beef trade scenario analysis                                         *
*                                                                                                   *
*****************************************************************************************************
FILE  CON / CON /;
      CON.lw = 0;
      CON.nw = 0;

$offlisting

* read sets
$include sets.gms

* read policy information
$include policy.gms

* definition of auxiliary parameters
$include auxiliary parameters.gms

parameters
   bd_sens(r,xx,yy,acto,i)      slope parameter of demand function
   cd_sens(r,xx,acto,i)         constant term of demand function

   bs_sens(r,xx,yy,acto,i)      slope parameter of supply function
   cs_sens(r,xx,acto,i)         constant term of supply function

   fcost(r)                     cost for freezing
   tcu_cat(r,r1,xx)             transport cost
   pritrans(r,xx)               price transmission between producer and consumer price

   ai(r)                        constant term of income allocation system
   bi(r)                        slope parameter of income allocation system
```

```
   ci(r)                        slope parameter of income allocation system

   ai_sens(r,i)                 constant term of income allocation system in sensitivity analysis
   bi_sens(r,i)                 slope parameter of income allocation system  in sensitivity analysis
   ci_sens(r,i)                 slope parameter of income allocation system  in sensitivity analysis

   GDP(r)                       GDP of country
   ;

* read base data
$include read basedata.gms

* read parameters for baseline and stochastic analysis
execute_load "parameters_sens.gdx" bd_sens, cd_sens, bs_sens, cs_sens;

* read parameters of the income allocation system
execute_load "income_parameters_sens.gdx"  ai_sens, bi_sens, ci_sens, iscal, PMcal, pcal, incomecal, GDP;

* initialise parameters with result from calibration to values from literature (i=1)
 ai(r)=ai_sens(r,"1");
 bi(r)=bi_sens(r,"1");
 ci(r)=ci_sens(r,"1");

* calculate missing parameters for price transmission
pritrans(r,xxt) $ (sum(acto,prical(r,xxt,acto)) AND hconcal(r,xxt,"cons")) =
                                          priconscal(r,xxt)/sum(acto ,prical(r,xxt,acto));

* set the pricetransmission to 1 where it is missing
pritrans(r,xxt) $ (not pritrans(r,xxt) and hconcal(r,xxt,"cons"))=1;

*****************************************************************************************
   equations
        m_ (r, xx,acto)          market balance
        sa_(r,r1,xx,ql)          spatial arbitrage condition
        quota_(r,r1,xx,ql)       bilateral TRQ for high quality beef
        prodt_(r,xx,acto)        production of farmers and slaughterhouses and freezers
        procdem_(r,xx,acto)      demand of processors for beef_ah and beef_ao
```

```
        hcon_(r,xx,acto)          demand by consumers
        procmarg_(r,xx, acto)     processing margin of the  slaughterhouse
        pritrans_(r,xx)           price transmission from slaughterhouses and freezers to consumers

*       demand
        f_(r,acto)                part of the generalized leontief expenditure system
        g_(r,acto)                part of the generalized leontief expenditure system
        gi_(r,xx,acto)            first derivative of g versus own prices
        income_(r)                equation allocating income to meat and other products
        is_(r)                    equation determining the budget share spent on meat
        P_(r)                     general price index
        PM_(r)                    meat price index
        ;

  Variables

        trade(r,r1,xx,ql)         trade flow from region r1 to region r
        pri(r,xx,acto)            price
        pricons(r,xx)             consumer price

        qr(r,r1,xx,ql)            bilateral quota rent per unit
        prodt(r,xx,acto)          production of each of the actors
        procdem (r,xx,acto)       demand of processors for beef_ah and beef_ao
        hcon (r,xx,acto)          demand by consumers
        procmarg(r,xx,acto)       processing margin of the slaughterhouse

        g(r,acto)                 part of the generalized leontief expenditure system
        gi(r,xx,acto)             first derivative of g versus own prices
        f(r,acto)                 part of the generalized leontief expenditure system

        P(r)                      stone-geary price index
        PM(r)                     stone-geary price index for meat
        income(r)                 budget allocated to meat consumption
        is(r)                     share of total income allocated to meat products
         ;
```

```
 Parameters
        bs(r,xx,yy,acto)        matrix of slope parameters for SUPPLY (hessian matrix of objective function)
        cs(r,xx,acto)           constant term of the supply function

        bd(r,xx,yy,acto)        matrix of slope parameters for DEMAND (hessian matrix of objective function)
        cd(r,xx,acto)           constant term of demand function
        ;


* set parameters to calibrated values. i=1 is the value from calibration to values from literature (i=1)
bs(r,xx,yy,acto) $ ((prodtcal(r,xx,acto) AND prodtcal(r,yy,acto))
                    OR (procdemcal(r,xx,acto) AND (procdemcal(r,yy,acto)))) =bs_sens(r,xx,yy,acto,"1");

cs(r,xx,acto)    $ (prodtcal(r,xx,acto) or procdemcal(r,xx,acto))=cs_sens(r,xx,acto,"1");
bd(r,xx,yy,acto) $ (hconcal(r,xx,acto) AND hconcal(r,yy,acto))=bd_sens(r,xx,yy,acto,"1");
cd(r,xx,acto)    $ (hconcal(r,xx,"cons"))= cd_sens(r,xx,acto,"1");

* restrict certain variables to values greater zero
positive variable  prodt;
positive  variable trade;
positive variable  hcon;
positive  variable qr;
positive  variable pri;
positive  variable procdem;
positive  variable hcon;
positive variable  pricons;

* create price index
parameter prindex(r);
prindex(r)=1;
```

```
************************ Income allocation module ***********************************************************

*     Income allocated to meat
      income_(r) ..
      income(r)=E=is(r)* GDP(r);

*     Equation determining the share of income spent on meat
      is_(r) ..
      is(r)=E= (ai(r)+ bi(r)* LOG(PM(r)) + ci(r)* LOG(GDP(r)/P(r)));

*     Definition of the price index
      P_(r)..
      LOG(P(r))=E=((sum(xxt $ hconcal(r,xxt,"cons"),
                  ((priconscal(r,xxt)* hconcal(r,xxt,"cons"))/GDP(r)))* LOG(PM(r))));

*     Definition of the meat price index
      PM_(r)..
      LOG(PM(r))=E=((sum(xxt $ hconcal(r,xxt,"cons"),
                    ((priconscal(r,xxt)* hconcal(r,xxt,"cons"))/GDP(r))* LOG(pricons(r,xxt)))));

******************** BEHAVIOURAL FUNCTIONS ***************************************************************

*      Human consumption
       hcon_(r,xx,acto) $ (hconcal(r,xx,acto))..
       hcon(r,xx,acto)=E=cd(r,xx,acto)+ gi(r,xx,acto)/g(r,acto) * (income(r) - f(r,acto));


*      Demand of the processing industry
       procdem_(r,xx,acto) $  procdemcal(r,xx,acto)..
       procdem(r,xx,acto)=E=
                (cs(r,xx,"slau")+ sum(yy $ (inputtoactos(yy,acto)),
                 bs(r,xx,yy,"slau") * procmarg(r,yy,"slau")/prindex(r)))
                                                    $ (sameas(acto,"slau") AND inputtoactos(xx,acto))
```

```
            + (cs(r,xx,"freez") + sum(yy $ (inputtoactos(yy,acto)),
               bs(r,xx,yy,"freez") * procmarg(r,yy,"freez")/prindex(r)))
                                                $ (sameas(acto,"freez") AND (inputtoactos(xx,acto)));


*     Definition of the processing margin
      procmarg_(r,xx,acto) $ (procmargcal(r,xx,acto))..
      procmarg(r,xx,acto) =E=(((sum(yy $ (outputtoactos(yy,acto)),
                           pri(r,yy,"slau") * leofact(r,xx,yy)))- pri(r,xx,"farm"))
                                                $ (sameas(acto,"slau") AND (inputtoactos(xx,acto)))

         + (sum (yy $ (outputtoactos(yy,acto) and xxtocountries(r,yy)), pri(r,yy,"freez") * 1)-

                                     sum(zz $ (outputtoactos(zz,"farm") AND xxtocountries(r,zz) AND
                                              (sameas (zz, "other_ali_eu")OR
                                              sameas (zz, "other_ali_arg")OR
                                              sameas (zz, "other_ali_bra")OR
                                              sameas (zz, "other_ali_uru")OR
                                              sameas (zz, "other_ali_row")))
                                              ,
                                               pri(r,zz,"farm"))- fcost(r))
                                               $ (sameas(acto,"freez")and inputtoactos(xx,acto)));

*      Supply function for famers, slaughterhouses and freezing units
       prodt_(r,xx,acto) $ (prodtcal(r,xx,acto))..
       prodt(r,xx,acto) =E=(cs(r,xx,acto) + sum (yy $ (outputtoactos(yy,acto) AND prodtcal(r,yy,acto)),
                                  bs(r,xx,yy,acto) * (pri(r,yy,acto))/prindex(r)))
                                               $ (sameas (acto, "farm") AND outputtoactos(xx,acto))

                                        + sum(yy $ (inputtoactos(yy,acto)),
                                  procdem(r,yy, "slau") * leofact(r,yy,xx ))
                                               $ (sameas (acto,"slau") AND (outputtoactos(xx,acto)))

                                + (procdem("arg","high_fre_arg",acto)) $ (sameas (acto,"freez")
                                                                          AND sameas(xx,"other_fro_arg")
                                                                          AND sameas(r,"arg"))
```

```
+ (procdem("arg","other_fre_arg",acto)) $ (sameas (acto,"freez")
                                          AND sameas(xx,"other_fro_arg")
                                          AND sameas(r,"arg"))

+ (procdem("bra","high_fre_bra",acto)) $ (sameas (acto,"freez")
                                          AND sameas(xx,"other_fro_bra")
                                          AND sameas(r,"bra"))

+ (procdem("bra","other_fre_bra",acto)) $ (sameas (acto,"freez")
                                          AND sameas(xx,"other_fro_bra")
                                          AND sameas(r,"bra"))

+ (procdem("uru","high_fre_uru",acto)) $ (sameas (acto,"freez")
                                          AND sameas(xx,"other_fro_uru")
                                          AND sameas(r,"uru"))

+ (procdem("uru","other_fre_uru",acto)) $ (sameas (acto,"freez")
                                          AND sameas(xx,"other_fro_uru")
                                          AND sameas(r,"uru"))

+ (procdem("row","high_fre_row",acto)) $ (sameas (acto,"freez")
                                          AND sameas(xx,"other_fro_row")
                                          AND sameas(r,"row"))

+ (procdem("row","other_fre_row",acto)) $ (sameas (acto,"freez")
                                          AND sameas(xx,"other_fro_row")
                                          AND sameas(r,"row"))

+ (procdem("eu","high_fre_eu",acto)) $ (sameas (acto,"freez")
                                          AND sameas(xx,"other_fro_eu")
                                          AND sameas(r,"eu"))

+ (procdem("eu","other_fre_eu",acto)) $ (sameas (acto,"freez")
                                          AND sameas(xx,"other_fro_eu")
                                          AND sameas(r,"eu")) ;
```

```
************************* Other equations ********************************************************


*     Spatial arbitrage condition
      sa_(r,r1,xxt,ql)  $  (tradecal(r,r1,xxt,ql)) ..
           (sum(acto $ outputtoactos(xxt,acto), pri(r1,xxt,acto) + tcu_cat(r,r1,xxt))*(1+tarv(r,xxt,ql)))
                 + tars(r,xxt,ql) + qr(r,r1,xxt,ql) =G= sum(acto $ outputtoactos(xxt,acto), pri(r,xxt,acto));

*     Fix trade within a country to zero
      trade.fx(r,r,xxt,ql)=0;

*     Market balance
      m_(r,xx,acto) $ ((outputtoactos(xx,acto) AND sameas (acto,"farm") AND (prodtcal(r,xx,"farm")
                                                                              or hconcal(r,xx,"cons")))
               or (outputtoactos(xx,acto) AND sameas (acto,"slau") AND (hconcal(r,xx,"cons")
                                                                       OR prodtcal(r,xx,"slau")))
               or (outputtoactos(xx,acto) AND sameas (acto,"freez") AND  (hconcal(r,xx,"cons" )
                                                                       OR prodtcal(r,xx,"freez")))))..


       0 =E= 0+
         prodt(r,xx,"farm") $ (sameas (acto,"farm") AND outputtoactos(xx,acto) and xxtocountries(r,xx))
       + prodt(r,xx,"slau") $ (sameas (acto,"slau") AND outputtoactos(xx,acto)and xxtocountries(r,xx))
       + prodt(r,xx,"freez")$ (sameas (acto,"freez") AND outputtoactos(xx,acto) and xxtocountries(r,xx))

       - hcon(r,xx,"cons") $ (inputtoactos(xx,"cons"))
       - procdem(r,xx,"slau") $ (sameas(acto,"farm") AND outputtoactos(xx,acto) and xxtocountries(r,xx)
                                 and procdemcal(r,xx,"slau"))

       - procdem(r,xx,"freez")$ (sameas(acto,"slau")AND outputtoactos(xx,acto) and xxtocountries(r,xx)
                                 and procdemcal(r,xx,"freez"))


*      + total imports
          + (sum((r1,ql)$ (xxtocountries(r1,xx) ), trade(r,r1,xx,ql))) $ (hconcal(r,xx,"cons"))

*      - total exports
```

```
          - (sum((r1,ql), trade(r1,r,xx,ql))) $ (xxtocountries (r,xx));


*      Price transmission to consumer
       pritrans_(r,xxt) $ hconcal(r,xxt,"cons") ..
       pricons(r,xxt) =E=
*                        from slaughterhouse
                          sum(acto $ (sameas(acto,"slau") AND  outputtoactos(xxt,"slau")),
                                   (pri(r,xxt,acto)* pritrans(r,xxt)))

*                        from freezing unit
                           +sum(acto $ (sameas(acto,"freez") AND outputtoactos(xxt,"freez")),
                             (pri(r,xxt,acto)* pritrans(r,xxt)))

*                        from farmer
                           + (pri(r,xxt,"farm")* pritrans(r,xxt)) $ sum(omea $ xxtoomea(xxt, omea), 1);

*       Quota rent
        quota_(r,r1,xxt,ql) $ (sameas(ql, "q1") AND tradecal(r,r1,xxt,"q1") AND qr_cal(r,r1,xxt,"q1")
                                      and not sum(omea $ xxtoomea(xxt, omea), 1) AND SAMEAS(r, "EU"))..
                                      trqnt(r,r1,xxt,ql) =G= trade(r,r1,xxt,ql);

*       Definition of the equation f
        f_(r,acto) $ (sameas (acto,"cons"))..
        f(r,acto) =E= sum(xx $ (hconcal(r,xx,"cons") AND inputtoactos(xx,acto)), cd(r,xx,acto) *
                      pricons(r,xx));

*       Definition of g
        g_(r,acto) $ (sameas(acto,"cons"))..
        g(r,acto)=E=sum((xx,yy) $ (hconcal(r,xx,acto) AND hconcal(r,yy,acto)),
                                (bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
                              +  bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))*SQRT(pricons(r,xx)*pricons(r,yy)));


*      Definition of gi
       gi_(r,xx,acto) $ (sameas (acto,"cons") AND priconscal(r,xx) AND  hconcal(r,xx,acto))..
```

```
       gi(r,xx,acto)=E=sum(yy $ (hconcal(r,yy,acto) and priconscal(r,yy)),
              ( bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
             +  bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))* SQRT(pricons(r,yy)/pricons(r,xx)));



********************** Model definition *************************************************************

* Full model (with income allocation system)
 Model MULTCOM / sa_.trade,m_.pri,pritrans_.pricons, quota_.qr,prodt_.prodt,
             procdem_.procdem, hcon_.hcon,procmarg_.procmarg,f_.f, g_.g,
             gi_.gi,income_.income,is_.is,p_.p,PM_.pm  /;

* Restricted model(without income allocation system)
 Model MULTCOM1 / sa_.trade,m_.pri,pritrans_.pricons,quota_.qr,prodt_.prodt,
             procdem_.procdem,hcon_.hcon, procmarg_.procmarg, f_.f,g_.g,gi_.gi/;

******************************** Start baseline simulations ***************************************
* start loop
 LOOP (i,

*   set parameter values to stochastic one (i=1 is still the deterministic value)
    bd(r,xx,yy,acto) $ (hconcal(r,xx,acto) AND hconcal(r,yy,acto))=bd_sens(r,xx,yy,acto,i);
    cd(r,xx,acto) $ (hconcal(r,xx,"cons"))= cd_sens(r,xx,acto,i);

    bs(r,xx,yy,acto)=bs_sens(r,xx,yy,acto,i);
    cs(r,xx,acto)$ (procdemcal(r,xx,acto) OR prodtcal(r,xx,acto)) = cs_sens(r,xx,acto,i);

    ai(r)=ai_sens(r,i);
    bi(r)=bi_sens(r,i);
    ci(r)=ci_sens(r,i);


*   set bounds and start values
     trade.lo(r,r1,xx,"q1") $ tradecal(r,r1,xx,"q1") = tradecal(r,r1,xx,"q1")/10000;
     trade.up(r,r1,xx,ql)   = +inf;
```

```
pri.lo(r,xx,acto)      =  EPS;
pri.up(r,xx,acto)      = +inf;

pricons.lo(r,xx) $ priconscal(r,xx)=1;
pricons.up(r,xx)       = +inf;

qr.lo(r,r1,xx,ql)      = 0;
qr.up(r,r1,xx,ql)      = +inf;

prodt.lo(r,xx,acto)    = 0;
prodt.up(r,xx,acto)    = +inf;

procdem.lo(r,xx,acto)  = 0;
procdem.up(r,xx,acto)  = +inf;

hcon.lo (r,xx,acto)    = 0;
hcon.up (r,xx,acto)    = +inf;

procmarg.lo(r,xx,acto) = -inf;
procmarg.up(r,xx,acto) = +inf;

P.l(r)= Pcal(r);
income.l(r)=incomecal(r);
g.lo(r, "cons")=1;


*   some variables have to be fixed to zero for the MCP solver
    trade.fx(r,r1,xx,ql) $ (not hconcal(r,xx,"cons") )=0;

*   fix trade under q2 to zero where no quota exists
    trade.fx(r,r1,xx,"q2") $ (not qr_cal(r,r1,xx,"q1"))=0;

*   fix quota rent of intra trade to zero
    qr.fx(r,r,xx,ql)=0;
    qr.fx(r,r1,xx,ql) $ (not qr_cal(r,r1,xx,ql))=0;
```

```
*   Fix the quota rent to zero, where nothing was trade in base year
    qr.fx(r,r1,xx,"q1") $ (not sum(ql,tradecal(r,r1,xx,ql)))=0;

*   Fix the quota rent to zero for omea
    qr.fx(r,r1,xx,ql) $ sum(omea $ xxtoomea(xx, omea), 1)=0;
    pri.fx(r,xx,acto) $ (not outputtoactos(xx,acto)) = 0;

*   Fix prices for other meat products that are not consumed in the base year

    pri.fx("URU","omea_eu","farm") = 0;
    pri.fx("URU","omea_arg","farm")= 0;
    pri.fx("ARG","omea_eu","farm") = 0;
    pri.fx("BRA","omea_row","farm")= 0;
    pri.fx("BRA","omea_eu","farm") = 0;

*   Some variables that need to be fixed

    prodt.fx(r,xx,acto)   $ (not prodtcal(r,xx,acto))=0;
    hcon.fx(r,xx,acto)    $ (not hconcal(r,xx,acto))=0;

    trade.up(r,r1,xx,ql)  $ (not tradecal(r,r1,xx,"q1"))=0;
    procdem.fx(r,xx,acto) $ (not procdemcal(r,xx,acto))= 0;

    pri.fx(r,xx,acto)     $ (not prical(r,xx,acto))=0;
    pricons.fx(r,xx)      $ (not priconscal(r,xx))=0;

    procmarg.fx(r,xx,acto)$ (not procmargcal(r,xx,acto))=0;

    qr.fx(r,r1,xxt,ql)    $ (not sameas(r,"EU"))=0;
    qr.fx(r,r1,xxt,"q2")=0;

*   Set start values
    prodt.l(r,xx,acto)   $ prodtcal(r,xx,acto)=prodtcal(r,xx,acto);
    hcon.l(r,xx,acto)    $ hconcal(r,xx,acto)=hconcal(r,xx,acto);
    procdem.l(r,xx,acto) $ procdemcal(r,xx,acto)=procdemcal(r,xx,acto);
```

```
procmarg.l(r,xx,acto)$ procmargcal(r,xx,acto) = procmargcal(r,xx,acto);
trade.l(r,r1,xx,ql)  $ tradecal(r,r1,xx,ql)=tradecal(r,r1,xx,ql);

pri.l(r,xx,acto)     $ prical(r,xx,acto)= prical(r,xx,acto);
pricons.l(r,xx)      $ priconscal(r,xx)= priconscal(r,xx);
qr.l(r,r1,xxt,ql)    $ qr_cal(r,r1,xxt,ql)=qr_cal(r,r1,xxt,ql);

g.l(r,acto) $ (sameas(acto,"cons") )=  sum((xx,yy) $  (hconcal(r,xx,acto) AND hconcal(r,yy,acto)),
                (bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
              +  bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))* SQRT(priconscal(r,xx)*priconscal(r,yy)));

gi.l(r,xx,acto) $ (sameas (acto,"cons")AND priconscal(r,xx) AND  hconcal(r,xx,acto))
               = sum(yy $ (hconcal(r,yy,acto) and priconscal(r,yy)),
                (bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
              +  bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))* SQRT(priconscal(r,yy)/priconscal(r,xx)));


f.l(r,acto) $ sameas (acto,"cons") = sum (xx $ (hconcal(r,xx,"cons") AND inputtoactos(xx,acto)),
                                          cd(r,xx,acto) * priconscal(r,xx));

pm.l(r)=pmcal(r);

is.l(r)= ai(r)+ bi(r)*LOG(PM.l(r)) +ci(r)* LOG(GDP(r)/P.l(r));

is.up(r)=1;

*   Set model options and solve
     MULTCOM.limcol     = 0;
     MULTCOM1.limcol    = 0;

     MULTCOM.limrow     = 0;
     MULTCOM1.limrow    = 0;

     MULTCOM.solprint   = 1;
     MULTCOM1.solprint  = 1;

     MULTCOM.Holdfixed  = 0;
```

```
     MULTCOM1.Holdfixed = 0;
     MULTCOM.OPTFILE    = 2;
     MULTCOM1.OPTFILE   = 2;

*   Solve model
    SOLVE MULTCOM Using MCP;

*   Count 1 successful model solutions
    dummy(i,"solv","bas") $ (multcom.modelstat=1) =1;
    putclose con "*** BASELINE Loop i done= " i.tl ;


*   check if baseline reproduces base data
$include check baseline.gms

*    Close loop
  );

* Count successful model solutions
 parameter solutions(scen);
 solutions("BAS") =sum(i, dummy(i,"solv","bas"));

* Store baseline data in  GDX file
execute_unload  "Baseline.GDX"tradeflow, price, quotarent, production, processingdem,
                                                           consumption, processingmar, tottrade;

************************ Scenario analysis ************************************************************

* Create some dummy parameters (are used for setting start values later on)

parameter tradeflowoutdummy(r,r1,xxt,ql,gen,scen);
parameter priceoutdummy (r,xx,acto,priit, gen,scen);
parameter quotarentoutdummy(r,r1,xx,ql,qrit,gen,scen);
parameter productionoutdummy   (r,xx,acto,gen,scen);
parameter processingdemoutdummy(r,xx,acto,gen,scen);
parameter consumptionoutdummy  (r,xx,acto,gen,scen);
parameter processingmaroutdummy(r,xx,acto,gen,scen);
```

```
parameter incomeoutdummy(r, gen, scen);
parameter isoutdummy(r,gen,scen);
parameter poutdummy(r, gen, scen);
parameter pmoutdummy(r, gen, scen);

* Get startvalues from database
execute_load  "Startvalues.GDX" processingmaroutdummy, processingdemoutdummy, priceoutdummy,
                      consumptionoutdummy,quotarentoutdummy,processingmaroutdummy,productionoutdummy ,
                      tradeflowoutdummy,incomeoutdummy, isoutdummy,poutdummy,pmoutdummy,incomeoutdummy  ;

* Save expenditure allocated to meat in the base line on a special parameter
parameter incomesave;
incomesave(r,"VAL", "BAS", i)= incomeout(r, "VAL", "BAS", i) ;

*** first scenario ************************************************************************

* Include new policy parameters and rerun model
$include scenario1.gms

* Set model options
MULTCOM.holdfixed = 0;
MULTCOM.OPTFILE   = 2;
MULTCOM.limrow    = 0;

* Define convergence parameter
parameter dev(i,scen);

* Start loop
LOOP(i $ dummy(i,"solv","bas"),

     display " FIRST SCENARIO";

*    Set parameters to stochastic values (note: i=1 is calibrated to values from literature)
     bd(r,xx,yy,acto) $ (hconcal(r,xx,acto) AND hconcal(r,yy,acto))=bd_sens(r,xx,yy,acto,i);
     cd(r,xx,acto)    $ (hconcal(r,xx,"cons"))= cd_sens(r,xx,acto,i);

     bs(r,xx,yy,acto) $ (procdemcal(r,xx,acto) OR prodtcal(r,xx,acto)) = bs_sens(r,xx,yy,acto,i);
```

```
     cs(r,xx,acto)    $ (procdemcal(r,xx,acto) OR prodtcal(r,xx,acto)) = cs_sens(r,xx,acto,i);

     ai(r)=ai_sens(r,i);
     bi(r)=bi_sens(r,i);
     ci(r)=ci_sens(r,i);

*    Set convergence parameter to 1 and zero
     dev(i,"scen1")=1;
     dev(i,"scen2")=0;

*    Start loop to solve income module
     LOOP(j $ dev(i,"scen1"),

*        Set start values and bounds
         prodt.l(r,xx,acto)   = productionoutdummy (r,xx,acto,"VAL", "SCEN1");
         hcon.l(r,xx,acto)    = consumptionoutdummy (r,xx,acto,"VAL", "SCEN1");

         procdem.l(r,xx,acto) = processingdemoutdummy (r,xx,acto,"VAL", "SCEN1");
         procmarg.l(r,xx,acto)= processingmaroutdummy (r,xx,acto,"VAL", "SCEN1");

         trade.l(r,r1,xxt,ql) $ tradecal(r,r1,xxt, ql)=tradeflowoutdummy  (r,r1,xxt,ql,"VAL", "SCEN1");
         trade.lo("EU","URU",xx,"q1")  = tradecal("EU","URU",xx,"q1")/100;
         hcon.lo("EU","high_fre_uru","cons")  = hconcal("EU","high_fre_uru","cons")/100;

         trade.fx("URU","BRA","high_fre_bra","q1")  = tradecal("URU","BRA","high_fre_bra","q1");
         hcon.fx("URU","high_fre_bra","cons")  = hconcal("URU","high_fre_bra","cons");

         pri.fx("URU","high_fre_bra","slau")= prical("URU","high_fre_bra","slau");
         pricons.fx("URU","high_fre_bra")= priconscal("URU","high_fre_bra");


         g.l(r,acto) $ (sameas(acto,"cons") )= sum((xx,yy) $  (hconcal(r,xx,acto) AND hconcal(r,yy,acto)),
                   (bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
                  +  bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))*
             SQRT(priceoutdummy(r,xx,"cons","pricons","VAL", "SCEN1")*
                                               priceoutdummy(r,yy,"cons","pricons","VAL", "SCEN1")));
```

```
gi.l(r,xx,acto) $ (sameas (acto,"cons")AND priconscal(r,xx) AND  hconcal(r,xx,acto))
          =sum(yy $ (hconcal(r,yy,acto) and priconscal(r,yy)),

          (bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
        +  bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))*
                        SQRT(priceoutdummy(r,yy,"cons","pricons","VAL", "SCEN1")/
                                        priceoutdummy(r,xx,"cons","pricons","VAL", "SCEN1")));

f.l(r,acto) $ sameas (acto,"cons") = sum (xx $ (hconcal(r,xx,"cons") AND inputtoactos(xx,acto)),
                       cd(r,xx,acto) * priceoutdummy(r,xx,"cons","pricons","VAL", "SCEN1"));

pri.l(r,xx,acto) = priceoutdummy  (r,xx,acto,"pri","VAL", "SCEN1");
pricons.l(r,xx)=   priceoutdummy  (r,xx,"cons","pricons","VAL", "SCEN1");

qr.l(r,r1,xxt,ql) =quotarentoutdummy  (r,r1,xxt,ql,"qr","VAL", "SCEN1");
is.l(r)=          isoutdummy  (r,"VAL", "BAS");
pm.l(r)=pmoutdummy  (r,"VAL", "BAS");

pm.lo(r)=0.00000001;
p.lo(r) =0.00000001;

*       Fix expenditure on meat to value from earlier runs to get started if income.GDX is empty
                                                                        (is later overwritten)
income.fx("EU")=  966660072007 ;
income.fx("URU")= 5484818960 ;
income.fx("ARG")= 76261595074  ;
income.fx("BRA")= 178215534773  ;
income.fx("ROW")= 4099913715690  ;

*       Take value for meat expenditue from GDX data base and fix income varibale to this value
execute_load  "income.GDX"  incomeout;
income.fx(r) $ incomeout(r, "VAL", "SCEN1",i) = incomeout(r, "VAL", "SCEN1",i);

*       Overwrite incomeout with value from baseline
incomeout(r, "VAL", "BAS", i)= incomesave(r,"VAL", "BAS", i) ;
```

```
*        Solve restricted model
         SOLVE MULTCOM Using MCP;

*        Compute the share of income spent on meat in the model solution
         isout(r, "VAL", "SCEN1",i)= ai(r)+ bi(r)* LOG(PM.l(r)) + ci(r)* LOG(GDP(r)/P.l(r));

*        Compute and check deviation from fixed income
         convergeSCEN1(r,i)= income.l(r)- is.l(r)* GDP(r);
         DEV(i,"scen1") $ (SMAX((r), ABS(convergeSCEN1(r,i)) ) LT 10) = 0;

*        Compute income allocated to meat in the model solution and store on parameter
         incomeout(r,"VAL", "SCEN1",i)   = is.l(r)* GDP(r);
         incomeoutj(r,"VAL", "SCEN1",i,j)= is.l(r)* GDP(r);

*        Unload data into GDX file

         execute_unload "income.GDX"
                                incomeoutj, incomeout,dev,incomeout, convergescen1;

         putclose con "*** First scenario Loop i in progress= " i.tl ;
         putclose con "*** First scenario Loop j done= "  j.tl ;

*        Close loop
         );

*    Fix income to value from last iteration
     income.fx(r)= incomeout(r,"VAL", "SCEN1",i);

*    Solve model again with income allocated to meat from last iteration
     SOLVE MULTCOM1 Using MCP;


*    Count 1 successful model solutions
     dummy(i,"solv","scen1") $ (multcom.modelstat=1) =1;
```

```
     CON.lw = 0;
     CON.nw = 0;
     putclose con "*** First scenario Loop i done= " i.tl ;

*    Create output
$batinclude Create_output.gms SCEN1

*    Close loop
     );

* Count successful model solutions
solutions("SCEN1")=sum(i, dummy(i,"solv","scen1"));

CON.lw = 0;
CON.nw = 0;

* Loosen bounds
trade.lo("URU","BRA","high_fre_bra","q1")  = EPS;
trade.up("URU","BRA","high_fre_bra","q1")  = inf;

hcon.lo("URU","high_fre_bra","cons")  = EPS;
hcon.up("URU","high_fre_bra","cons")  = inf;

pri.lo("URU","high_fre_bra","slau")= EPS;
pri.up("URU","high_fre_bra","slau")= inf;

pricons.lo("URU","high_fre_bra")= EPS;
pricons.up("URU","high_fre_bra")= inf;

*** second scenario ********************************************************************************

* Reset policy varaibles to base values
$include reset_policies.gms

* Include new policy parameters and rerun model
$include scenario2.gms
```

```
MULTCOM.limcol    = 0;
MULTCOM.limrow    = 0;
MULTCOM.Holdfixed = 0;
MULTCOM.OPTFILE   = 2;

* Start loop
LOOP(i  $ dummy(i,"solv","bas"),

      display "SECOND SCENARIO" ;

*    set parameters to stochastic values
     bd(r,xx,yy,acto) $ (hconcal(r,xx,acto) AND hconcal(r,yy,acto))=bd_sens(r,xx,yy,acto,i);
     cd(r,xx,acto) $ (hconcal(r,xx,"cons"))= cd_sens(r,xx,acto,i);

     bs(r,xx,yy,acto)=bs_sens(r,xx,yy,acto,i);
     cs(r,xx,acto)$ (procdemcal(r,xx,acto) OR prodtcal(r,xx,acto)) = cs_sens(r,xx,acto,i);

     ai(r)=ai_sens(r,i);
     bi(r)=bi_sens(r,i);
     ci(r)=ci_sens(r,i);

*    Set convergence parameter to 1
     dev(i,"scen2")=1;

*    Start loop to solve income module
     LOOP(j $ dev(i,"scen2"),

*         Set start values and bounds
          prodt.l(r,xx,acto) = productionoutdummy(r,xx,acto,"VAL", "SCEN2");
          hcon.l(r,xx,acto) = consumptionoutdummy(r,xx,acto,"VAL", "SCEN2");
          procdem.l(r,xx,acto) =processingdemoutdummy(r,xx,acto,"VAL", "SCEN2");
          procmarg.l(r,xx,acto)  = processingmaroutdummy(r,xx,acto,"VAL", "SCEN2");

          trade.l(r,r1,xxt,ql) = tradeflowoutdummy(r,r1,xxt,ql,"VAL", "SCEN2");
          trade.lo(r,r1,xxt,ql) =0;
          trade.lo("EU","URU",xx,"q1")  = tradecal("EU","URU",xx,"q1")/100;
          hcon.lo("EU","high_fre_uru","cons")  = hconcal("EU","high_fre_uru","cons")/100;
```

```
 pri.l(r,xx,acto) = priceoutdummy(r,xx,acto,"pri","VAL", "SCEN2");
 pricons.l(r,xx)=  priceoutdummy(r,xx,"cons","pricons","VAL", "SCEN2");
 qr.l(r,r1,xxt,ql) =quotarentoutdummy(r,r1,xxt,ql,"qr","VAL", "SCEN2");

 is.l(r)=          isoutdummy(r,"VAL", "BAS");
 is.lo(r)=          0.00001;
 is.up(r)=          1;

 g.l(r,acto) $ (sameas(acto,"cons") )= sum((xx,yy) $  (hconcal(r,xx,acto) AND hconcal(r,yy,acto)),
      (bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
    +  bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))*
       SQRT( priceoutdummy(r,xx,"cons","pricons","VAL", "SCEN2")
                                        * priceoutdummy(r,yy,"cons","pricons","VAL", "SCEN2")));

 gi.l(r,xx,acto) $ (sameas (acto,"cons")AND priconscal(r,xx) AND  hconcal(r,xx,acto))
     =sum(yy $ (hconcal(r,yy,acto) and priconscal(r,yy)),

     ( bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
    +  bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))*
                  SQRT(priceoutdummy(r,yy,"cons","pricons","VAL", "SCEN2")/
                       priceoutdummy(r,xx,"cons","pricons","VAL", "SCEN2")));

f.l(r,acto) $ sameas (acto,"cons") = sum (xx $ (hconcal(r,xx,"cons") AND inputtoactos(xx,acto)),
        cd(r,xx,acto) * priceoutdummy(r,xx,"cons","pricons","VAL", "SCEN2"));

p.l(r)=poutdummy (r,"VAL", "BAS");
pm.l(r)=pmoutdummy(r,"VAL", "BAS");
pm.lo(r)=0.00000001;
p.lo(r) =0.00000001;
```

```
*       Fix expenditure on meat to value from earlier runs to get started if income.GDX is empty
                                                                              (is later overwritten)
        income.fx("EU")=  964788232092;
        income.fx("URU")= 5493094925;
        income.fx("ARG")= 76467569918 ;
        income.fx("BRA")= 178671170223 ;
        income.fx("ROW")= 4099879455985 ;

*       Take value for meat expenditue from GDX data base and fix income varibale to this value
        execute_load  "income.GDX" incomeout;
        income.fx(r) $ incomeout(r, "VAL", "SCEN2",i) =incomeout(r, "VAL", "SCEN2",i);

*       Overwrite incomeout with value from baseline
        incomeout(r, "VAL", "BAS", i)= incomesave(r,"VAL", "BAS", i) ;

        MULTCOM.limcol   = 0;
        MULTCOM.limrow   = 0;
        MULTCOM.Holdfixed= 0;
        MULTCOM.OPTFILE =  2;

*        Solve restricted model
         SOLVE MULTCOM Using MCP;

*        Compute the share of income spent on meat in the model solution
         isout(r, "VAL", "SCEN2",i)= ai(r)+ bi(r)* LOG(PM.l(r)) + ci(r)* LOG(GDP(r)/P.l(r));

*        Compute and check deviation from fixed income
         convergeSCEN2(r,i)= income.l(r)- is.l(r)* GDP(r);
         DEV(i,"scen2") $ (SMAX((r), ABS(convergeSCEN2(r,i)) ) LT 10)= 0;

*        Compute income allocated to meat in the model solution and store on parameter
         incomeout(r,"VAL", "SCEN2",i)= is.l(r)* GDP(r);
         incomeoutj(r,"VAL", "SCEN2",i, j)=is.l(r)* GDP(r);

*        Unload data into GDX file
```

```
        execute_unload "income.GDX"
                                convergescen1, convergescen2,  incomeoutj, incomeout, dev;

         putclose con "*** second scenario Loop i in progress= " i.tl ;
         putclose con "*** second scenario Loop j done:= "  j.tl ;

*        Close loop
         );

*    Fix income to value from last iteration
     income.fx(r)= incomeout(r,"VAL", "SCEN2",i);

*    Solve model again with income allocated to meat from last iteration
     SOLVE MULTCOM1 Using MCP;

*    Count 1 successful model solutions
     dummy(i,"solv","scen2") $ (multcom.modelstat=1) =1;

     CON.lw = 0;
     CON.nw = 0;
     putclose con "*** second scenario Loop i done:= " i.tl ;

*    Create output
$batinclude Create_output.gms SCEN2

*    Close loop
     );

* Count successful model solutions
solutions("SCEN2")=sum(i, dummy(i,"solv","scen2"));

CON.lw = 0;
CON.nw = 0;
putclose con "*** solutions ABC ";

* Unload data into GDX file
execute_unload  "Results.GDX" processingmarout,tarvout, tarsout, trqntout, tottradeout, totrent,
```

```
                        devpri, devquant, processingdemout,procmargout, tarrev,quotarentout,
                        procrentout,prodrentout,equivalout,welfare, priceout,consumptionout,
                        productionout,tradeflowout, incomeout,  isout, pout, pmout ;

* Write data in XLS file
execute "GDXXRW i=Results.GDX o=RESULTS par=processingdemout RNG=PROCDEM!A1 rdim=5 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=processingmarout RNG=PROCMAR!A1 rdim=5 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=tarrev RNG=TARREV!A1 rdim=5 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=welfare RNG=WELF!A1 rdim=4 cdim=1";
execute "GDXXRW i=Results.GDXX o=RESULTS par=quotarentout RNG=QUOTARENT!A1 rdim=7 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=totrent RNG=totrent!A1 rdim=6 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=procrentout RNG=PROCRENT!A1 rdim=5 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=prodrentout RNG=PRODRENT!A1 rdim=5 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=equivalout RNG=EQUIVAL!A1 rdim=5 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=priceout RNG=PRICE!A1 rdim=6 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=consumptionout RNG=HCON!A1 rdim=5 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=productionout RNG=PRODUCTION!A1 rdim=5 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=tradeflowout RNG=TRADE!A1 rdim=6 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=tarvout RNG=TARV!A1 rdim=4 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=tarsout RNG=TARS!A1 rdim=4 cdim=1";
execute "GDXXRW i=Results.GDX o=RESULTS par=trqntout RNG=TRQNT!A1 rdim=5 cdim=1";

************************** End of programme ************************************************************
```

ANNEX III MODEL CALIBRATION

```
*******************************************************************************************************
*                                                                                                     *
*      Parameter generation process                                                                   *
*                                                                                                     *
*******************************************************************************************************
$offlisting
$include sets.gms

FILE  CON / CON /;
      CON.lw = 0;
      CON.nw = 0;

* Definition of auxiliary parameters
$include auxiliaryparameters.gms

* Definition of parameters
parameter selad_sens(r,xx,yy,acto,i) elasticiy of demand from literature;
parameter elad_sens(r,xx,yy,acto,i)  elasticiy of demand after calibration;
parameter bd_sens(r,xx,yy,acto,i)    slope parameter of demand function after calibration;
parameter cd_sens(r,xx,acto,i)       constant of demand function after calibration ;

parameter selas_sens(r,xx,yy,acto,i) elasticiy of supply from literature;
parameter elas_sens(r,xx,yy,acto,i)  elasticiy of supply after calibration;
parameter bs_sens(r,xx,yy,acto,i)    slope parameter of supply function after calibration ;
parameter cs_sens(r,xx,acto,i)       constant of supply function after calibration ;
```

```
parameter seladm(r)                group demand elasticity of income allocation system taken from literature;
parameter selaym(r)                group income elasticity of income allocation system taken from literature;

parameter bi_sens(r,i)             parameter of income allocation system after calibration;
parameter ci_sens(r,i)             parameter of income allocation system after calibration;
parameter ai_sens(r,i)             parameter of income allocation system after calibration;
parameter eladm_sens(r,i)          group demand elasticity of income allocation system after calibration;
parameter elaym_sens(r,i)          group income elasticity of income allocation system after calibration;
parameter adapt(r,xx,yy,acto)      parameter defining standard deviation of normal distribution
                                   of demand elasticity;
parameter adapty(r,xx,acto)        parameter defining standard deviation of normal distribution
                                   of income elasticity;

parameter  GDP(r)                  Gross Domestic Product;
parameter  income(r)               income allocated to meat products;

* Definition of variables
variable ai(r)                     constant term of income allocation system;
variable bi(r)                     slope parameter of income allocation system;
variable ci(r)                     slope parameter of income allocation system ;
variable pm(r)                     meat price index;
variable p(r)                      price index;



* Load data
execute_load "Startvalues.gdx",  bd_cal, bs_cal, cd_cal, cs_cal;
execute_load "Incomeparameters.gdx" GDP,  Pcal, PMcal,iscal;
execute_load "Basedata.gdx"  prodtcal, procdemcal, hconcal, prical,income, priconscal, procmargcal,leofact;


* Read elasticities from literature
$include elasticities.gms

*******************************************************************************************************
```

```
  equations
*       behavioural functions
        prodt_(r,xx,acto)        production of farmers and slaughterhouses and freezers
        procdem_(r,xx,acto)      demand of processors for beef_ah and beef_ao
        hcon_(r,xx,acto)         demand by consumers
        procmarg_(r,xx, acto)    processing margin of the  slaughterhouse


*       equations needed for the calibration procedure

*       supply
        hess_(r,xx,yy,acto)       calculation of the slope parameter for supply
        chol_(r,xx,yy,acto)       test whether b can be decomposed by means of the cholesky decomposition
        homs_(r,xx,acto)          equation imposing something, maybe adding up?
        penaltys_                 penalty function to achieve least squared deviation from given elasticities
        symms_                    equation imposing symmetry on bs matrix
        DET1_(r,acto)             first principal minor
        DET2_(r,acto)             second principal minor
        control2_(r,xx,acto)      equation controling for relation of elasticities
        control1_(r,xx,yy)        equation controling for sign of the intercept

*       demand
        f_(r,acto)                 part of the generalized leontief expenditure system
        g_(r,acto)                 part of the generalized leontief expenditure system
        gi_(r,xx,acto)             first derivative of g versus own prices
        gij_(r,xx,yy,acto)         second derivative of g versus  prices
        elad_(r,xx,yy,acto)        price elasticiy of demand
        elado_(r,xx,yy,acto)       cross price elasticity of demand
        elay_(r,xx,acto)           income elasticity of demand

        penaltyd_                  penalty function to achieve least squared deviation from given elasticities
        symmd_                     equation imposing symmetry on bd matrix

*       income allocation system
        is_                        equation determining share of  income allocated to meat
        elaym_                     equation defining group income elasticity
        eladm_                     equation defining group price elasticity
```

```
penaltym_               squared deviation from given elasticities
homm_                   equation assuring homogeneity
income_                 equation determining income spent on meat
 ;
```

```
  Variables
        pri(r,xx,acto)          producer price
        pricons(r,xx)           consumer price
        prodt(r,xx,acto)        production of each of the actors
        procdem (r,xx,acto)     demand of processors for beef_ah and beef_ao
        hcon (r,xx,acto)        demand by consumers
        procmarg(r,xx,acto)     processing margin of the processing sector

*       variables needed for the calibration procedure
*       supply and demand of the processing industry

        elas(r,xx,yy,acto)      supply elasticities that give parameters in line with micro economic theory
        bs(r,xx,yy,acto)        matrix of slope parameters for SUPPLY ( hessian matrix of objective function)
        cs(r,xx,acto)           constant term of the supply function
        penaltys                squared deviation from given elasticities for supply and for demand of the
                                processing industry
        DET1(r,acto)            first principal minor
        DET2(r,acto)            second principal minor
        priq0(r,xx,acto)

*       human consumption
        elad(r,xx,yy,acto)     price elasticities of demand in line with microeconomic theory
        elay(r,xx,acto)        income elasticites of demand in line with microeconomic theory
        bd(r,xx,yy,acto)       matrix of slope parameters for DEMAND (hessian matrix of objective function)
        cd(r,xx,acto)          constant term of demand function
        g(r,acto)              part of the generalized leontief expenditure system
        gi(r,xx,acto)          first derivative of g versus own prices
        gij(r,xx,yy,acto)      second derivative of g versus own and cross prices
        f(r,acto)              part of the generalized leontief expenditure system
        penaltyd               squared deviation from given elasticities for demand
```

```
*       income allocation system
        is(r)                   share of  income allocated to meat
        elaym(r)                group income elasticity
        eladm(r)                group price elasticity
        penaltym                squared deviation from given elasticities
        ;

positive variable DET1;
positive variable DET2;
parameter prindex(r);
prindex(r)=1;


************************* Model equations  ***********************************************************************

*     Income  allocated to meat
      income_(r) ..
      income(r)=E=is(r)* GDP(r);

*     Equation determining the share of income spent on meat
      is_(r) ..
      is(r)=E= (ai(r)+ bi(r)* LOG(PM(r)) + ci(r)* LOG(GDP(r)/P(r)));

*     Price elasticity of meat consumption
      eladm_(r)..
      eladm(r)=E=-1+bi(r)/is(r)-ci(r);

*     Income elasticiy of meat
      elaym_(r)..
      elaym(r)=E= 1+ci(r)/is(r);

*     Penalty function

*     Human consumption
      hcon_(r,xx,acto) $ (hconcal(r,xx,acto) and sameas(acto,"cons"))..
```

```
              HCon(r,xx,acto)=E=cd(r,xx,acto)  + gi(r,xx,acto)/g(r,acto) *  (income(r) - f(r,acto));

*     Demand of the processing
      procdem_(runr,xx,acto) $ procdemcal(runr,xx,acto)..
           procdem(runr,xx,acto) =E= (cs(runr,xx,"slau") + sum(yy $ (inputtoactos(yy,acto)),
                    bs(runr,xx,yy,"slau") * procmarg(runr, yy,"slau")/prindex(runr))) $ (sameas(acto,"slau")
                                                                    AND inputtoactos(xx,acto))

               + (cs(runr,xx,"freez") + sum(yy $ (inputtoactos(yy,acto)),
                   bs(runr,xx,yy,"freez") * procmarg(runr,yy,"freez")/prindex(runr))) $ (sameas(acto,"freez")
                                                                  AND (inputtoactos(xx,acto)));

*    Supply function for famers, slaughterhouses and freezing units
      prodt_(runr,xx,acto) $ ( prodtcal(runr,xx,acto) AND xxtocountries(runr,xx) AND
                                          (sameas (acto, "farm"))).

            prodt(runr,xx,acto) =E= (cs(runr,xx,acto) + sum (yy $ (outputtoactos(yy,acto)
                                AND prodtcal(runr,yy,acto)),
                                      bs(runr,xx,yy,acto) * (pri(runr,yy,acto))/prindex(runr)))
                                                          $ (sameas (acto, "farm")
                                                              AND outputtoactos(xx,acto))

                + sum(yy $ (inputtoactos(yy,acto)),procdem(runr,yy, "slau") * leofact(runr,yy,xx ))
                                      $ (sameas (acto,"slau")AND (outputtoactos(xx,acto)))

                                  + (procdem("arg","high_fre_arg",acto)) $ (sameas (acto,"freez")
                                                                          AND sameas(xx,"other_fro_arg")
                                                                          AND sameas(runr,"arg"))


                                  + (procdem("arg","other_fre_arg",acto)) $ (sameas (acto,"freez")
                                                                           AND sameas(xx,"other_fro_arg")
                                                                           AND sameas(runr,"arg"))

                                  + (procdem("bra","high_fre_bra",acto)) $ (sameas (acto,"freez")
                                                                           AND sameas(xx,"other_fro_bra")
                                                                           AND sameas(runr,"bra"))
```

```
                    + (procdem("bra","other_fre_bra",acto)) $ (sameas (acto,"freez")
                                                        AND sameas(xx,"other_fro_bra")
                                                        AND sameas(runr,"bra"))

                    + (procdem("uru","high_fre_uru",acto)) $ (sameas (acto,"freez")
                                                        AND sameas(xx,"other_fro_uru")
                                                        AND sameas(runr,"uru"))


                    + (procdem("uru","other_fre_uru",acto)) $ (sameas (acto,"freez")
                                                        AND sameas(xx,"other_fro_uru")
                                                        AND sameas(runr,"uru"))


                    + (procdem("row","high_fre_row",acto)) $ (sameas (acto,"freez")
                                                        AND sameas(xx,"other_fro_row")
                                                        AND sameas(runr,"row"))

                    + (procdem("row","other_fre_row",acto)) $ (sameas (acto,"freez")
                                                        AND sameas(xx,"other_fro_row")
                                                        AND sameas(runr,"row"))

                    + (procdem("eu","high_fre_eu",acto)) $ (sameas (acto,"freez")
                                                        AND sameas(xx,"other_fro_eu")
                                                        AND sameas(runr,"eu"))

                    + (procdem("eu","other_fre_eu",acto)) $ (sameas (acto,"freez")
                                                        AND sameas(xx,"other_fro_eu")
                                                        AND sameas(runr,"eu"));



*   Definition of the hessian matrix
    hess_(runr,xx,yy,acto) $ (((prodtcal(runr,xx,acto) AND prodtcal(runr,yy,acto)and sameas(acto,"farm"))
                        OR (procdemcal(runr,xx,acto) AND procdemcal(runr,yy,acto)))
                         AND xxtocountries(runr,xx) and xxtocountries(runr,yy))..
```

```
*          for farmers
           bs(runr,xx,yy,acto) =E= elas(runr,xx,yy,acto) *  ((prodt(runr,xx,acto)/pri(runr,yy,acto)) $

                                                              (sameas(acto,"farm") AND prodtcal(runr,xx,acto)
                                                                          and outputtoactos(xx,acto)
                                                                          and outputtoactos(yy,acto))

*           for the meat industry
                                                     +  ((procdem(runr,xx,acto)/procmarg(runr,yy,acto))
                                                            $ (procdemcal(runr,xx,acto)
                                                                      AND (sameas (acto,"slau")
                                                                         OR sameas (acto,"freez")))));


*     Equation ensuring homogeneity
      homs_(runr,xx,acto) $ (NOT sameas (acto,"freez") AND xxchol(xx,acto) and xxtocountries(runr,xx))..
               sum(yy $ (xxchol(yy,acto) and xxtocountries(runr,yy)), elas(runr,xx,yy,acto))=G= 0;

*      Equation ensuring symmetry
       symms_(runr,xx,yy,acto) $ (not sameas(acto, "cons") and not sameas(acto,"freez")
                                  AND xxchol(xx,acto) AND xxchol(yy,acto)
                                  AND ((procdemcal(runr,xx,acto) AND procdemcal(runr,yy,acto))
                                  OR  (prodtcal(runr,xx,acto) AND prodtcal(runr,yy,acto))))..

                                  bs(runr,xx,yy,acto) =E= bs(runr,yy,xx,acto);

*     Equation ensuring correct sign of intercept
      control2_(r,xx,acto) $ (sameas(acto,"farm")and prodtcal(r,xx,"farm"))..
                           priq0(r,xx,"farm") =E= (-cs(r,xx,"farm")-sum(yy $ (not sameas(xx,yy)),
                                                  bs(r,xx,yy,"farm") * prical(r,yy,"farm") ))/
                                                         bs(r,xx,xx,"farm");


*      Definition of determinants for both farmers and slaughterhouses
       DET1_(runr,acto) $ (not sameas(acto, "freez"))..
```

```
      DET1(runr,acto)=E=
*             a11*a22
              PROD(xx $ (ORD(XX) LT 3), bs(runr,xx,xx,acto))-
*            - a12*a21
              PROD((xx,yy) $ ((ORD(XX) LT 3) AND (ORD(YY) LT 3) AND (NOT SAMEAS(xx,yy))),
                             bs(runr,xx,yy,acto));

*      Definition of determinant for farmers
       DET2_(runr,acto) $ (sameas(acto,"farm"))..

       DET2(runr,acto)=E=
*             a11*a22*a33
              PROD(xx, bs(runr,xx,xx,"farm"))

*            + a12*a23*a31
             + PROD((xx,yy) $ (
                       ((ORD(XX) EQ 1) AND (ORD(YY) EQ 2))
                   OR  ((ORD(XX) EQ 2) AND (ORD(YY) EQ 3))
                   OR  ((ORD(XX) EQ 3) AND (ORD(YY) EQ 1))
                              ), bs(runr,xx,yy,"farm"))

*            +a13*a21*a32
             + PROD((xx,yy) $ (
                       ((ORD(XX) EQ 1) AND (ORD(YY) EQ 3))
                   OR  ((ORD(XX) EQ 2) AND (ORD(YY) EQ 1))
                   OR  ((ORD(XX) EQ 3) AND (ORD(YY) EQ 2))
                              ), bs(runr,xx,yy,"farm"))
*            -a31*a22*a13
             - PROD((xx,yy) $ (
                       ((ORD(XX) EQ 3) AND (ORD(YY) EQ 1))
                   OR  ((ORD(XX) EQ 2) AND (ORD(YY) EQ 2))
                   OR  ((ORD(XX) EQ 1) AND (ORD(YY) EQ 3))
                              ), bs(runr,xx,yy,"farm"))
*            -a32*a23*a11
             - PROD((xx,yy) $ (
                       ((ORD(XX) EQ 3) AND (ORD(YY) EQ 2))
                   OR  ((ORD(XX) EQ 2) AND (ORD(YY) EQ 3))
```

```
                OR   ((ORD(XX) EQ 1) AND (ORD(YY) EQ 1))
                                ), bs(runr,xx,yy,"farm"))

*            -a33*a21*a12
             - PROD((xx,yy) $ (
                      ((ORD(XX) EQ 3) AND (ORD(YY) EQ 3))
                OR   ((ORD(XX) EQ 2) AND (ORD(YY) EQ 1))
                OR   ((ORD(XX) EQ 1) AND (ORD(YY) EQ 2))
                                ), bs(runr,xx,yy,"farm"));

*     Definition of the penalty function
      penaltys_..
           penaltys =E= sum((runr,xx,yy,acto) $ (selas(runr,xx,yy,acto)),
                                SQR(elas(runr,xx,yy,acto) - selas(runr,xx,yy,acto)));
      penaltym_.. penaltym =E=SUM(r, SQR(selaym(r)-selaym(r)) + SQR (seladm(r)-eladm(r)));
*     Homogeneity  condition  for  income  module
      homm_(r).. elaym(r)+eladm(r)=E=0;

*     Definition of the equation f
      f_(r,acto) $ sameas (acto,"cons")..
      f(r,acto) =E= sum (xx $ (hconcal(r,xx,"cons") AND inputtoactos(xx,acto)), cd(r,xx,acto) * pricons(r,xx));


*     Definition of g
      g_(r,acto) $ (sameas(acto,"cons"))..
      g(r,acto)=E=sum((xx,yy) $  (hconcal(r,xx,acto) AND hconcal(r,yy,acto)),
                                  (bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
                               +  bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))*SQRT(pricons(r,xx)*pricons(r,yy)));

*     Definition of gi
      gi_(r,xx,acto) $ (sameas (acto,"cons")AND priconscal(r,xx) and  hconcal(r,xx,acto))..
      gi(r,xx,acto)=E=sum(yy $ (hconcal(r,yy,acto) and priconscal(r,yy)),
                                 (bd(r,xx,yy,acto) $ (ORD(XX) LE ORD(YY))
                               + bd(r,yy,xx,acto) $ (ORD(XX) GT ORD(YY)))* SQRT(pricons(r,yy) /pricons(r,xx)));
```

```
*     Definition of Gij
 gij_(r,xx,yy,acto)$(sameas(acto,"cons")and hconcal (r,xx,acto)and hconcal(r,yy,acto) and not  sameas(xx,yy))..
      gij(r,xx,yy,acto) =E= (( bd(r,xx,yy,acto) $ (ORD(xx) LE ORD(yy))+  bd(r,yy,xx,acto)
                                                                          $ (ORD(xx) GT ORD(yy)))
                            * 0.5/ SQRT(pricons(r,yy) * pricons(r,xx)))
                            +(sum(zz $ (not sameas (xx,zz)and hconcal(r,zz,acto)), bd(r,xx,zz,acto)
                            *(-0.5)*(pricons(r,xx)**(-1.5))*(pricons(r,zz)**0.5))) $ (sameas(xx,yy));


*     Definition of price elasticities
      elad_(r,xx,yy,acto) $  (hconcal(r,xx,acto) AND hconcal(r,yy,acto) AND sameas (acto,"cons")
                              AND not sameas (xx,yy))..
      elad(r,xx,yy,acto)=E=((gij(r,xx,yy,acto) / g(r,acto)- gi(r,xx,acto) * gi(r,yy,acto) / SQR(g(r,acto))) *
                            (income(r)-f(r,acto))
                           - gi(r,xx,acto)/g(r,acto) * cd(r,yy,acto))* pricons(r,yy)/prindex(r)/hcon(r,xx,acto);

      elado_(r,xx,xx,acto) $ (hconcal(r,xx,acto) AND hconcal(r,xx,acto) AND sameas(acto,"cons") ) ..

      elad(r,xx,xx,acto) =E= (((gij(r,xx,xx,acto)*g(r,acto)-SQR(gi(r,xx,acto)))/SQR(g(r,acto))  )
                           * (income(r)-sum(yy $ priconscal(r,yy), pricons(r,yy)* cd(r,yy,acto)))
                           + cd(r,xx,acto)* (gi(r,xx,acto)/g(r,acto)))*
                           (pricons(r,xx)/prindex(r)/hcon(r,xx,"cons"));


*     Definition of the income elasticity
      elay_(r,xx,acto) $ (hconcal(r,xx,acto) AND sameas (acto,"cons"))..
      elay(r,xx,acto) =E= gi(r,xx,acto) / g(r,acto) * (income(r)/ hcon(r,xx,acto));


*     Ensuring symmetry
      symmd_(r,xx,yy,acto) $ (hconcal(r,xx,acto) and hconcal(r,yy,acto)AND sameas (acto, "cons")
                           AND inputtoactos(xx,acto) AND inputtoactos(yy,acto) and (not sameas(XX,YY)))..
                           bd(r,xx,yy,acto)=E=bd(r,yy,xx,acto);


*     Ensure that elasticity of slaughterhouses is higher than farmers (arbitrary value: 5 percent)
      control1_ (runr,xx, xx) $ (prodtcal(runr,xx,"farm")) ..
```

```
     elas(runr,xx, xx,"slau") =G=  elas(runr,xx, xx,"farm")*1.05;

*    Definition of the penalty function

     penaltyd_ .. penaltyd =E=  SUM((r,xxt,yyt) $ (hconcal(r,xxt,"cons") AND hconcal(r,yyt,"cons")),
                           SQR(elad(r,xxt,yyt,"cons")- selad(r,xxt,yyt,"cons")))
                           +  SUM((r, xxt) $ (inputtoactos(xxt,"cons") and hconcal(r,xxt,"cons")),
                           SQR(elay(r,xxt,"cons") - selay(r,xxt,"cons")));



*********  Preparations for optimisation process ******************************************************
*    Supply side
*    Fix some variables to their base year values
     prodt.fx(r,xx,acto)     = prodtcal(r,xx,acto);
     procdem.fx(r,xx,acto)   = procdemcal(r,xx,acto);
     hcon.fx (r,xx,acto)     = hconcal(r,xx,acto);
     pri.fx(r,xx,acto)       = prical(r,xx,acto);
     pricons.fx(r,xx)        = priconscal(r,xx);
     procmarg.fx(r,xx,acto)  = procmargcal(r,xx,acto);

*   Set start values
     elas.l(runr,xx,yy,acto) $ selas(runr,xx,yy,acto) = selas(runr,xx,yy,acto);
     elas.l(r,xx,xx,"freez") $ procdemcal(r,xx,"freez")=0.3;
     elas.l(r,xx,yy,acto)    $ (NOT xxchol(xx,acto))= 0;

*    Fix supply elasticities for products that cannot be produced to zero
     elas.fx(r,xx,yy,acto) $ (not sameas(xx,yy) AND not prodtcal(r,yy,acto) )=0 ;

*    Set some bounds
     elas.lo(r,xx,xx,"farm")     $ selas(r,xx,xx,"farm")= selas(r,xx,xx,"farm")/50;
     bs.lo(r,xx,xx,"farm")       $ prodtcal(r,xx,"farm")= 1;
     elas.lo("uru",xx,yy,"farm") $ (prodtcal("uru",xx,"farm") and prodtcal("uru",yy,"farm"))= -5;
     elas.up(r,xx,yy,"farm")     $ (not sameas(xx,yy)) = 0;
     elas.lo(r,xx,xx,"slau")                           = 0.009;
     elas.lo(r,xx,yy,"slau")     $ (not sameas(xx,yy)) = -2;
     elas.lo("EU",xx,yy,"slau")  $ (not sameas(xx,yy)) = -0.5;
```

```
      elas.up(r,xx,yy,"slau") $ (not sameas(xx,yy)) = 0;
      elas.up(r,xx,yy,"slau") $ (not sameas(xx,yy) and not sameas(r, "URU")and
               not sum(omea $ sameas(xx,omea),1)and not sum(omea $ sameas(yy,omea),1) ) = -0.1;
      elas.up(r,xx,yy,"farm") $ (not sameas(xx,yy)and not sameas(r, "URU")and
                not sum(omea $ sameas(xx,omea),1)and not sum(omea $ sameas(yy,omea),1)) = -0.1;
      elas.lo(r,xx,xx,"freez") = 0;
      elas.lo(r,xx,yy,"freez") $ (not sameas(xx,yy)) =-0.8;
      elas.up(r,xx,yy,"freez") $ (not sameas(xx,yy)) = 0;

*     Put start value (from earlier run) on values of the hessian matrix and on constant
      bs.l(r,xx,yy,acto) $ prical(r,xx,acto) = bs_cal(r,xx,yy,acto);
      cs.l(r,xx,acto)=cs_cal(r,xx,acto);

*     Impose sign on the constant terms
      cs.lo(r,xx,"farm")=0;
      cs.lo(r,xx,"slau")=0;
      cs.lo(r,xx,"freez")=0;

*     Demand side
*     Put bounds and start values (from earlier runs)
      cd.lo(r,xx,acto)=0;
      cd.l(r,xx,acto) = cd_cal(r,xx,acto);

      f.lo (r, acto)=0;
      f.l(r,acto) $ sameas (acto,"cons") = sum ((xx) $  (hconcal(r,xx,"cons")),cd.l(r,xx,acto)
                   * pricons.l(r,xx));
      bd.lo(r,xx,yy,acto) $ (NOT sameas(xx,yy) and hconcal(r,xx,acto) and
                                          hconcal(r,yy,acto)) = bd_cal(r,xx,yy,acto)*0.5;
      bd.l (r,xx,xx,"cons") $ (hconcal(r,xx,"cons"))=bd_cal(r,xx,xx,"cons")*0.8;
      bd.lo (r,xx,xx,"cons") $ (hconcal(r,xx,"cons"))=bd_cal(r,xx,xx,"cons")*1.5;
      bd.up(r,xx,xx,"cons")=0;
      bd.up("BRA","other_fre_bra", "other_fre_bra", "cons")=-0.0000001;
      bd.l (r,xx,yy,acto) $ ( sameas(acto,"cons") AND NOT bd.l (r,xx,yy,acto) AND inputtoactos(xx,acto)
                                         AND inputtoactos(yy,acto)) = bd_cal(r,xx,yy,acto);
      g.l(r,acto)   $ sameas (acto,"cons") = sum((xx,yy) $ (hconcal(r,xx,acto) AND hconcal(r,yy,acto)),
                                bd.l(r,xx,yy,acto) * SQRT(pricons.l(r,xx) * pricons.l(r,yy)));
      g.lo(r,acto) = 0.000005;
```

```
gi.l(r,xx,acto)   $ (sameas (acto,"cons") AND priconscal(r,xx) AND hconcal(r,xx,acto))
            = sum((yy) $ (hconcal(r,yy,acto)), bd.l(r,xx,yy,acto) *
                                                SQRT(pricons.l(r,yy)/pricons.l(r,xx)));

gij.l(r,xx,yy,acto) $ (sameas (acto,"cons")AND hconcal(r,xx,acto)AND
                                                        hconcal(r,yy,acto)AND (not sameas (xx,yy)))
          = (bd.l(r,xx,yy,acto)  * 0.5/SQRT(pricons.l(r,xx) * pricons.l(r,yy)))
                                     $ (hconcal(r,xx,acto) and hconcal(r,yy,acto)AND(not sameas (xx,yy)));

elay.lo(r,xx,acto)$ hconcal(r,xx,acto) =0.01;
elay.l(r,xx,acto) $ (hconcal(r,xx,acto) AND sameas (acto,"cons"))= gi.l(r,xx,acto) / g.l(r,acto)
            * (income(r)/ hcon.l(r,xx,acto));
elay.up(r,xx,acto)$ hconcal(r,xx,acto)=10;

elad.l(r,xx,yy,acto) = 0;
elad.l(r,xx,yy,acto) $ (hconcal(r,xx,acto) and hconcal(r,yy,acto) AND sameas (acto,"cons")AND
           not sameas (xx,yy))
     = ((gij.l(r,xx,yy,acto) / g.l(r,acto)
      - ((gi.l(r,xx,acto) * gi.l(r,yy,acto)) / SQR(g.l(r,acto)))) * (income(r)-f.l(r,acto))
      - (gi.l(r,xx,acto)/g.l(r,acto)) * cd.l(r,yy,acto))
                 * pricons.l(r,yy)/prindex(r)/hcon.l(r,xx,acto);

elad.l(r,xx,xx,acto) $ (hconcal(r,xx,acto))= - sum(yy $ hconcal(r,yy,acto),
          elad.l(r,xx,yy,acto)) - elay.l(r,xx,acto);
elad.lo(r,xx,yy,acto) $ (hconcal(r,xx,acto) AND hconcal(r,yy,acto) AND not sameas(yy,xx))
                        = 0.000001;

*    Put lower limit on cross price elasticities within meat of high quality
     elad.lo(r,bfh, bfh1,"cons") $ (sameas(r, "EU") and hconcal(r,bfh,"cons") and hconcal(r,bfh1,"cons")
                                       and (not sameas(bfh, bfh1)))=0.001;

     elad.up(r,xx,yy,acto) $ (hconcal(r,xx,acto) AND hconcal(r,yy,acto) AND not sameas(yy,xx)) = 2;

*    Limit the range of the own price elasticites
     elad.up (r,xx,xx,acto) $ hconcal(r,xx,acto)=-0.01;
     elad.lo (r,xx,xx,acto) $ hconcal(r,xx,acto)=-2;
```

```
*    Limit cross price elasticities between different quality to small values
     elad.up("EU", bfh, bfo, "cons") $ (hconcal("EU",bfh,"cons") and hconcal("EU",bfo,"cons")) = 0.05;
     elad.up("EU", bfo, bfh, "cons") $ (hconcal("EU",bfh,"cons") and hconcal("EU",bfo,"cons")) = 0.05;

     elad.up("EU", bfh, bff, "cons") $ (hconcal("EU",bfh,"cons") and hconcal("EU",bff,"cons")) = 0.05;
     elad.up("EU", bff, bfh, "cons") $ (hconcal("EU",bfh,"cons") and hconcal("EU",bff,"cons")) = 0.05;


****** Define and solve models ***************************************************************

*     Supply
      MODEL TrimElas /homs_,penaltys_, prodt_,procdem_, hess_,control1_, DET1_, DET2_, symms_,  control2_ /;

      TrimElas.limcol    = 0;
      TrimElas.limrow    = 5;
      TrimElas.limrow    = 0;
      TrimElas.solprint  = 1;
      TrimElas.Holdfixed = 1;
      TrimElas.Holdfixed = 0;

      Solve TrimElas USING NLP Minimizing Penaltys;

*    Demand
     MODEL TrimElad / g_, gi_, f_, gij_,elad_,elado_,elay_,hcon_, symmd_, penaltyd_ /;

     TrimElad.limcol    = 0;
     TrimElad.limrow    = 0;
     TrimElad.solprint  = 1;
     TrimElad.Holdfixed = 0;
     TrimElad.optfile   = 2;

     Solve TrimElad USING NLP Minimizing Penaltyd;

******** Calibration of the parameters of the income module**********************

*   Fix variables to their base year values
```

```
    is.fx(r)    = iscal(r);
    P.fx(r)     = pcal(r);
    PM.fx(r)    = pmcal(r);

*   Read elasticities for group expenditure
$include groupelas.gms

*   Set bounds
    ai.lo(r)=0;
    eladm.up(r)=0;

    elaym.up(r)=selaym(r)*5;
    elaym.lo(r)=selaym(r)/2;

    eladm.l(r)=seladm(r);
    elaym.l(r)=selaym(r);

*   Define and solve model
    MODEL TRIMEXP/is_,elaym_,eladm_,penaltym_, homm_ /;

    TrimExp.limcol    = 0;
    TrimExp.limrow    = 0;
    Trimexp.solprint  = 1;

    SOLVE TRIMEXP Using NLP minimizing Penaltym;

*   Store results
    eladm_cal(r)=eladm.l(r);
    elaym_cal(r)=elaym.l(r);
    incomecal(r)=income(r);
    elay_cal(r,xx,acto)=elay.l(r,xx,acto);

    elas_cal(r,xx,yy,acto)= elas.l(r,xx,yy,acto);
    elad_cal(r,xx,yy,"cons")= elad.l(r,xx,yy,"cons");

    bs_cal(r,xx,yy,acto)= bs.l(r,xx,yy,acto);
    cs_cal(r,xx,acto)= cs.l(r,xx,acto);
```

```
    bd_cal(r,xx,yy,acto)= bd.l(r,xx,yy,acto);
    cd_cal(r,xx,acto)=  cd.l(r,xx,acto);


****** Start random generation of elasticities ******************************************************

* Store elasticities from first calibration on parameter
  selaym_ori(r)=selaym(r);
  seladm_ori(r)=seladm(r);

  selad_ori(r,xx,yy,acto)=selad(r,xx,yy,acto);
  selas_ori(r,xx,yy,acto)=selas(r,xx,yy,acto);

* Load factors derived from the standard error
execute_load "STNDERROR.gdx",ADAPT, ADAPTY;

* Set the factor arbitrarily to 0.5 where no value from literature exists

  ADAPT(r,xx,yy,acto) $ (not ADAPT(r,xx,yy,acto) AND ((hconcal(r,xx,acto) AND hconcal(r,yy,acto)) OR
                      (prodtcal(r,xx,acto) AND prodtcal(r,yy,acto)) OR (procdemcal(r,xx,acto)
                          AND procdem_cal(r,yy,acto))))=0.5;

  ADAPTY(r,xx,"cons") $ (not ADAPTY(r,xx,"cons") AND hconcal(r,xx,"cons"))=0.5;
```

```
* Demand
* Start loop
LOOP(i,

*      Create random elasticities
       selad(r,xx,yy,acto) =NORMAL(selad(r,xx,yy,acto), ABS(selad(r,xx,yy,acto))* ADAPT(r,xx,yy,acto));

*      For the first iteration, set elasticity back to original value
       selad(r,xx,yy,acto) $ sameas(i,"1")= selad_ori(r,xx,yy,acto);


*      Solve model
       Solve TrimElad USING NLP Minimizing Penaltyd;

*      Store results
       bd_sens(r,xx,yy,acto,i)  $ (trimelad.modelstat=2 OR trimelad.modelstat = 7)= bd.l(r,xx,yy,acto);
       cd_sens(r,xx,acto,i)     $ (trimelad.modelstat=2 OR trimelad.modelstat = 7)= cd.l(r,xx,acto);
       elad_sens(r,xx,yy,acto,i)$ (trimelad.modelstat=2 OR trimelad.modelstat = 7)= elad.l(r,xx,yy,acto);

*      reset selad to original elasticities
       selad(r,xx,yy,acto)= selad_ori(r,xx,yy,acto);


       putclose con "*** TRIMELAD Loop i done= " i.tl ;
       CON.lw = 0;
       CON.nw = 0;
* Close loop

  );


* Supply
* Start loop
 LOOP(i,
```

```
*      Create random elasticities
       selas(r,xx,yy,acto) = NORMAL(selas(r,xx,yy,acto), ABS(selas(r,xx,yy,acto))* ADAPT(r,xx,yy,acto));

*      For the first iteration, set elasticity back to original value
       selas(r,xx,yy,acto) $ sameas(i,"1")= selas_ori(r,xx,yy,acto);


*      Solve model

       TrimElas.limcol    = 0;
       TrimElas.limrow    = 0;
       TrimElas.solprint  = 1;
       TrimElas.Holdfixed = 1;

       Solve TrimElas USING NLP Minimizing Penaltys;

*      Store results
       bs_sens(r,xx,yy,acto,i) $ (trimelas.modelstat=2 OR trimelas.modelstat = 7)= bs.l(r,xx,yy,acto);
       cs_sens(r,xx,acto,i)    $ (trimelas.modelstat=2 OR trimelas.modelstat = 7)= cs.l(r,xx,acto);
       elas_sens(r,xx,yy,acto,i)=elas.l(r,xx,yy,acto);

*      Reset selas to original elasticities
       selas(r,xx,yy,acto)= selas_ori(r,xx,yy,acto);

* Close loop
        );


* Income allocation module

* Read elasticities for groups
$include groupelas.gms
```

```
* Start loop
 LOOP(i,

*   Set bounds and start values
    ai.lo(r)=0;
    eladm.up(r)=-EPS;
    elaym.lo(r)= EPS;

    eladm.l(r)=seladm(r);
    elaym.l(r)=selaym(r);

*   Create random elasticities
    seladm(r) $ (not sameas(i, "1")) = NORMAL(seladm(r), ABS(seladm(r))*0.5);
    selaym(r) $ (not sameas(i, "1"))=  NORMAL(selaym(r), ABS(selaym(r))*0.5);

*   Solve model
    SOLVE TRIMEXP Using NLP minimizing Penaltym;

*   Store results
    ai_sens(r,i)$ (trimexp.modelstat=2 OR trimexp.modelstat = 7)=ai.l(r);
    bi_sens(r,i)$ (trimexp.modelstat=2 OR trimexp.modelstat = 7)=bi.l(r);
    ci_sens(r,i)$ (trimexp.modelstat=2 OR trimexp.modelstat = 7)=ci.l(r);
    eladm_sens(r,i)$(trimexp.modelstat=2 OR trimexp.modelstat = 7)=eladm.l(r);
    elaym_sens(r,i)$(trimexp.modelstat=2 OR trimexp.modelstat = 7)=elaym.l(r);

*   Reset to original elasticities
    seladm(r)=seladm_ori(r);
    selaym(r)=selaym_ori(r);
* Close loop
      );

* Store parameters
execute_unload "Parameters.gdx"  bd_sens, cd_sens, elad_sens, ai_sens, bi_sens, ci_sens, eladm_sens,
                                 bs_sens, income,cs_sens elas_sens, elaym_sens;


************************************ End of programme ************************************************
```