Macedonia at the doorstep of the European Union

- A Partial Equilibrium Analysis of the Implications for the Feed-Livestock Complex

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Macedonia at the doorstep of the European Union
- A Partial Equilibrium Analysis of the Implications for the Feed-Livestock Complex

Makedonien på tröskeln till Europeiska Unionen
- En partiell jämviktsanalys av konsekvenserna för foder- och boskapskomplexet

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Abstract

Macedonia, which applied for membership in the European Union in March 2004 and was granted candidate status in December 2005, is likely to become a member, if and when the next enlargement takes place. Now, at the doorstep of the European Union and before real accession negotiations start, it is a good idea for policy makers and the general public in Macedonia to carefully analyze the likely effects of membership and to consider what can be done to dampen the negative aspects and to get the most out of the good ones.

In this thesis the implications of Macedonia's possible accession to the European Union is analyzed. Focus is on the effects on Macedonia's agriculture in general and the feed-livestock complex in particular. The method used is twofold and consists of a qualitative and a quantitative assessment. The qualitative analysis includes an introduction to Macedonia and Macedonia's agriculture. The use of models in economic trade analysis is also discussed in connection with a review of relevant literature. The quantitative analysis is based on a comparative static analysis of a set of scenarios related to a possible future accession. In order to carry out this analysis, a synthetic single-country partial equilibrium model for the feed and livestock complex in Macedonia has been constructed, calibrated, and used for scenario analysis. The scenario analysis allows for some general conclusions to be drawn but its strength lies in its impact assessment of individual commodities in the feed-livestock complex. The model simulation indicates that EU-Accession "today" would have a significant impact on the feed-livestock complex in Macedonia. However, these impacts will vary from one commodity to another in both magnitude and signs as the rates of support to individual commodities in the EU and in Macedonia diverge. The adjustment of Macedonian support levels to EU standards will therefore imply both raises and cuts.

Keywords: Economic modeling, partial equilibrium model, comparative statics analysis, FYR Macedonia, feed-livestock complex, EU enlargement

Sammanfattning

Makedonien ansökte om medlemskap i den Europeiska Unionen i mars 2004 och beviljades kandidatstatus i december 2005. Nu på tröskeln till den Europeiska Unionen och innan regelrätta medlemskapsförhandlingar äger rum är det en god idé för politiker och den breda allmänheten att noggrant analysera de potentiella konsekvenserna av ett medlemskap, liksom att begrunda vad som kan göras för att mildra de negativa följderna och få ut det mesta av de positiva.

Syftet med den här studien är att analysera de tänkbara konsekvenserna av ett makedonskt EU-medlemskap. I fokus är det makedonska jordbruket i stort men i synnerhet dess foder- och boskapskomplex. Den valda metoden är tvåfaldig och innehåller både en kvalitativ och en kvantitativ analys. I den kvalitativa delen ges en introduktion till Makedonien och landets jordbrukssektor. Här ryms också en genomgång av det makroekonomiska läget i landet samt en analys av konsumtionsmönster och jordbrukspolitik. Användandet av ekonomiska modeller i den här typen av analyser diskuteras även och en diskussion förs kring för sammanhanget relevant litteratur. Den kvantitativa delen bygger på en statisk jämförande analys av ett antal scenarier relaterade till en möjlig framtida EU-anslutning. I detta syfte har en syntetisk partiell jämviktsmodell för det makedonska foder- och boskapskomplexet konstruerats och kalibrerats. Från resultaten kan ett antal övergripande slutsatser dras men simuleringens styrka ligger i de slutsatser som kan dras om enskilda produkter. Scenarioanalysen ger vid handen att ett EU-medlemskap ”idag” kommer att ha en betydande påverkan på Makedoniens foder – och boskapsproduktion. De olika stödnivåerna i EU och i Makedonien gör dock att resultaten varierar. En EU-anpassning av Makedoniens jordbruksstöd medför därför ett högre stöd för vissa produktionsgrenar men ett lägre för andra.

Nyckelord: Ekonomisk modellering, partiell jämviktsmodell, statisk jämförande analys, den f.d. Jugoslaviska republiken Makedonien, foder och boskapskomplex, EU-utvidgning

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1. Introduction

The first two waves of the European Union's eastward expansion that took place in 2004 and 2007, respectively, have received much attention in academic research both before and after accession. Given the size and relative importance of agriculture in many of the acceding countries, the implications for agriculture and the food processing industry in both old and new member countries have been one matter of concern. Macedonia[1], which applied for membership in the European Union in March 2004 and was granted candidate status in December 2005, is likely to be part of the third wave if and when it comes. Now, at the doorstep of the European Union and before real accession negotiations start, it is a good idea for policy makers and the general public to carefully analyze the likely effects of membership and to consider what can be done to dampen the negative outcomes and to get the most out of the good effects. The size of the agricultural sector in Macedonia, the number of people concerned and, not the least, the role agricultural issues have played in earlier accession negotiations do warrant the inclusion of agriculture and agricultural policy in such analysis. The terms of accession will be the outcome of tough negotiations and it is always better to arrive to the negotiation table with a clear notion of the pros and cons of accession, and aware of what can be yielded and what not.

Aim

The aim of this thesis is to assess the consequences accession may have on Macedonia's agricultural sector in general and the feed and livestock complex in particular. How will accession affect livestock and feed producers? Will there be any impact on trade and on consumer demand?

Method

The selected method is twofold and involves both a qualitative and a quantitative approach. The qualitative analysis has been conducted through a review of relevant literature to which the compilation and analysis of data on production and trade has been added. I have also made two trips to Macedonia, involving visits to a former state farm, a dairy plant, and the State Statistical Office of Macedonia, as well as a presentation of the preliminary model results for the staff of the department of Agricultural Economics and Organization at St Cyril and Methodius University in Skopje. The quantitative approach consists of a comparative static analysis for a set of scenarios related to the possible future accession of Macedonia to the European Union. In order to carry out this analysis, a synthetic single-country partial equilibrium model for the feed and livestock complex in Macedonia has been constructed and calibrated.

Demarcations

The enlargement of the European Union to the southeast is a broad issue that can be analyzed from many perspectives. As already mentioned the scope of this thesis is limited to the agricultural sector and it dwells deeper only into the production and consumption of livestock and feed in Macedonia. The livestock and feed commodities covered in the scenario analysis represent an important share of Macedonia's agricultural output value but do by no means add up to a complete coverage of the feed-livestock complex. The results must therefore be interpreted with caution.

Structure of the Study

The model is described in detail in this paper. Before that, an introduction to Macedonia and Macedonia's agriculture is given in **chapter 2**. The macroeconomic setting, food consumption patterns as well as Macedonia's trade and agricultural policy is also discussed here. The use of models in economic analysis of trade is discussed in **chapter 3,** which also gives a more extensive account of the

[1] Macedonia is formally known as the Former Yugoslav Republic of Macedonia (FYROM). Throughout this document, the name Macedonia will be used.

methods used. **Chapter 4** describes the structure of the model and gives a detailed presentation of each step in this modeling effort. Model scenarios and the results obtained from the model is presented and discussed in **chapter 5**. To sum up, some general conclusions are given and discussed in **chapter 6**. Since the data collection for this thesis has been both time consuming and crucial for the scenario analysis, the annexes are quite extensive. Base data such as supply and utilization accounts, prices, and elasticities are listed in the **annexes**. The model and the detailed results of the scenario analysis are also to be found in the annexes.

2. The Former Yugoslav Republic of Macedonia

Map 1. Macedonia and EU-27.

Macedonia is a mountainous country on the Balkan Peninsula. The immediate neighbors are Albania, Serbia (and Kosovo) and the EU-members, Bulgaria and Greece. With two million inhabitants and only about twice the size of a middle-sized Swedish province such as Uppland, it is one of the smaller former Yugoslav republics.

Macroeconomic setting

Macedonia gained its independence in 1991 in the wake of the break up of Yugoslavia the same year. Unlike many of its Balkan neighbors, independence was negotiated and not preceded nor followed by an armed conflict. The ongoing transition from Yugoslavian market socialism to a multi-party democracy and fully-fledged market economy, however, has been turbulent. The move from an economy built to satisfy not only the needs of what was then called the Socialist republic of Macedonia but the needs of the 20 million people in the Socialist Federal Republic of Yugoslavia as a whole, to a domestic market of merely two million people would be a shock for any country (Bogoev, 1999). The presence since 1992 of international peacekeeping forces from the UN, followed by NATO and subsequently EU troops, may have spared the country from a major armed conflict. But the spillovers from the economic and institutional breakdown of Albania in 1997, the Kosovo war in 1999 as well as UN sanctions imposed on Serbia in the early 90´s, the dispute with Greece over the official name of the country resulting in a Greek embargo in 1993-1994, and internal conflicts between different ethnic groups erupting into armed clashes in 2001 have all had their impact. As a landlocked country dependent on its neighbors for access to the wider world market and with the former Yugoslav republics and the other neighbors as important trade partners, Macedonia continues to be sensitive to the development in the region.

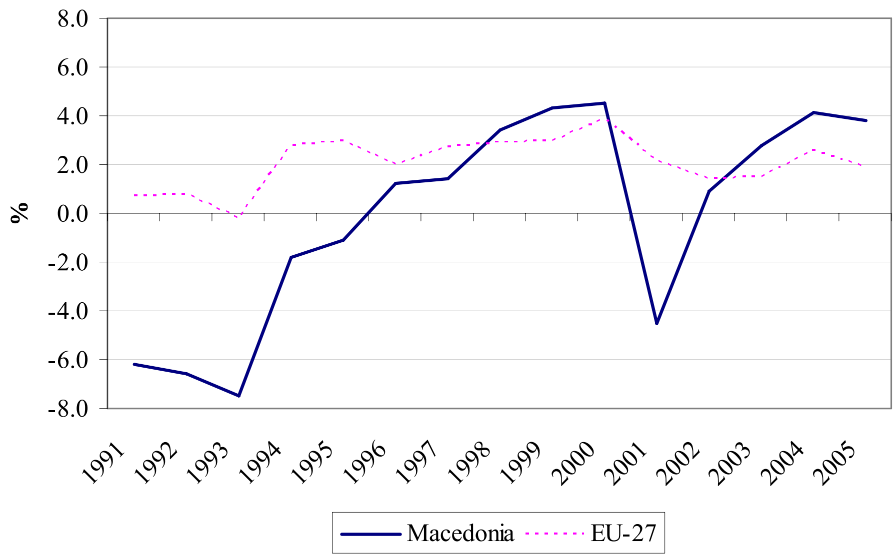

Figure 1. Real GDP growth.
Source: IMF

Macedonia was one of the least developed republics in the former Yugoslavia and the decade preceding Macedonia's independence was characterized by economic stagnation with little or no economic growth (UNDP, 2001). Figure 1, however, gives a hint of the magnitude of the economic upheaval following the breakup of Yugoslavia. The average growth rate in the period 1991 to 2005 was –0.1 and the country is yet to return to the levels of economic performance preceding independence. Nevertheless, there are signs of recovery. With the exception of 2001 when Macedonia for some months was on the brink of civil war, the economy has been growing since 1996. The projected growth rate for 2006 and 2007 is 4.0 percent (EBRD, 2006 and COM, 2007). Economic development is concentrated in the larger cities and the capital Skopje in particular, and there are significant regional disparities in terms of infrastructure and income between urban and rural areas.

Macedonia is considered a middle-income country with medium human development, which gives it the 66th place among the 177 countries in the most recently published human development index, HDI[2] (UNDP, 2006a). The presence of an informal sector makes it difficult to asses the real magnitude of unemployment. Still unemployment is a major problem and reached two-digits rates already in the 1980´s. In 1990 unemployment was estimated at 24 percent and it has increased further during transition. In 2005 unemployment according to labor survey data peaked at 37.3 percent (COM, 2007), which makes it extremely high at both European and world standards, and the same goes for the low level of formal employment. Jobless growth is a term applicable on the Macedonian economy as job creation lags behind growth in GDP. (EU, 2005). Poverty and income inequality have increased since independence. In 2002, 30.2 percent of the population lived in poverty according to the expenditure-based head count index. The latter measure is thought to take also the large informal sector into account. Income inequality, as measured by the Gini index[3] has increased from 22 at the beginning of transition to 39 in 2003 (UNDP, 2006a, and UNDP, 2004).

The Agricultural Sector

Despite Macedonia's mountainous character and a widespread need for irrigation, natural conditions especially in the lowland areas are favorable to agriculture. In addition, land as well as labor is relatively cheap. The agricultural sector does no longer reach the pre-independence levels when it generated 14-16 percent of the gross domestic product (UNDP, 2004). However, with a share of GDP above ten percent the agricultural sector does still play a significant role in the Macedonian economy (*e.g.*, EBRD, 2006). This is true also in a regional perspective as indicated by table 1. If marketing and processing of agricultural products is included, the share of agriculture in the national economy is even greater. The share of agriculture in total employment according to the latest workforce survey was 16.8 percent in 2004 but there is a large grey market in Macedonia and with about 45 percent of the total population living in rural areas the real figure may well be higher (MAFWE, 2006 and World Bank, 2003). Agriculture has to some extent served as a buffer during the transition and has absorbed especially low-skilled surplus labor from other sectors (EU, 2005).

Table 1. *Agriculture, hunting, forestry and fishing in % of GDP (current prices), 2005*[4]

Macedonia	10.9
EU-27	1.7
Bulgaria	7.8
Romania	8.5
Slovenia	2.2
Greece	4.7
Croatia	6.3
Turkey	10.3

Source: NBRM and EUROSTAT

Of available 1.3 million hectares of agricultural land, 44 percent is cultivable and the remaining 55 percent is pasture. The most important products by output value in 2003 were grapes, tomatoes, cow milk, pigs, pepper, wheat, potatoes, cattle, tobacco, sheep milk and sheep. (MAFWE, 2005). Total agricultural production in terms of volume has been volatile during the period 1992-2005 but is higher in 2004 than in any other year since the reference year 1992 (see figure 2). By sub-sector, however, it is only cereals and vegetables that were above their 1992-level in 2005. The meat production has had a mostly decreasing trend during the whole period and the production of fruits, although very volatile, has not yet returned to its 1992-level.

[2] The 66th ranking in the 2004 Human Development Index places Macedonia after its neighbors Greece (24th) and Bulgaria (54th) as well as after the former Yugoslav republics Slovenia (27th), Bosnia and Herzegovina (62nd) and Croatia (44th), but before neighboring Albania (73rd). There are no data available for Serbia and Montenegro.
[3] The Gini index ranges from perfect equality (0) to perfect inequality (100).
[4] The share of agriculture in GDP is derived as the gross value added (at basic prices) in percentage of GDP.

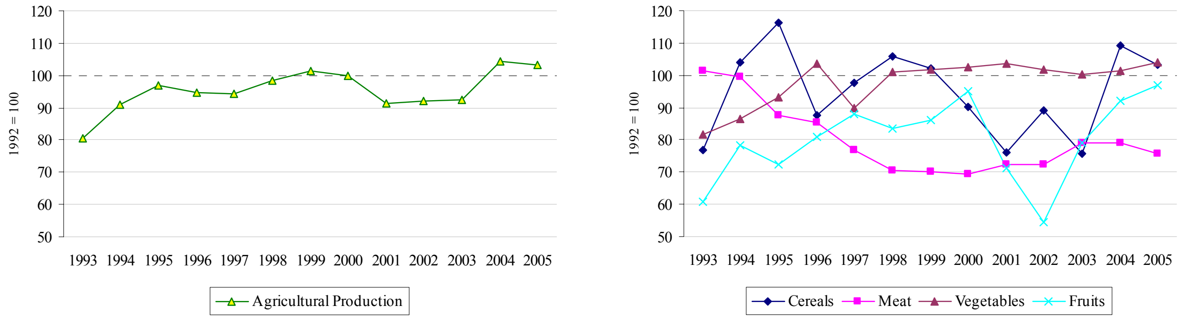

Figure 2. Primary agricultural production index, Macedonia 1992-2005.
Source: FAOSTAT, 2007

In a recently published report by a Blue Ribbon Commission organized by the UNDP the agricultural sector is believed to have a significant potential (UNDP, 2006b). This, however, on the condition that a set of reforms are implemented satisfactorily, productivity in agriculture increases, and the produce manage to meet EU and world standards. In addition to improvements in the overall business climate, the Commission highlights the need for:

- Land market liberalization to enable rational land usage.
- Direct financial support and other actions for the rural poor instead of subsidies to agriculture that preserves their use as cheap and underutilized labor in agriculture.
- Deregulation of the market for inputs and an upgrade of the technology used in the agri-food sector.
- Further improvements in the rural credit market.
- Efforts to obtain and update information on the sector.
- A move from self-sufficiency as the overall goal for agricultural policy to a less ambitious goal of maintaining a trade surplus in agricultural products.

The Feed-Livestock Complex

Macedonia's abundance of pastureland and a significant acreage of meadows form a good basis for livestock grazing in general, and due to the mountainous character of the pasturelands for smaller ruminants in particular. In addition, the per capita consumption of milk and dairy products is relatively high and there are many traditional dairy products to choose among. Accordingly, it comes as no surprise that sheep as well as cattle husbandry are central activities. Goats are usually permanently housed. The abolition of the pre-independence ban on goat husbandry has revived interest for goats. The production of goat milk and goat meat, however, is still small. (MAFWE, 2005 and SFARM, 2005).

Livestock and dairy production has historically been an important agricultural sub-sector in Macedonia. The livestock and dairy production was valued at around 225 million Euros in 2003 and represented 34 percent of the total agricultural output value that year. The main products, in descending order according to their value shares, were cow milk (8%), pigs (8%), cattle (5%), sheep milk (4%), sheep (4%), eggs (2%), poultry (1%), and other meats (1%) (MAFWE, 2005). The sector, however, has largely had a decreasing trend as measured by herd size and meat production since independence. The exceptions have been the pig industry that grew substantially from 1990 to 2002 and dairy that showed modest growth in the same period (MAFWE, 2005 and World Bank, 2003a).

In the 1980´s, most cattle were kept on large state-owned farms or so-called "agro-kombinats". The typical livestock holder today, however, is a small farm household, with 1 to 10 animals of different kinds, producing mostly for subsistence needs. The agro-kombinats that survived the first years of transition are now private enterprises but their numbers are declining. The number of commercially oriented family farms is small but growing. (MAFWE, 2005, and MAFWE, 2006).

Both fodder crops and coarse grains are important feedstuffs. There is no exact measure on how much of the grain production that is used for feed but it is clear that a substantial amount of the wheat produced and most of the maize, barley, rye, and oat production remain on farms as feed. In terms of output quantities, pasture is the main fodder crop followed by alfalfa, clover, fodder beet, meadow, fodder maize, motley hay, fodder peas, and forage beets. Macedonia is a net importer of feed but those imports are marginal as the bulk of the feed used is produced domestically. Oilseed cake represented 51 percent of feed imports in 2003 but premixes and compound feed also held important shares of imports. Feeding is a major constraint on productivity as livestock seldom is optimally fed. (MAFWE, 2005).

Food Consumption Patterns

'Tell me what you eat, and I will tell you what you are' the French gastronomist Anthelme Brillat-Savarin (1825) once wrote. What we eat can indeed say a great deal about how rich or poor we are. It is an intuitive and empirical truth that our wealth or lack of it will decide how much of our disposable income we spend on food and other necessities relative to other goods, as well as how sensitive our food consumption will be to changes in income and prices. In addition, wealth will influence the composition of our food bundle. On aggregate, the budget share spent on food, price and income elasticities of food, and the proportions of the various food items we buy are therefore indicative of the living standards in the country. In general, the poorer we are the more we spend on food relative to other goods and the more sensitive are we to changes in income and prices.

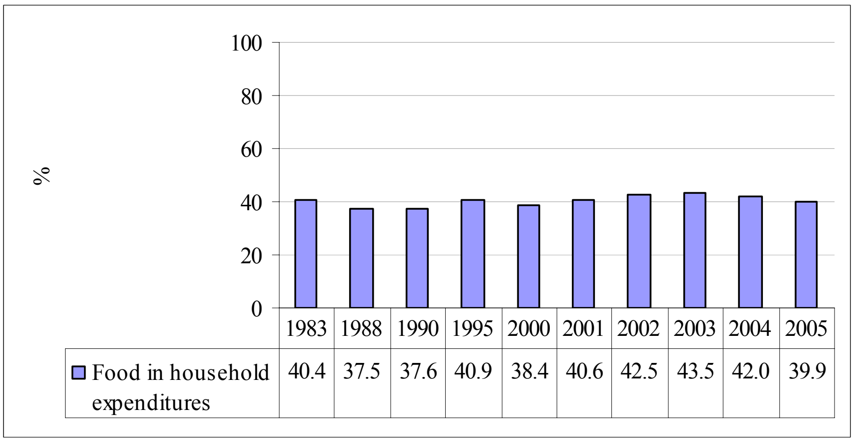

Figure 3. Food expenditures per average household in Macedonia.
Source: UNDP, 2004 and SSO, 2003-2006

A cross-country analysis for 1996 by Regmi *et al.* (2001) revealed that on average, consumers in low-income countries spend almost half their budget on food, whereas food represents only 13 percent of total expenditures in high-income countries. The corresponding average for middle-income countries is 29 percent. For a middle-income country, Macedonia has a fairly large food budget share. In the study by Regmi *et al.,* it amounted to 34.7 percent. Figures that are more recent are even higher. According to the annual household survey conducted by the Macedonian State Statistical Office, almost two-fifths or 39.9 percent of the disposable funds in the average household went to food in 2005 but there are substantial differences in the expenditure patterns across socio-economic groups. In agricultural households, food expenses represented almost half of the disposable funds or 48.1 percent that year, whereas the corresponding share in non-agricultural households was 38.2 percent. Cereals and meat were the main food items in 2005, with 20 percent each of the annual food expenditures in the average household, whereas milk, dairy products and eggs stood for 17 percent (SSO, 2006). As shown in figure 3, food represents a larger share in total household expenditures in 2005 than in 1990, which was just before independence. The food shares are consistent with the economic growth pattern of Macedonia (see figure 1). Larger food shares followed the economic downturns in the early 1990s and in 2001, and the economic recovery since 2001, with positive growth rates from 2003 and onwards, has been translated into successively smaller food shares.

A comparison with the other former Yugoslav republics and Macedonia's neighbors with Sweden as benchmark is instructive. Table 2 displays that Macedonia spends relatively more on food, have less purchase power, and less advanced human development than most of the countries compared.

Table 2. *Human development [2004], purchase power [2004], food consumption [1996], income elasticity [1996], and price elasticity [1996] in the region and in Sweden*

	HDI rank	PPP GNI (US$/capita)	PPP GNI (rank)	PPP GNI per capita (% of EU-15[5])	Food Share[6]	Income Elasticity (food)[7]	Price Elasticity[8]
Sweden	5	29,880	17	104	13.3	0.361	-0.269
Greece	24	22,230	41	77	21.2	0.456	-0.327
Slovenia	27	20,830	45	72	21.3	0.486	-0.342
Croatia	44	11,920	69	41	..	..	..
Bulgaria	54	7,940	86	28	30.7	0.621	-0.391
Romania	60	8,330	85	29	45,3	0.602	-0.387
Bosnia and Herzegovina	62	7,230	95	25	..	..	..
Macedonia	66	6,560	102	23	34.7	0.643	-0.393
Serbia and Montenegro[9]	..	..	106	..	..	..	..
Albania	73	5,070	124	18	69.3	0.689	-0.390

Source: UNDP, 2006a, World Bank, 2006 and ERS, 2006

The estimates of income and own price elasticities for Macedonia, used in the study by Regmi *et al.* (see also Seale, Regmi and Bernstein, 2003), are large relative to the averages for high-income countries, which is just as theory predicts. A closer examination of the estimates reveals that food, beverages & tobacco and to a lesser extent clothing & footwear are the only necessities among the various consumption goods. Accordingly, the demand for these consumption items is relatively more inelastic with respect to price. Among food subgroups, however, bread & cereals, followed by fat & oils stand out as the real necessities in the Macedonian diet and the demand for these products are thus significantly less responsive to both price and income changes. As less of necessities, the demand for fish, dairy, and meat, on the other hand, is more responsive to price and income changes. Table 2 indicates that a change in income in Macedonia will translate into a larger change in consumption of food, beverages & tobacco than in the other compared countries except Albania. People in Macedonia are also more responsive to price changes on food, beverages & tobacco.

If to believe the theory, we can expect rising income levels to decrease the budget share of food and to reduce the consumption of starchy staple foods such as bread and cereals in favor of more protein rich and higher-value food items such as dairy and meat. A change in consumption patterns is thus one factor that needs to be taken into account when assessing the future of the Macedonian feed-livestock complex. An increase in the demand for meat represents an opportunity to domestic livestock producers and that in turn requires either domestically produced or imported feed. However, Macedonia is already a net importer of meat and further expansion of these imports is also a plausible outcome.

[5] Data not available for Luxemburg.

[6] Share of total household expenditures spent on food.

[7] Income elasticity for food, beverages & tobacco. Income elasticities greater than 1 indicates that the good is considered a luxury.

[8] Price elasticity for food, beverages & tobacco.

[9] The constellation Serbia-Montenegro ceased to exist in 2006, since Montenegro after a referendum proclaimed its independence in June that year.

EU Accession, Agricultural Policy and Trade

Several factors may explain EU's expansion to the East. A national interest, although not always a positive public opinion in the potential accession country and EU's own willingness to further enlarge the union are of course necessary preconditions. From an EU perspective, on one hand, the ambition to stabilize a historically unstable and war-ridden region is probably more important than the potential for economic gains. For the potential accession countries, on the other hand, the prospective for economic development and access to a larger market is probably highly important. Gaisford, Kerr and Perdikis (2003) argue that the Union's successive growth from six to 27 member countries can be viewed from such economic perspective. The success of EU and its predecessors as regional trade organization has continuously attracted new members. The openness to trade and the economic integration within the EU is economically beneficial for members but builds on higher trade barriers towards non-members. As trade tends to increase with proximity, forgone trade opportunities is therefore a compelling reason to seek EU-Accession. The expectation that membership can provide security, help democratic institutions get rooted and assure a successful transition to market economy are additional reasons for transition countries to seek accession. This thesis will not dwell deeper into the driving forces behind EU enlargement. It is a fact, however, that many Southern Eastern European countries, including Macedonia actively seek accession. Countries that either already are EU-members, have candidate status, or at least are in the process to become candidate countries surround Macedonia. In addition, the two newest EU-members, Romania and Bulgaria that joined the EU January 1, 2007 are both from the region and can be seen as competitors to Macedonia when it comes to agriculture. EU-Accession is thus likely to remain on the political agenda in Macedonia.

Trade

As a small landlocked country, it comes as no surprise that Macedonia on aggregate runs a trade deficit. At the aggregate level, as indicated by figure 4 it is only in miscellaneous manufactured goods, *i.e.*, mainly clothing and footwear that Macedonia is a net exporter. An in-depth review of each commodity group, however, will single out occasional products that are net exported.

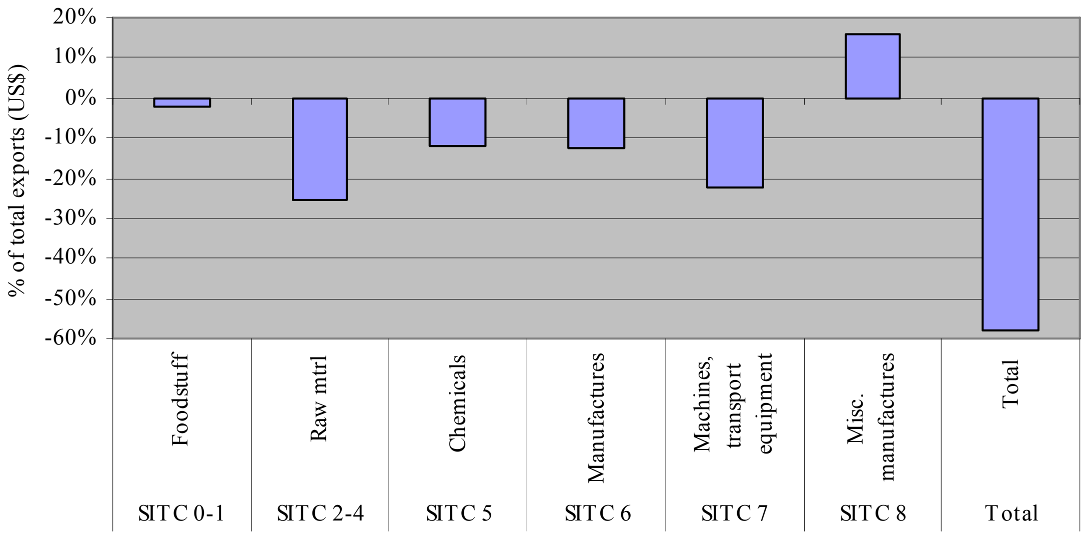

Figure 4. Net Exports (US$) in percentage of total exports – SITC, 2005.
Source: COMTRADE

Agricultural and food products are no exception. However, as indicated by figure 5, the trade deficit in terms of agro-food commodities seems to be decreasing.

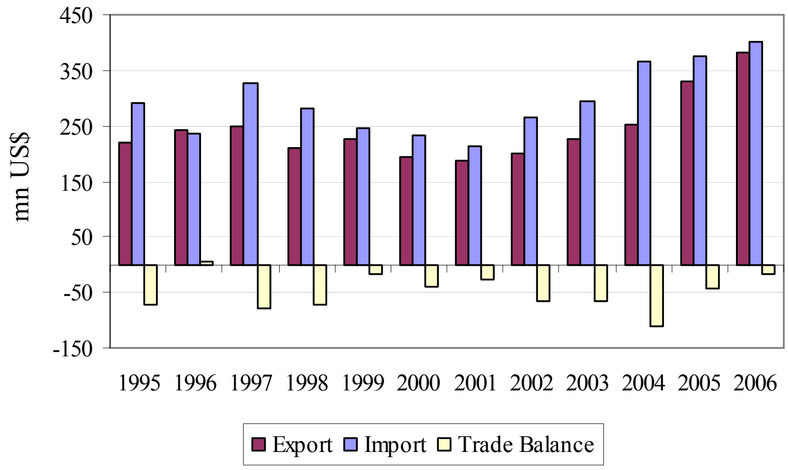

Figure 5. Agri-food trade (million US$) in Macedonia, 1995-2006 – SITC.
Source: COMTRADE

Both imports and exports of agro-food products show an increasing trend and these commodities accounts for an important share of total trade value. According to trade data, it amounted to 11.6 percent of total imports and 16.2 percent of total exports in 2005 (COMTRADE). Important product groups on the import side that year were meat, cereals, chocolate, and sugar. On the export side, the most important product groups were tobacco, followed by wine, fresh and chilled vegetables, and mineral waters. These products are also Macedonia's only net exports in agri-food products as indicated by figure 6.

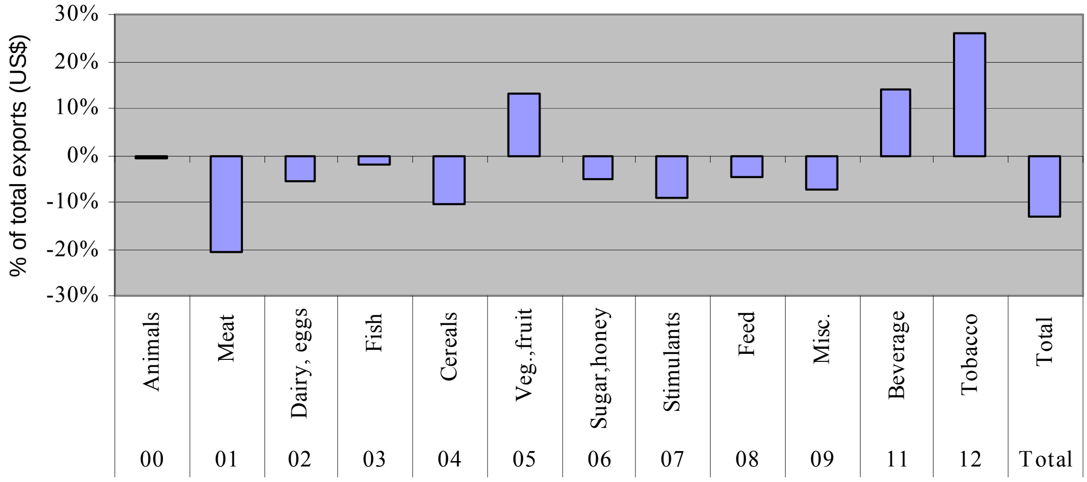

Figure 6. Net Exports (US$) in percentage of total agri-food exports – SITC 0 and 1, 2005.
Source: COMTRADE

The so-called Balassa or the revealed comparative advantage (RCA) index may give an indication of where to find export potentials in Macedonia. The index compares the share of a given sector in national exports with the share of this sector in world exports and serves as an indicator of its level of specialization within a country but not between countries (Nilsson *et al.*, 2007). The fact that both processed food and fresh food have values above 1 indicates that Macedonia is specialized in exporting those products. The revealed comparative advantage is 1.94 for processed food and 2.23 for fresh food (ITC, 2006). However, the fact that trade barriers of different kinds affect trade in agri-food products makes it difficult to assess whether Macedonia would have a comparative advantage in these products also on a non-distorted market (Lindner, 2005). An index value greater than one, thus does not automatically imply that Macedonia should specialize in these commodities. It can give a hint though.

Given that Macedonia's net exports in agri-food products is limited to tobacco, beverages, and vegetables it is reasonable to presume that the revealed comparative advantage in processed and fresh food arise from these commodities. The average Balassa index in the corresponding period were 4.25 for wine and 8.47 for tobacco (Tasevska, 2006 and Tuna, 2006).

A study by the European Commission (COM, 2006b) reveals that Macedonia is no different from its Balkan neighbors in having a heavily EU-oriented export structure. A glance at the trade data presented in table 4 confirms this assessment. More than half of total exports in 2005 went to the EU. The EU orientation, though, is less pronounced for food and live animals. Instead, these exports to a higher degree find their markets in the Western Balkans, and in particular Serbia and Montenegro.

Table 3. *Revealed Comparative Advantage (Balassa) for the period 1999-2003*

Revealed comparative advantage 1999-2003	Macedonia
Clothing	8.76
Basic manufactures	3.36
Leather products	2.34
Fresh food	2.23
Processed food	1.94
Textiles	1.20
Minerals	0.64
Chemicals	0.43
Electronic components	0.35
Wood products	0.27
Miscellaneous manufacturing	0.16
Transport equipment	0.14
Non-electronic machinery	0.06

Source: ITC, 2006

Table 4. *Macedonian export destinations in percentage of total export value – SITC, 2005*

	ALL COMMODITIES	AGRI-FOOD PRODUCTS	FOOD AND LIVE ANIMALS	BEVERAGES AND TOBACCO
	SITC 0-9	SITC 0 + 1	SITC 0	SITC 1
EU-25	53.1	46.7	40.5	52.9
Belgium	1.7	7.2	0.2	14.5
Germany	17.8	6.4	2.3	10.6
Greece	15.3	20.3	19.2	21.4
Italy	8.3	6.0	11.3	0.6
Slovenia	1.6	2.1	3.7	0.5
Western Balkans	30.3	42.0	51.2	32.5
Albania	1.3	2.1	3.2	0.9
Bosnia Herzegovina	2.5	5.3	6.2	4.3
Croatia	4.0	6.6	8.2	5.0
Serbia and Montenegro	22.5	28.0	33.6	22.3
Eastern Balkans	3.9	2.3	3.2	1.4
Bulgaria	3.7	1.9	2.8	0.9
Romania	0.2	0.4	0.4	0.4
Other Partners	12.7	9.1	5.0	13.2
Turkey	2.3	0.8	1.6	0.0
% of total export value	100	16.2	8.2	8.0

Source: COMTRADE

On a single country basis, Serbia and Montenegro is the major export destination on aggregate as well as for agri-food products. Germany comes second on aggregate but Greece holds that position in terms of agri-food exports (see annex A). With about one-third of total exports, the former communist countries in the Balkans seem to be important export partners. The bulk of these exports, however, end up in Serbia and Montenegro, whereas the other Balkan countries have only modest shares. The relative unimportance of the immediate neighbors, Albania and Bulgaria, is striking, as is the minuscule share absorbed by the, in terms of population, regional "giant" Romania[10]. The study mentioned above sees historical reasons for this lack of regional trade. The consequences of the break up of the former Yugoslavia have already been mentioned and can be illustrated by a comparison of

[10] Population wise and with 21.6 million inhabitants, Romania is almost as large as all Western Balkan countries together and more than twice the size of Bulgaria.

pre- and post- independence trade data, *e.g.*, the share of Macedonian exports absorbed by former Yugoslav republics decreased from 55 percent in 1987 to only 27 percent in 2000 (World Bank, 2003b). History plays a role also in the case of Albania, Bulgaria, and Romania. Albania under Enver Hoxha, on one side, got increasingly isolated and relations to the former Yugoslavia in particular were characterized by discord. Whereas Bulgaria and Romania, on the other side, had their focus on the countries under Soviet influence, to which Yugoslavia, after its break with the Soviet Union under Stalin did not belong. History, however, is just one factor and it can be argued that there in absence of major natural hindrances is room for more trade among the countries of the region as well as with the EU and other countries.

The import patterns of Macedonia are somewhat different (table 5). The EU is the main partner also in terms of imports but its importance, although somewhat larger for food and live animals is less pronounced on aggregate. The import share of Bulgaria, both on aggregate and in terms of food and live animals, is larger than its export share. Albania and Romania however are as unimportant in terms of imports as they are in terms of exports.

Table 5. *Macedonian import origins in percentage of total import value – SITC, 2005*

	ALL COMMODITIES	AGRI-FOOD PRODUCTS	FOOD AND LIVE ANIMALS	BEVERAGES AND TOBACCO
	SITC 0-9	SITC 0 + 1	SITC 0	SITC 1
EU-25	45.5	41.7	42.0	38.3
Austria	2.1	6.3	6.3	6.8
Germany	10.4	4.8	4.9	4.1
Greece	9.2	8.1	8.0	9.7
Italy	6.0	2.6	2.6	2.6
Slovenia	4.0	5.9	6.2	2.9
Western Balkans	11.5	25.2	24.2	36.9
Albania	0.3	0.1	0.1	0.2
Bosnia Herzegovina	0.7	2.4	2.5	1.1
Croatia	2.3	6.4	5.8	13.9
Serbia and Montenegro	8.2	16.3	15.8	21.7
Eastern Balkans	9.3	5.5	5.9	1.3
Bulgaria	7.3	5.4	5.8	1.3
Romania	2.0	0.1	0.1	0.0
Other Partners	33.7	27.5	27.9	23.5
Turkey	3.5	5.5	6.0	0.6
% of total import value	100	11.6	10.6	1.0

Source: COMTRADE

A striking difference is that the import share of the countries from Western Balkans, and Serbia and Montenegro in particular is smaller relative to their export shares. Instead, Macedonia relies comparatively more on partners other than the EU and the Balkan countries. As can be seen in annex A, Russia is the top import origin on aggregate, whereas Serbia and Montenegro, notwithstanding, holds the top position in terms of foodstuffs (SITC 1 and 0).

Agricultural and Trade Policy

Macedonia has spent the time since independence trying to restore trade relations lost in the transition and to explore new ones. WTO-membership, bilateral free trade agreements and the strive for EU-Accession have been the key ingredients in this endeavor to boost trade. Macedonia became a member of the WTO in 2003 after almost ten years of negotiations and delays. Free trade agreements have been signed with all former Yugoslav republics, with several other eastern European countries, as well as with the EFTA and Turkey. Macedonia joined the Central European Free Trade Agreement (CEFTA) in 2006 and when its new treaty enters into force in 2007 it will replace many of Macedonia's existing free trade agreements (COM, 2007). Macedonia applied for membership of the

European Union in Mars 2004 and was granted candidate status in December 2005. EU-Accession, however, remains in a distant and unclear future as neither the time frame nor the starting date for accession negotiations have been settled. Meanwhile, a Stabilization and Association agreement signed in 2001 aiming at the harmonization of Macedonian laws and regulations to EU standards known as the *aquis communautaire*, stipulates the conditions for trade between Macedonia and the EU. Effective implementation of this agreement is also one of the prerequisites for negotiations to take place.

Agricultural policy in Macedonia has gone through substantial changes since independence in 1991. The changes have included reductions in producer support to agriculture, abolition of guaranteed prices, curbing of the preferential treatment enjoyed by the agro-kombinats, partial removal of trade barriers, and shifts towards a policy framework more in line with the Common Agricultural Policy of the EU. The long-term objective of these changes is a market-oriented policy and demand-driven production (van Berkum, 2001). According to the 2006 EU progress report on Macedonia, however, there is still much to be done before Macedonia's agricultural policy meets EU-standards (Com, 2006). The various Free Trade Agreements and the commitments to WTO and EU have already exposed Macedonian producers to increased competition and presented new export opportunities. Direct subsidies and import tariffs are the principal tools of support to agriculture today.

- Tariffs are to be reduced gradually in accordance with Macedonia's commitments to the WTO, EU, and other bilateral free trade agreements. The average tariff rate on agricultural goods in 2006 was 17.3 percent and that of industrial goods 7.4 percent (Com, 2006). Whereas tariffs have been reduced for most traded goods, they remain high or moderate for highly sensitive products, *i.e.*, products that are net exported or for which Macedonia has a significant processing interest (MAFWE, 2004)
- Direct subsidies, as from 2004 are distributed in the form of payments per hectare. In 2004 crop producers got half the available support. (MAFWE, 2005).

Import tariffs typically represent a lion share of agricultural support. Similar to many developing countries the importance of tariffs is even more pronounced in Macedonia, as there are few resources to spare for direct budgetary support to agriculture. It has been said that Macedonian farmers receive about 40 times less budgetary support than EU farmers (MAFWE, 2006b). Tariffs and other barriers to trade, aimed at keeping the domestic market price up are expected to have a greater impact on trade and welfare relative to budgetary support. Whereas the latter may boost production, market price support affects both supply and demand directly as the higher price spurs production but at the same time discourages domestic consumption.

Macedonia's agricultural policy faces substantial changes ahead. What the outcome of the current round of trade negotiations, the so-called Doha round will be, is hard to predict but agriculture is indeed one of the hottest topics in the negotiations. As member of the WTO, Macedonia will have to comply with further cuts in trade barriers if that is demanded. This is true regardless of whether Macedonia joins the EU or not. Accession to the EU, however, will have a deeper impact. As described by Van Marrewijk (2002) EU is something more than just a free trade area and do not only affect tariffs and other barriers to trade but as a future member, Macedonia will be part of a customs union, a common market, and perhaps also an economic and monetary union with a single currency. In the customs union, Macedonia will have to adapt to a common trade policy and scrap trade barriers against other EU members. The common market includes a common agricultural policy (CAP) and the free movement of goods and services, as well as of capital, labor, and other factors of production. Further institutional and policy harmonization will be required within the economic and monetary union. It is thus not an easy task to assess the consequences of accession. It will certainly open up for imports from other EU countries and provide complete access for Macedonian exports to the same. But it may also shut former trade partners out as Macedonia adopt the common trade barriers of the EU. In addition, Macedonia will not longer benefit from the preferential treatment Macedonia currently enjoys under the current trade agreement with the EU. Membership may thus boost trade with other EU members but it may also shrink trade with non-members. It is therefore, by no means, certain that Macedonia will be able to increase or even maintain its net exports as competition increases.

Producer Support Estimates

Given the relative importance of agriculture in Macedonia and the significant role played by the Common Agricultural Policy (CAP) in the EU, any impact assessment of EU-Accession must consider Macedonia's agricultural sector. To do so properly, a detailed notion of at least the level and distribution of the support to agriculture in Macedonia is necessary. However, it is not an easy task to get a complete picture of the agricultural support in Macedonia. It is, nonetheless, possible to get a rough estimate of the level and its distribution among individual agricultural commodities. OECD has conducted such analysis for its member countries since the mid 1980´s. The method, which is known by the name of one of its indicators, the producer support estimate (PSE), is now widely used and accepted for comparisons between countries. With sufficient data on domestic producer prices and the corresponding international reference prices, as well as quantities produced and consumed, and with reliable budgetary data on the policy measures in place, the OECD-method provide a measure of the support enjoyed by producers and consumers[11]. The PSE is made up of two main components, market price support (MPS), which keep the domestic producer price at a level higher than the price at the border and budgetary payments to the farmers. Ericson, Pelling and Surry (2007) have been able to compute PSEs for 16 agricultural commodities in Macedonia for the period 1999 to 2004. According to these figures and as indicated by figure 7, Macedonia has a lower level of support to agriculture than the European Union. There are also differences in the way support is provided. Whereas Macedonia relies heavily on market price support, the EU devotes more resources to direct budgetary payments to farmers and have less of market price support. Individual commodities, however, do diverge from this general pattern and some commodities receive even more support than in the EU. Harmonizing support levels with the EU may therefore include both cuts and raises.

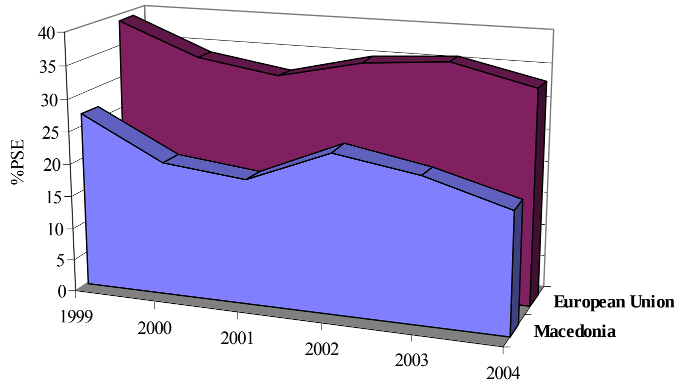

Figure 7. Aggregate %PSE in Macedonia vs EU.

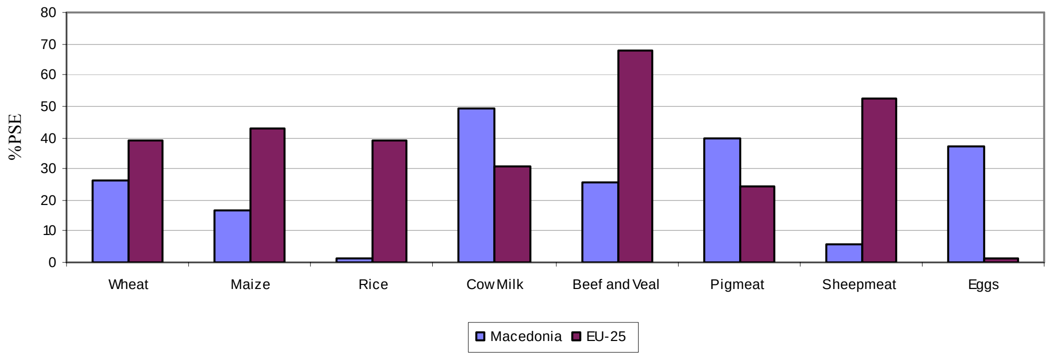

Figure 8. Percentage PSEs for selected commodities in Macedonia and the European Union, 2004.

[11] See Portugal, 2002 for a detailed description of measures and methodology.

3. Economic Models

The use of models has become an important part of contemporary economics. The notion of a model is quite straightforward. Just as an architect for the sake of illustration may build a miniature model replicating a future building, an economist may try to formulate a theoretical representation of an observed phenomenon in order to understand or explain it. To describe something in the form of a scientific model is not so different from explaining it in a theory but by calling it a model it is usually understood that it is a simplified description and not a complete picture of the reality. The use of models in economics has many merits. One key factor is that it forces economists to analyze a problem and organize data in a structured manner, while making them aware of the assumptions made.

Economic models can be used to explain and predict how consumers act, how producers make their decisions and how consumers and producers interact on the market. Their amount of detail as well as their assumptions differs of course, as do the problems the models are designed to analyze. There are, however, some common features. Nicholson (2002) identifies three elements habitual in most economic models. *First*, their results should be understood given the *ceteris paribus* assumption, *i.e.*, it is assumed that other factors outside the models are held constant. *Second*, the agents whose economic decisions the models are set to analyze are rationally seeking to optimize something. Be it to maximize profit, well-being or public welfare or to minimize costs. And *third*, there is a distinction between normative and positive questions. That is, statements on how things ought to be are not mixed with statements on how things actually are.

Variables and parameters are common terms in the model terminology and should not be mixed. A variable is something that changes, whereas a parameter is held constant until it is given another value. Variables that are determined within, that are by the model are called endogenous variables, and variables that are decided outside but influence the model are called exogenous variables. Parameters such as slopes and intercepts are calibrated on the basis of the exogenous variables and different model simulations are obtained by changing those exogenous variables. It is a mathematical rule that each endogenous variable of a model should have only one equation linked to it. The assumptions made regarding how prices are formed to make supply equal demand are crucial in the design of a market equilibrium model. This is called the model closure and also involves the process in which variables are classified as either endogenous or exogenous. (Van Tongeren *et al.*, 2001 and Meyer, 2006).

Modeling Agricultural Trade

There are many different topics that can be dealt with through economic models and there are many ways to construct a model. The focus of this chapter, however, is on applied trade models. Whereas theoretical trade models analyze the consequences of policy changes given an initial non-distorted market equilibrium, applied trade models examine policy changes given a base equilibrium. The so-called non-distorted equilibrium does not include the effects of any policy that might affect the trade flows. In the base equilibrium, on the other hand, the effects of relevant policies are included. (Van Marrewijk, 2004).

When it comes to the analysis of agricultural policy and trade there are several different modeling approaches. Econometric, mathematical programming, and partial and general equilibrium modeling are perhaps the most common approaches (Salvatici *et al.*, 2000). An important distinction can be made between econometric models on one hand, and partial and general equilibrium models or so-called market equilibrium models on the other hand. Whereas econometric models emphasize the use of statistical data to make forecasts without necessarily considering behavioral effects, market equilibrium models builds on equations that are designed to picture the different economic agents' behavior in response to price changes. (Van Tongeren & Van Meijl, 1999).

The focus of this chapter, as already mentioned, is on applied trade models. To further narrow it down it should be added that only market equilibrium models designed to tackle issues related to agricultural policy and trade will be addressed.

Partial versus General Equilibrium Analysis

Any modeler embarking on a new project will strive for a representation of the economy of concern that is as comprehensive as possible. Time, data, and other constraints or the very complexity of a complete representation, however, may motivate a narrower more simplified representation. Depending on its scope of representation a trade model can be sorted into one of two broad categories: partial equilibrium or general equilibrium models.

A partial equilibrium model analyses the determination of prices and quantities in the market or markets of one or a few sectors or segments at a time only, *e.g.*, the agricultural sector or the feed-livestock complex. Factors of production other than the ones analyzed as well as other variables are exogenous and assumed constant, thus excluding any interdependency with other sectors of the economy. Conversely, a general equilibrium model attempts to analyze the determination of prices and quantities in the economy as a whole. Factors of production and other variables are endogenous. Feedback relationships between all different sectors of the economy are thus taken into account. Partial equilibrium models have an advantage in that they can offer a more detailed picture of a specific problem, whereas general equilibrium models do offer a better overview of the general setting. Partial equilibrium models may also yield a more intuitive understanding of a problem as it is easy to get lost in the many interdependencies included in general equilibrium models.

A cornerstone in both theoretical and applied trade models is the so-called Marshallian cross, *i.e.*, the supply and demand graph found in most economic textbooks and taught in all basic courses in economics. It dates back to the British economist Alfred Marshall's theory from 1890 that prices are determined by both demand and supply acting simultaneously (Nicholson, 2002). Marshall is credited for being the father of the partial equilibrium analysis ("economics", 2005) and if we limit the analysis to the determination of price and quantity by the forces of supply and demand acting in this quite straightforward graph, we are in fact conducting a partial equilibrium analysis and the graph itself is a partial equilibrium model.

The Marshallian cross could be said to be the first partial equilibrium model and is an indispensable part of successive models. If to credit someone for the birth of the general equilibrium analysis, it should be the French economist Léon Walras. The so-called Walras' law states that supply and demand on one market depends on the supply and demand on other markets ("Walras lag", 2005). The general equilibrium is thus the result of the simultaneous determination of partial equilibriums in all individual markets ("economics", 2005). The analysis of these interdependencies is of course more complex than the analysis of one market at a time.

Options in Model Design

Once a modeler of trade has decided whether his or her model should have an economy-wide scope or a more limited one, that is if the market equilibrium analysis should be general or partial, there is still a wide array of design options left. Van Tongeren *et al.* (2001) describes the choices available when building a "standard" general or partial equilibrium trade model. The options, which are summarized in figure 9 regard the geographical coverage, the unit of analysis, the dynamics, how to represent the trade flows, how to incorporate different trade policies, and the way to define the parameters. In addition, Frank van Tongeren and his co-authors highlight some important differences between the standard partial and general equilibrium models. The differences regard the characterization of global markets, the theoretical consistency, and the model closure. All these options and differences require some explanations before proceeding to the description of a selection of applied trade models. The rest of this section draws heavily on van Tongeren *et al.* (2001).

Coverage

Nothing prevents a market equilibrium model from concentrating on one country only. Trade models, however, tend to focus on international trade. The options when it comes to the geographical coverage therefore are boiled down to the choice between a fully global coverage and a non-global coverage such as a limited set of trading partners or a group of countries. A model with a global coverage aims for a globally closed accounting of the trade flows it wants to analyze, whereas a model with non-global coverage does not. A closed accounting of the trade flows, however, does not necessarily imply that all countries or group of countries are modeled with the same degree of detail. For partial equilibrium models, the choice of coverage involves both this geographical choice between a single or multi country option and a choice between one or several markets within a sector. The level of trade integration, the size and importance of markets as well as the availability of statistical data and parameters are factors that should or need to be taken into account when different areas, sectors, and markets are modeled. The result is that some are described in detail, while others are grouped in sometimes quite wide and heterogeneous aggregations such as "rest of the world" or "other agricultural products", which include only the most important variables. (Se also Conforti, 2001).

Unit of Analysis

A trade model that includes several countries and regions has to be able to represent the important peculiarities of each individual economy. There are two ways to do that. One way is to build a model for each economy and allow for the inclusion of country-specific institutional and economic details. These individual country or regional models can then be linked together. The advantage of this "linked country" approach is its ability to represent structural differences. A major drawback though, is its lack of transparency as it allows each model to build on different assumptions. The other way is to use a model template, *i.e.*, impose a uniform modeling structure for all economies and thus only represent the differences through the use of country or region specific data and parameters. This "one model fits all" approach lacks the ability to represent structural differences in depth. Such a model, on the other hand, makes the interpretation of results much easier. (Se also Van Tongeren & Van Meijl, 1999).

Dynamics

Economic models are not only used to describe and explain economic phenomena. The ability to simulate and predict the effects of policy changes and other economic events is also in great demand and this is very much the purpose of applied trade modeling. Modelers who pretend to be scientific can of course only produce empirically testable hypotheses and not true predictions (Currier, 2000, p. vii). One of the main methods to produce such hypotheses is through comparative statics analysis, *i.e.*, the study of how the equilibrium or optimal values changes as outside factors is altered (Currier, 2000, p. 11). It is essentially a comparison between the equilibria at two static points in time, and therefore not a study of the time path or process from one equilibrium to another.

There are, however, ways to incorporate dynamic features in market equilibrium models and thus make the time frame variable. A common approach is to model the adjustment process through a *recursive* criterion. With this method, an equilibrium solution is generated using forecasts of parameters and the values of the endogenous variables in the previous period. Recursive dynamics, however, do not necessarily give a time-consistent behavior. Intertemporal dynamics or rational expectations, on the other hand, is a forward looking approach that do guarantee optimal behavior both over time and within periods.

In contrast to comparative static models, dynamic models do allow for the description of how variables within the model adjust over time as well as the analysis of certain lagged transmissions. A key difference is that dynamic models permit the analysis of how policy changes influence the accumulation of capital, commodity and other stocks, which in turn may affect the production possibilities, whereas comparative static models are unable to do so.

As described by Tongeren & Van Meijl (1999), both comparative static and dynamic market equilibrium models can be classified as short term, medium term, or long-term depending on their assumptions regarding the flexibility of production factors. Production factors such as capital, farmland and farm labor may be assumed fixed (short term) or to be variable in response to exogenous events (medium term). Some models allow for both variable production factors and the formation of capital within the model (long term). Comparative static models, however, are less suitable for short-term simulations as they assume that variables adjust completely between the two static points in time (Conforti, 2001).

Representation of Trade

There are two important and mutually exclusive assumptions that can be made regarding the nature of traded goods. If goods are assumed *homogeneous* or identical, goods from different producers are considered perfect substitutes for one another. There is thus no difference between domestically produced and imported goods. If assumed *heterogeneous*, that is allowing for product differentiation, goods from one producer are deemed only imperfect substitutes for goods from other producers.

One important implication of the homogeneity assumption is that each actor on the market must be either a seller or a buyer of the good, which in turn implies that a country must be either an exporter or an importer of that good. This is sometimes called the "pooled market approach" or "non-spatial" modeling since only net-trade is emphasized. The rationale for this is that, under perfect competition and assuming homogeneous goods only, the firms that manage to produce the good without losses at the prevailing market price will do it. The market price will equalize and be the same for all producers and consumers of the same good, since there is no product differentiation.

A good, however, is seldom identical across producers and the empirics demonstrate that countries do tend to be both importers and exporters of the same good. The latter fact is a well-known phenomenon called intra-industry or two-way trade. (Francois & Reinert, 1997). To assume homogenous goods is therefore a simplification and implies that only inter-industry trade can be analyzed. The decision a model builder has to make on the nature of traded goods is essentially a choice between two of the key features in what has been called the "New Trade Theory" and the neoclassical trade theory, although there is no need to pick all ingredients of either theory and exclude those of the other. The neoclassical trade theory which assumes perfectly competitive markets where individual firms lack the power to influence prices, constant returns to scale, and that countries specialize according to their factor endowments also assumes trade based on homogenous goods. The new trade theory, however, sees the possibility for increasing returns to scale as the driving force behind specialization and do not assume perfect competition and homogenous good. (Sarker & Surry, 2006 and Van Marrewijk, 2004).

Despite its drawbacks, the homogeneity assumption seems to be widely used, at least in partial equilibrium models. Van Tongeren's *et al.* (2001) review of eight partial and eight general equilibrium applied agricultural trade models of recent vintage shows that all reviewed partial equilibrium models do assume homogeneous goods. Apparently, it is a simplification worth making. In a recent review on the state of the art regarding the inclusion of product differentiation in applied trade models Sarker & Surry (2006) admit that there are problems in need to be solved before trade in heterogeneous goods can be easily introduced in partial equilibrium models. However, in the light of the proven importance of trade in heterogeneous goods they do urge modelers to justify the assumption of homogenous goods.

To allow for product differentiation and thus assume that goods are heterogeneous may give a more realistic model but makes trade modeling more difficult as it opens up for differing price movements among suppliers of the same good, and while allowing actors to be both buyers and sellers of the same good. Product differentiation can be introduced in applied trade models either exogenously at the demand side, or endogenously at the supply side. If introduced exogenously the so-called Armington assumption is commonly used, whereby imported and domestic goods are assumed different in the eyes of the buyer, which yields different prices. If introduced endogenously instead, it is assumed that firms produce differentiated goods because consumers prefer it.

Policy Representation

The essence of protective trade policies is to keep the domestic price of a product at a level different from the price encountered internationally. In addition, some policies tend to mitigate the effect on domestic prices of price changes on the world market. How to model border protection instruments, such as tariffs and different quantitative restrictions, and other policies that affect trade and domestic prices is of course a crucial aspect of applied trade modeling.

Tariffs or customs duties, *i.e.*, a tax imposed by a government on commodities as they cross the national border (Koo & Kennedy, 2005), are perhaps the easiest to model since they commonly are or can be expressed as ad valorem tariff rates, that is as a fixed percentage of the price of the good (Koo & Kennedy, 2005 and Van Tongeren & Van Meijl, 1999). Quotas, voluntary export restraints and other quantitative restrictions as well as other so-called non-tariff barriers are more difficult to model. It is done through one of two main approaches, either through a tariff equivalent representation as described above, or through a direct specification of relevant quantitative restrictions. Neither approach is unproblematic. To calculate a tariff equivalent directly, goods need to be homogenous and international prices must be readily available. This is often not the case and the tariff equivalent must be estimated. (Van Tongeren & Van Meijl, 1999). Tariff-rate quotas that combine the features of a tariff with that of a quantitative restriction while allowing for a lower tariff rate up to a specified quantity present additional difficulties.

The best option is always to model policies explicitly as the policy makers design them, but reality often forces modelers to find ways to do it indirectly instead. The latter is most commonly done by using either a "price transmission" equation that let international prices affect domestic prices only partially through a price transmission elasticity, or by using a "price linkage" equation that uses a calculated price wedge between the domestic and the international price, to represent policies (Salvatici *et al.*, 2000). The "price linkage" equation is essentially the perfect transmission case of the "price transmission" equation and the difference between the two prices is instead given by the size of the price wedge.

However, to find a price transmission elasticity or a price wedge that resembles reality is not all that easy. OECD`s producer support estimates (PSE) or more often its market price support element (MPS) can be used to approximate the price wedge for agricultural commodities. As pointed out by Giovanni Anania (2001), a problem with the PSE´s and to a lesser extent MPS is that they may include a wide range of trade and domestic policies affecting the domestic price. It is thus not only an implicit measure of the price gap but also an aggregation of measures with different mechanisms, effects and origins. With aggregation comes less detail and it may for instance be hard to separate the effect of a trade measure such as a tariff change from a change in domestic policy such as a guaranteed minimum price. The PSE gives a rough approximation of the price wedge as it includes all transfers from consumers and taxpayers that support agricultural producers. The MPS is more precise as it includes only transfers that really create a gap between the price farmers get at the farm gate and the price they would get at the border net of any handling or transportation costs that may arise between the farm gate and the border. An important caveat to bear in mind if using PSE or MPS as price wedges is that they are measured in nominal terms and may change with exchange rates and world prices even if trade and domestic policies are unaltered.

Definition of Parameters

The parameters in applied trade models can be estimated using one of two main approaches: econometric estimation or calibration. The parameters in the models will be used in behavioral equations and will decide the magnitude by which policy changes affect prices and quantities. The choice of exogenous variables used to estimate the parameters is therefore of crucial importance. Among the usual key exogenous variables can be mentioned: price- and income elasticities and budget shares to be used in demand systems, and substitution elasticities and input cost shares to be used in supply systems.

Econometric estimations of parameters based on simultaneous equation systems may have a clear advantage as it is possible to assure that the parameters are estimated with the same functional form as the model and it can be guaranteed that the parameters have been statistically tested (Conforti, 2001). However, this is seldom feasible due to lack of data, the very size of applied trade models, and other complications. Instead, econometric estimates must be based on available parameters taken from diverse sources, literature, and expert judgments.

The difficulties described above may explain why many applied trade modelers use a "synthetic approach", that is calibration to estimate parameters. This way, available parameters from the literature, experts and other sources are used either directly or to generate estimates of missing parameters that are consistent with both the theoretical underpinnings of the model and the known values of the endogenous variables in the base period, *i.e.*, the benchmark data. Models based on calibrated parameters are called synthetic. (See also Conforti, 2001).

Other differences between Partial and General Equilibrium Models

The "standard" multi-region partial and general equilibrium models described in Van Tongeren *et al*. (2001) do not only differ with respect to their representation of national economies. Both model types can opt for similar solutions regarding the design options previously described but they do tend to take opposite ways when it comes to the characterization of global markets. All partial models reviewed by Van Tongeren and his co-authors assume homogenous goods and thus characterize their markets as pooled, *i.e*., only net trade is considered. The general equilibrium models, however, allow for product differentiation and two-way or bilateral trade of the same good.

The degree of theoretical consistency and type of model closures need to differ between partial and general equilibrium models due to their different structures. A fundamental requirement if a model is to be theoretical consistent is that its numerical results are consistent with the model's theoretical foundations. This places some conditions on parameters used in the models functional forms, *i.e.*, the statements made on the mathematical relationships between variables. Since general equilibrium models require incomes to equal expenditures at a global scale, theoretical consistency will be implied by the model structure. Partial equilibrium models, on the other hand, need not to be that strict and consequently they are not automatically theoretically consistent. Although, both partial and general equilibrium models need to comply with certain common closure rules, *e.g.*, that the number of variables is equal to the number of equations and that a valid economic environment is specified, partial equilibrium models do not need to take the link between investment and savings, *i.e.*, the so-called "macroeconomic closure" into consideration.

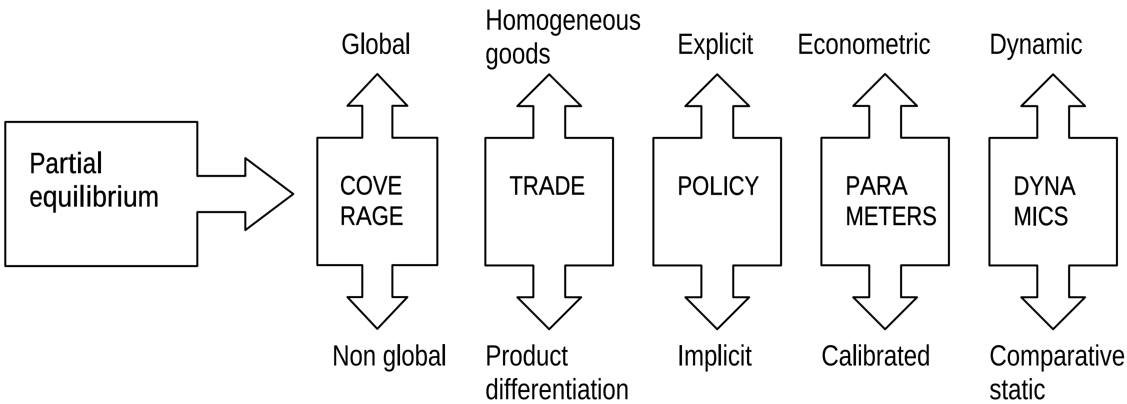

Figure 9. Modeling options in partial equilibrium analysis of trade.

Applied Trade Models

Research is a cumulative process and there is seldom something completely new under the sun. Therefore, and before proceeding to the presentation of the model developed for this thesis a brief description of four applied partial equilibrium models, which have acted as points of reference in the model design will be given. Focus is on how they deal with the feed-livestock complex.

AGLINK

AGLINK is a partial equilibrium model constructed by the Organization for Economic Co-operation and Development, OECD. It has provided the basis for the medium term projections in the annual *OECD Agricultural Outlook* since 1993 and is also used for other policy simulations. AGLINK is a partial equilibrium model for the agricultural market and models the most important agricultural commodities of the OECD countries. Its coverage is **global**, although the majority of the countries of the world are grouped under the heading the "Rest of the World". The model has complete modules for nine OECD member states and one for EU-15 as a region. In addition, there are separate modules for Argentina, China and the Rest of the World. (OECD, 1998). The modules may include country or region specific details but they all have the same overall structure to guarantee uniformity. It is thus possible to run simulations for one country separately as well as for the whole world. AGLINK allows for time lags in its exogenous and endogenous variables and is thus **dynamic** (OECD, 1998). The model is **non-spatial** in that it assumes homogenous goods and only describes net trade. Tariffs as well as export subsidies and taxes are **explicitly** modelled. (Conforti & Londero, 2001). AGLINK is a synthetic model, *i.e.*, its parameters are **calibrated** (Van Tongeren & Van Meijl, 1999). The only exceptions are the feed parameters, which are econometrically estimated.

How does AGLINK then represent the feed-livestock complex? Among the agricultural markets included in the model, we find the markets for meat, eggs, and milk, as well as the market for cereals and oilseeds. Both the livestock and the feed components are thus included. Feed supply is calculated as the product of the area that is harvested and the yield received per area unit. Those two components are modeled separately with the possibility to allow for changes by relative prices and policy variables. The feed demand in each country or region is modeled using total feed expenditures, which in turn is a function of the livestock production. Data on expenditure shares is also used. Farmers are assumed to use mainly wheat, coarse grains or oilseed meal for feed in response to their relative prices. The demand for feed responds to changes in feed prices in two ways. First, the shares of each feed stuff change depending on their substitutability and if they have complements or not, and second, the overall demand for feed changes with the herd sizes that in turn are dependent on feed prices. We have thus both a share and a scale effect. (OECD, 1998)

The supply of livestock, *i.e.*, the supply of beef, milk, pig, poultry and egg is based on a representation of farmers' production decisions. To produce beef and milk is assumed an ordinary investment decision. The expected cash flow from future sales of calves determines the value of the breeding animal today. As long as this capital value of animals for reproduction exceeds the market value of beef, cows and heifers will not be slaughtered, *i.e.*, farmers will invest in breeding animals instead of sending them off for slaughter. Thus, the higher the expected future income from producing beef and milk the greater the investment in breeding animals and the lower the availability of animals for immediate slaughter. In AGLINK the supply for beef and milk is a function of the number of breeding animals in previous years, producer prices for beef and its substitutes, and production costs. As the price of beef today may affect expectations of future beef prices, it is important to note that the production of beef actually may decrease in the short run in response to a higher beef price. (OECD, 1998, and Conforti & Londero, 2001). The demand for meat and egg are functions of farm prices, per capita income and population. The farm prices are real as they are deflated by the corresponding national consumer price index. Per capita income and own prices sets the demand for dairy products, (OECD, 1998).

ESIM

The first version of the European Simulation Model, ESIM was developed by the US Department of Agriculture in the early 1990´s. As suggested by the name its focus is on the European setting. The use and development of the current version is the responsibility of the Directorate General for Agriculture of the European Commission. ESIM is a partial equilibrium model of the agricultural sector. It does not only include production and consumption but also some primary processing activities. The coverage of the model is **global**. The model's key applications, however, are simulations regarding EU enlargement and the degree of detail differs accordingly between the European countries included and the US as well as the countries aggregated into the Rest of the World, ROW. The latter two react only to changes in world market prices, whereas the European countries are modeled to react to policy changes. ESIM does not allow for any adjustments in time and is thus a **static** model that simulates and compares long-term equilibriums only. Trade is modeled only in terms of net trade, which excludes the possibility of product differentiation. This homogeneity condition makes the model **non-spatial**. A variety of policy instruments are modeled **explicitly**. The parameters used in ESIM are calibrated making the model **synthetic**. (Banse *et al.*, 2004).

ESIM includes production and usage of both crops and animal products. A closer look on how the feed livestock complex is modeled reveals the following. In ESIM there are two ways to model crop supply. For European countries, production of crops is defined as area times yield. In order to take policy implications into account the effective area is used, *i.e.*, the area the farmer's desire to plant minus the area set aside due to policy demands. For non-European countries crop supply is calculated as a direct function of the own and cross incentive prices producers enjoy and technical progress. The model differentiates between food and feed demand. The feed demand in ESIM is based on expert's assumptions on the feed composition needed to produce one unit of a certain livestock product. This so-called feed rate, defined as feed demand per unit of livestock product is modeled as a function of relative feed prices. The prices used are the domestic feed prices on the wholesale market adjusted for feed subsidies and aggregated into a feed cost index. Total feed demand for each feed component is calculated as the sum of all individual feed rates multiplied by total livestock production. Feed demand of animals not included in ESIM is added to the total as an exogenous feed component. Using this modeling approach livestock prices affect livestock supply and thus also total demand for feed but have no impact on the individual feed rates. Feed prices, on the other hand, play a decisive role in both supply and demand of livestock. A change in feed prices affect the shares of each feed component as farmers substitute more expensive feed components for cheaper components and as the complementary effect provokes further shifts among the shares. The same change in feed prices affects the feed cost index, which will induce a change in the scale of livestock production. (Banse *et al.*, 2004 and Josling *et al.*, 1998).

Livestock supply is a function of the relative prices for each type of livestock commodity, the feed cost index, and a productivity shifter. The prices of livestock products used are adjusted for policy implications and include producer prices and direct payments. The demand for meat is a function of relative prices, population, and the growth rate of income. (Josling *et al.*, 1998).

FAPRI (EU-GOLD)

FAPRI is a partial equilibrium model of the world agricultural sector and has been the main analytical tool for the US-based Food and Agricultural Policy Research Institute or FAPRI since the 1980´s. The model has a **global** coverage. At present 24 commodities in 29 countries or regions are included in the model. In this global model the European Union forms one region and the member countries are not modeled individually.

Since 1999, however, a separate and more disaggregated model for the European Union has been developed under the name EU GOLD or the European Union Grains, Oilseeds, Livestock and Dairy model. This model may be run separately as well as solved simultaneously with the global FAPRI model. (Young and Westhoff, 2000). EU GOLD still puts most member countries in one block. The exceptions that are modeled in more detail are Ireland and, in a European perspective, the four agricultural "giants": France, Germany, Italy and the UK. FAPRI as well as EU GOLD are **dynamic** models. Both assume homogenous goods and pooled markets and are therefore **non-spatial**. Like in other non-spatial models net trade is merely the difference between domestic supply and demand. FAPRI does not use an explicit or direct representation of trade policies and nor does EU-GOLD. Instead, an **indirect** representation using price wedges is applied. Unlike the FAPRI global model and the Irish sub model in EU GOLD that estimates their parameters econometrically, the EU GOLD model is **synthetic**. The four sectors or commodity groups included in EU-GOLD are divided into three somewhat different model structures: grains and oilseeds form a crop model, there is one model for livestock, and one for dairy. The substitutability links the commodities in each model structure. These structures in turn are also linked to one another. The feed demand and input cost equations link the livestock model and the dairy model. The livestock model is dependent of the dairy model as the latter is the supplier of calves for beef production and cows for slaughter. (Hanrahan, 2001 and Young & Westhoff, 2000).

Area harvested and yield per hectare give the crop supply in EU-GOLD. The area equation is built on a two-stage decision process. In the first stage, real expected returns and compulsory set-aside rates determine the total area that is harvested and in the second stage, the share of each crop is determined as a function of relative expected returns at the market. The yield functions for grains and oilseeds are different. Grain yield per hectare is a function of technical change affecting growth in yields, grain prices, and the area devoted to grain production. The equation for oilseeds is similar to the one for grains but prices are not included in the yield equation for oilseeds. Feed demand is a function of livestock production and feed prices. (Hanrahan, 2001 and Young & Westhoff, 2000).

In EU-GOLD the livestock sector consists of sub models for cattle, pig, sheep and poultry linked together mainly through the assumption that all meats are substitutes for one another. The number of cows, sows and ewes determines the number of young animals eventually available for slaughter and is thus a key variable on the supply side of all except poultry. Poultry supply is a function of the preceding period's poultry production, the real price of chicken and a linear trend. EU policy is another key variable in the determination of cattle and beef supply. The domestic demand for meat is a function of price, price of substitutes, and real income per capita. (Hanrahan, 2001 and Young & Westhoff, 2000).

AGMEMOD

AGMEMOD is a partial equilibrium model for the EU agricultural sector based on a partnership between at present 27 European countries. The model was to a high degree developed along the same lines as the FAPRI EU-GOLD model and in particular, the econometric Irish sub-model. AGMEMOD has a **global** coverage although the world outside Europe as well as some European countries is treated as a Rest of the world bloc. The model is based on individual country models that are linked together through product prices and trade flows. To assure compatibility the country models maintain the same structure. Policies are modeled **explicitly** in AGMEMOD, in general as separate econometrically estimated explanatory variables within equations. The model is **dynamic**, **non-spatial** and **econometric**. (Ledebur O. *et al.*, 2005 and AG-MEMOD, 2006).

The determination of crop supply in AGMEMOD follows the same two-stage approach used in the EU-GOLD model. Unlike EU-GOLD, root crops are included among the possible crop groups in AGMEMOD. Once total area harvested of each crop group as well as the share of each of each individual crop and yield per hectare has been determined crop supply is obtained. Feed demand is a function of feed prices and other endogenous variables such as livestock production affecting the demand for feed. (AG-MEMOD, 2006).

Average slaughter weight times number of slaughtered animals determines the livestock supply in AGMEMOD. The herd inventory is a key factor as it determines the number of animals available for slaughter. Domestic demand for meat is the product of per capita demand and population, where per capita demand is a function of prices of substitutes and exogenous variables such as per capita real income. (AG-MEMOD, 2006).

4. Model Description

A great deal of the work behind this thesis is spent on the construction and calibration of a single-country partial equilibrium model for the feed and livestock complex, or rather the grain and livestock complex in Macedonia. As pointed out by Francois and Reinert (1997, p. 4), there is no clear-cut division between theoretical and applied trade models, but rather a sliding scale between pure theory via theory with numbers to numbers with theory. The model built for this thesis is not estimated econometrically but calibrated for "one" year. The base year chosen is a simple average of 2003 and 2004.

The goal of this modeling effort is of course the policy simulations and the conclusions that can be drawn from them. However, prior to that point several issues have to be resolved. The first step is to decide which theoretical framework to use and to make sure that all assumptions are made explicit. After that, it is time to gather the necessary data and to adopt the theoretical specifications to the reality in Macedonia. Whether the theoretical model really describes what we observe must always be questioned. Finally, the parameters of the model have to be calibrated to base year quantities, prices and elasticities.

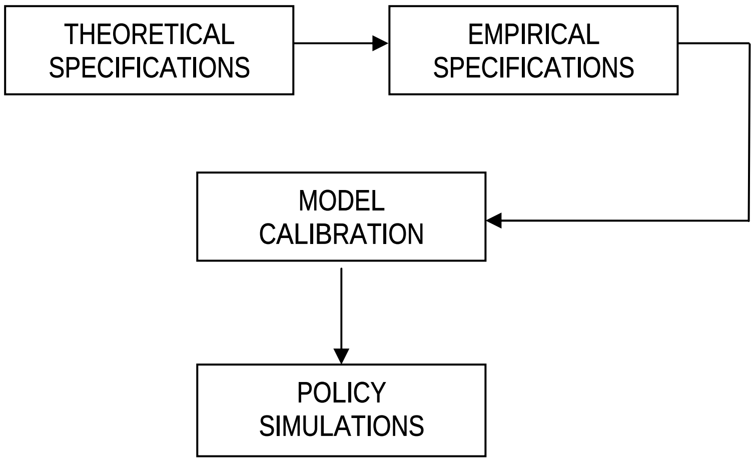

Figure 10. Stages of the modeling effort.

What follows is a brief overview of the model and an account of the process behind the model. For simplicity, the model will hereafter be called **FELIM,** or the Feed and Livestock Model for Macedonia. A detailed account of the base data used as well as the model setup is to be found in annex B and E, respectively.

Theoretical Specifications

FELIM is a **partial** equilibrium model for the Macedonian agricultural sector, or more specific its feed and livestock complex. Since a single-country model, by definition its geographical coverage is **non-global**. The world market enters the model only exogenously through trade and world prices. FELIM is a **comparative static** model. As no time lags are considered, the analysis is undertaken comparing long run market equilibria. Domestically produced and imported goods are assumed homogenous and only net trade is considered. The model is therefore **non-spatial**. Policy measures are **implicitly**[12] modeled and are introduced as price wedges based on market price support estimates, MPS's and as output subsidies derived from producer support estimates, PSE's. The model is completely **synthetic**; all elasticities used to estimate the parameters used in the behavioral equations are taken directly from the literature or are calibrated. The time frame of the model is medium to long term and the elasticities are chosen thereafter.

[12] To use an explicit policy representation may be complicated but it is feasible. The implicit representation used, however, fulfills the purpose of this thesis.

FELIM is a market equilibrium model. That implies a set of assumptions on how economic agents act in response to price changes. Any model is only as god as the assumptions that it makes. When assessing the simulation results it is therefore important to be aware of these assumptions as well as the limitations and simplifications that may come with them. The key assumptions are:

- ⇒ Small country
- ⇒ Homogenous goods
- ⇒ Perfect competition
- ⇒ Profit maximization
- ⇒ Utility maximization

Judging by the size of the economy in Macedonia it is reasonable to assume that domestic price fluctuations are unable to affect world prices. The **small country** assumption is thus applicable and world market prices can be taken as given. To assume that domestic goods and imports are perfect substitutes and thus **homogenous goods** is a simplification. For primary products like grains and meat, however, such an assumption should normally not diverge too much from reality. For the sake of simplicity, it is assumed that farmers and consumers in Macedonia face a **perfectly competitive** market characterized by perfect information, price takers, and costless transactions. Producers and consumers are assumed to act rationally, producers seek to maximize their **profit** and consumers their **utility**.

Empirical Specifications

FELIM is built according to the mathematical rule that the number of equations and identities cannot be different from the number of endogenous variables. As illustrated in figure 11, the model is divided into two modules, one for livestock and one for grains, which are linked through the demand for feed grains. The livestock and grain modules each have a core of linear behavioral equations, a set of identities that combines them and of course an equal amount of endogenous variables. The equations represent supply and demand, whereas net trade is obtained as a residual. The exogenous variables enter the model as base data and are used to calibrate the parameters. Initial quantities of supply and demand as well as prices, population, and income are to be found in the base data. The parameters used in the model are the slopes and intercepts of the behavioral equations. These are calculated on basis of the different price, income, and price transmission elasticities. Table 5 summarizes the different equations and identities used in the model, and the base date is listed in Annex B.

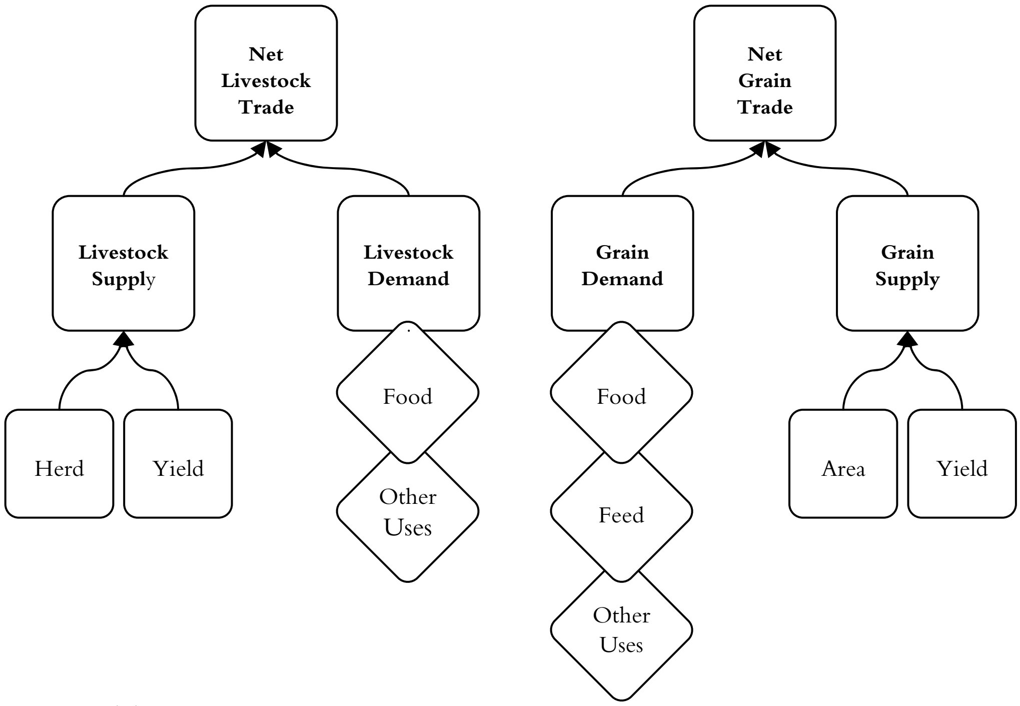

Figure 11. Model Structure.

Grains

Wheat, barley, and maize are the cereals or grains included in this model. Wheat has two competing usages, feed and flour for bread and other food items. But also barley and maize are used both for feed and food purposes. Grain production or supply is defined as area times yield (1). Area or more specific area harvested (2) is a function of relative unit returns for grain. Unit returns in turn are calculated as the effective return times yield. The effective return is the producer price plus any output subsidy. Yield (3) is a function of the own price and the purchase price of fertilizers.

Food demand for grains (4) is obtained as a function of the retail price and the consumer income expressed in per capita terms. Feed demand (6) for grains is modeled as a function of the cross prices of feed substitutes, an aggregated producer price of livestock, and the size of the livestock herd. As mentioned above the demand for feed grains is the link between the grain and the livestock modules.

The grain module includes two price transmission identities and one equation. Identity (7) calculates the producer price by multiplying the import price with the price wedge. The retail price (8) is modeled as a function of the own producer price whereas the import price is obtained by dividing the producer price with the tariff. The purchase price of fertilizers is assumed fixed. The only prices calculated endogenously are the retail and producer prices.

Net trade (9) is a simple identity where supply minus demand gives a trade surplus or a trade deficit expressed in metric tons.

Livestock

Livestock supply (10) is given by the identity herd size times yield. Herd (11) or number of livestock heads is a function of their own effective livestock returns, the effective returns of substitutes, and the producer price of feed grains. Meat yield (12a) is assumed fixed and is thus not endogenously modeled. The livestock products included in the model are beef and veal, pig meat, sheep meat, eggs, and cow milk. Milk yield (12b), however, is assumed more adaptable and is modeled as a function of the own effective return and relative producer prices of feed.

Per capita livestock demand (13) is function of relative retail prices of livestock products and consumer income. Identity (14) gives total demand for animal primary products.

As in the grain module, there are two price transmission identities and one equation. Producer prices (15) are obtained multiplying the import price with the price wedge. Livestock retail prices (16) are a function of own producer prices. To obtain the aggregated producer price of livestock, used to calculate feed demand in equation (6) in the grain module a set of exogenous livestock conversion rates obtained from GliPHA[13] have been used. Subsequently one livestock unit, LU is equal to:

$$LU = \mathbf{0{,}6}\text{Herd}_{\mathbf{beef}} + \mathbf{0{,}25}\text{Herd}_{\mathbf{pork}} + \mathbf{0{,}1}\text{Herd}_{\mathbf{sheep}} + \mathbf{0{,}01}\text{Herd}_{\mathbf{eggs}} + \mathbf{0{,}6}\text{Herd}_{\mathbf{cow\ milk}}$$

As for grains, net trade of livestock products (17) is obtained as the residual of domestic supply and demand.

[13] The conversion rates used to estimate the livestock units are the same used for transition markets in the Global Livestock Production and Health Atlas (GLiPHA). However, the conversion rate for cattle is applied also to cow milk, and the rate for poultry is applied to eggs.

Table 6. *Model Equations and Identities*

GRAINS	LIVESTOCK
Supply	
(1) $Q^S_i \equiv A_i * Y_i$	(10) $Q^S_z \equiv Herd_z * Y_z$
(2) $A_i = f(UR_i, UR_j, UR_k)$ where $UR = Y_i * (Pr_i + S_i)$	(11) $Herd_z = f(Pr_z + S_z, Pr_2 + S_2, Pr_3 + S_3, Pr_4 + S_4, Pr_5 + S_5, Pr_i, Pr_j, Pr_k)$
(3) $Y_i = f(Pr_i + S_i, P_{fertilizer})$	(12) a. Y_z = Fixed at base value b. $Y_{cml} = f(Pr_{cml} + S_{mlk}, Pr_i, Pr_j, Pr_k)$
Demand	
(4) $q^D_i = f(P_i, I)$	(13) $q^D_z = f(P_z, P_2, P_3, P_4, P_5, I)$
(5) $Q^{DFood}_i \equiv q^D_i * Pop / 1000$	(14) $Q^D_z \equiv q^D_z * Pop / 1000$
(6) $Q^{DFeed}_i = f(Pr_i, Pr_j, Pr_k, Pr_{livestock,} Herd_{lu})$	
Price	
(7) $Pr_i \equiv P_{imp} (1 + TAR_i)$	(15) $Pr_z \equiv P_{imp, z} (1 + TAR_z)$
(8) $P_i = \alpha + \beta Pr_i$	(16) $P_z = \alpha + \beta Pr_z$
Net Trade	
(9) $NT_i \equiv Q^S_i - (Q^{Dfood}_{i,} + Q^{Dfeed}_{i,} + Q^{Dother}_i)$	(17) $NT_z \equiv Q^S_z - Q^D_z$
Variables	
Q^S = domestic supply Q^D = domestic demand Q^{Dfeed} = domestic feed demand Q^{Dfood} = domestic food demand Q^{Dother} = domestic residual demand q^D = per capita food demand A = area harvested Herd = number of heads $Herd_{lu}$ = livestock herd in livestock units Y = yield UR = unit return NT = net trade	Pr = producer price P = retail price P_{imp} = import price TAR = percentage price differential S = output subsidy $P_{fertilizer}$ = price of fertilizers $Pr_{livestock}$ = aggregated livestock price I = income per capita Pop = population
Subscripts and Parameters	
i, j, k = wheat, barley, or maize α = intercept	z, 2, 3, 4, 5 = beef, pork, sheep, eggs, or cow milk β = slope coefficient

Exogenous Variables

The exogenous variables include base data on quantities, prices, income, population, policy measures as well as the elasticities of supply, demand and price transmission. Some of these exogenous variables are inserted directly into the model, while others are used to calculate the parameters, *i.e.*, the intercepts and slope coefficients used in the behavioral equations of the model.

Gross Domestic Product divided by the population is used as an approximation of consumer income in Macedonia. A consumer price index may be used to deflate the retail prices so that we use real prices when calculating consumer demand.

The policy measures are taken from the PSE calculations made by Ericson, Pelling and Surry (2007). Policy measures are introduced in the form of output subsidies and percentage price gaps. Output subsidies are direct budgetary payments to farmers based on what and how much they produce. The percentage price gaps are the price differentials between the domestic producer prices and the border price used to compute the market price support. Market price support and output subsidies are considered among the most trade distorting forms of support.

Since it is a synthetic model, there has been no attempt to estimate the different price and income elasticities by econometric means. Instead, the search for plausible elasticities in the literature and other sources has been an important part of the modeling effort. Unfortunately, it has not been possible to obtain these elasticities from or even for Macedonia. Data for other transition economies, however, is available and due to lack of relevant information for Macedonia, this data may be used as a proxy or a "guestimate". The elasticity database used in the European Simulation Model, ESIM described earlier proved very useful in this respect. The information drawn from this database provided reference values from three transition countries located in South Eastern Europe. More specifically, by using a simple average of the elasticities used in ESIM for Bulgaria, Romania and Slovenia plausible price and income elasticities for Macedonia could be derived. To assure theoretical consistency and relevance in the Macedonian setting these values have been compared and when needed adjusted to price and income elasticities from other sources. The demand elasticities for broad food subgroups in Macedonia provided by the USDA-ERS for 1996 (ERS) has been used to that end and so has the different elasticities used by Stoforos *et al.* (2000) with 1996 as base year, to depict the feed-livestock complex in APAS, a synthetic partial equilibrium model for the agricultural sector in Slovenia.

Model Calibration

Once the theoretical and the empirical specifications are in place it is time to calibrate the model. In essence, calibrating is about making sure that the results correspond to the reality depicted by base data and parameters. The parameters of the model are therefore calculated and calibrated to the elasticities chosen at base year quantities and prices.

Policy Simulations

As soon as the model is calibrated and running accordingly it can fulfill its purpose, to simulate different scenarios. All the exogenous variables are potential shock variables. For the purpose of this thesis, FELIM will be shocked by altering the different policy variables. The different scenarios and the policy variables used will be discussed in the next chapter.

5. Scenario Analysis

Although results should be interpreted with caution, the scenario analysis is the main tool in fulfilling the aim of this thesis. EU-Accession will undoubtedly imply changes in the agricultural policy of Macedonia. Even if impossible to foresee the exact outcome of the membership negotiations, we do know the current situation in terms of agricultural support to individual commodities in both Macedonia and in the EU. What we know in the case of Macedonia is the level of support from 1999 to 2004. This in turn can be compared with the available data for the EU, which currently goes up to 2005. A comparative static analysis, based on these two data sets, will at least give some valuable hints of what might be the implications of EU-Accession for the feed-livestock complex in Macedonia.

Scenarios

If to conduct a scenario analysis, we need a benchmark or reference to which the simulation results can be compared. In order to even out annual fluctuations in the level of support, an average of the support level for a set of years is used in the baseline. Since 2002 was a year with exceptionally large amounts of payments to farmers in Macedonia and must be considered an outlier, an average for 2003 and 2004 has been used. The model has thus been calibrated using the 2003-2004 average for quantities, prices and all other exogenous variables and base data. Two scenarios have been simulated and compared to the baseline, of which the scenario involving EU-accession will be analyzed in depth:

Baseline: "**Status Quo**"
Market Price Support → At 2003-2004 average for Macedonia (as measured by the %Price Gaps)
Output Subsidies → At 2003-2004 average for Macedonia (den/ton)

Scenario I: **EU-Accession**
Market Price Support → At 2003-2004 average for the EU (as measured by the %Price Gaps)
Output Subsidies → At 2003-2004 average for Macedonia (den/ton)

Scenario II: **Free Trade**
Market Price Support → Abolished
Output Subsidies → Abolished

What follows is a brief description of the baseline and the scenarios.

Baseline: "Status Quo"

The baseline, intends to resemble status quo. The level of support to individual commodities in the base year, *i.e.*, the 2003-2004 average is presented in table 6 below. The size of the market price support (MPS), as measured by the price gaps between producer prices and border prices differ considerably between commodities. As shown in table 7 and with the exception of barley, the price differentials are all quite large. Due to lack of reliable data, however, it has not been possible to estimate the price gap for sheep meat. In Ericson, Pelling and Surry (2007), the price gap for sheep meat is assumed zero. What is classified as output subsidies in the PSE data is with the exception of wheat a very small component of total payments, and is also vary in size among the various commodities. For barley and maize, there are no output subsidies. It is clear that the MPS element represents the lion share of the support producers enjoy.

Table 7. *Policy variables in Macedonia at the baseline*

	Average 2003-2004						
	PSE (%)	**Composition of PSE** (%) **MPS**	**Budgetary Payments** **Output**	**Other**	**MPS** (%)	**Output subsidies** (denar/t)	**Price Gap** (%)
Beef and Veal	48	96	0.01	4.09	47	**4.7**	**81**
Pork	42	94	0.01	5.97	39	**4.2**	**79**
Sheep meat	4	0	0.07	99.93	n/a	**6.2**	**0**
Eggs	18	91	0.02	9.44	16	**2.2**	**33**
Cow Milk	53	96	0.01	3.95	51	**0.5**	**104**
Wheat	27	79	16.77	3.77	22	**498.7**	**30**
Barley	10	63	0.00	37.12	7	**0.0**	**8**
Maize	20	88	0.00	11.80	17	**0.0**	**22**

Source: PSE-estimates for Macedonia in Ericson, Pelling and Surry (2007)

Scenario I: EU-Accession

In scenario I, the effects of accession "today" will be simulated. Although market price support in the EU still has a major share in the support to producers, its importance is less pronounced than in Macedonia. As indicated by table 8, the greater importance of other payments is noticeable.

Table 8. *Policy variables in the EU, average 2003-2004*

	Average 2003-2004						
	PSE (%)	**Composition of PSE** (%) **MPS**	**Budgetary Payments** **Output**	**Other**	**MPS** (%)	**Output subsidies** (denar/t)	**Price Gap** (%)
Beef and Veal	72	48	0.00	52.42	34	**0.2**	**128**
Pork	25	83	0.27	16.36	21	**50.7**	**29**
Sheep meat	56	29	0.01	70.63	17	**29.3**	**40**
Eggs	2	-111	0.05	210.77	-2	**0.6**	**0**
Cow Milk	37	85	0.31	14.86	31	**19.4**	**54**
Wheat	42	9	0.07	91.31	3	**2.4**	**5**
Barley	49	6	0.01	93.96	3	**0.4**	**5**
Maize	43	43	0.17	56.68	18	**6.9**	**31**

Source: Producer and Consumer Support Estimates, OECD Database 1986-2004

Given the relative un-importance of output subsidies in the production in both Macedonia and the EU, accession will be simulated by altering the price gaps only. As can be seen in figure 12, accession will thus imply a greater level of market price support (MPS) to the production of beef, sheep meat and maize, but less market price support to the production of pork, eggs, cow milk, wheat, and barley.

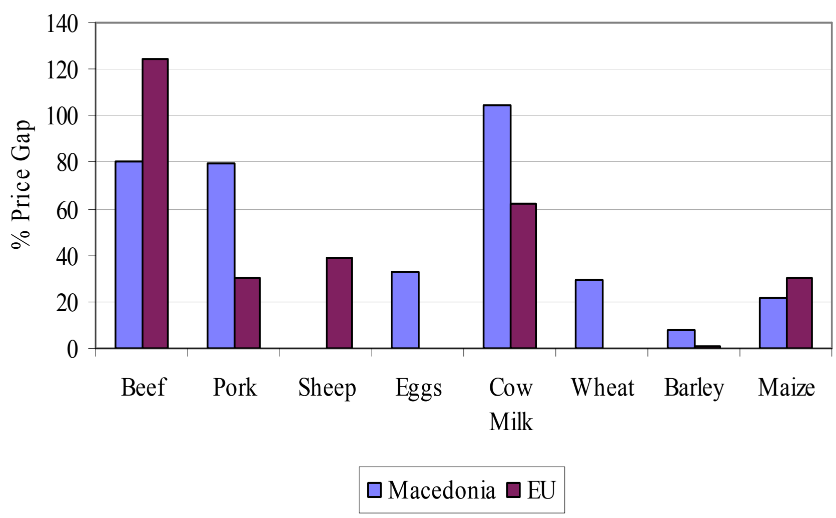

Figure 12. Average price differential for 2003-2004.

Scenario II: Free Trade

A complete trade liberalization, which is simulated in scenario II is not expected in any foreseeable future and certainly not in the short run. Even though unrealistic, a scenario with free trade is interesting as contrast to the other two scenarios. Free trade in this case, is simulated as a situation with no market price support and no output subsidies to farmers

Simulation Results

As any model, FELIM intends to bear resemblance to reality. The effects of EU-Accession are probably manifold, of which this model will capture only some. The elasticities used are believed to depict the price responsiveness of the different actors on the market. Direct price effects as well as cross-price or substitution effects on supply and demand can therefore be analyzed. Since a model for the feed-livestock complex, the direct price, cross-price and quantity effect on feed demand will also be analyzed. Detailed results for the base, the EU-Accession, and the Free Trade scenarios are listed in annex C and D. What follows is a presentation and discussion of the main findings of the scenario with EU-Accession "today".

Livestock

The analysis of the EU-Accession scenario for livestock products is quite straightforward. A reduction in the market price support will decrease the price received by farmers and thus the price consumers pay. As long as the direct price effect dominates, the result should be a decrease in production and a boost in consumer demand. An increase in the level of market price support should have the opposite effect. This is also what the simulation yields (see figure 13). Beef and sheep meat are the two livestock commodities for which support increases in the accession scenario. Thus, for beef a 25 percent increase in the producer price, a 22 percent increase in production, and a 19 percent decrease in demand is obtained. The effect on sheep meat is even more pronounced with a 39 percent increase in the producer price, a 44 percent increase in production, and a 25 percent decrease in demand. The greater effect obtained for sheep meat, for which no market price support was assumed in the base scenario, is due to the larger responsiveness of sheep producers to price changes. It is simply assumed that farmers more easily resize their sheep herds than their beef herds. The decrease in the producer price of pork, eggs and cow milk due to curbed support is 28, 25, and 20 percent, respectively. The combined result is that farmers shift over to beef and sheep meat production, while pork production is reduced with 47 percent, egg production with 43 percent, and the production of cow milk with 10 percent. The demand response is highest for pork with a 26-percentage increase. The increase in demand for eggs is 7 percent and for cow milk 9 percent.

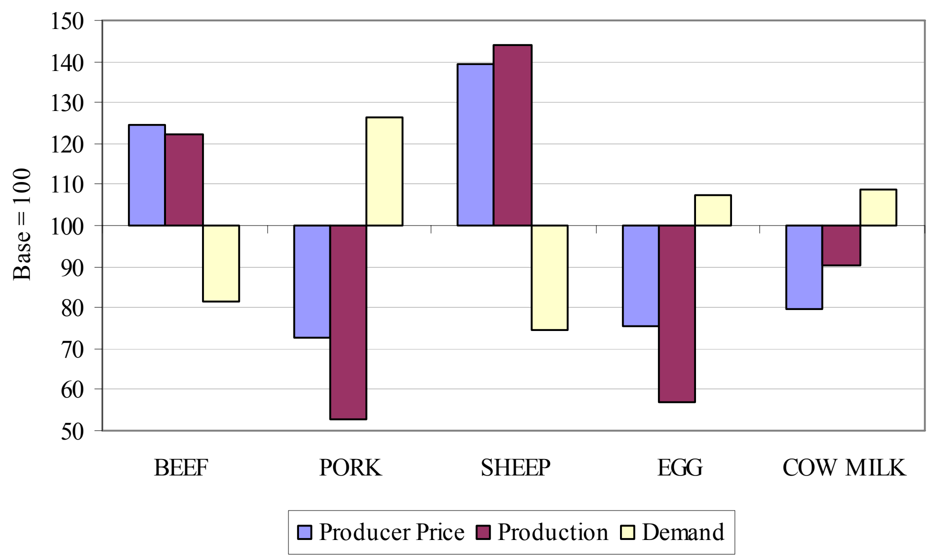

Figure 13. Percentage changes in the Livestock Sector due to EU-Accession.

The cross-price effect and the feed cost effect are in this scenario not able to offset or override the direct price effect described above. However, they do influence the size of the effects on production and demand. The increase in beef production, for instance, would have been greater were it not for the price fall suffered by its joint product cow milk and the simultaneous improvement in the price of sheep meat, one of the substitutes for beef. The increase in the price of maize described in the next section is also a drawback for beef producers.

EU-Accession will not overturn the existing pattern in terms of trade positions in the livestock sector (see figure 14). Macedonia will still be a net importer of beef, pork and milk, and in the case of pork and milk even more so than in the base scenario. In fact, the slight net exports of eggs, observed in the base scenario, are turned into net imports in the accession scenario. The only commodity that will improve its trade position is sheep meat that goes from net exports to more net exports.

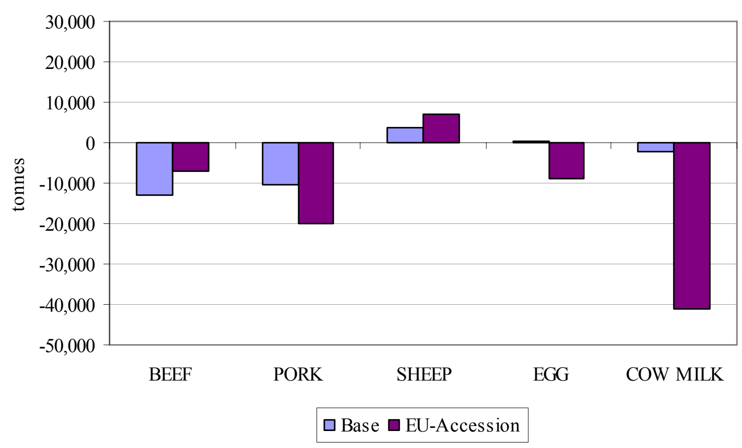

Figure 14. Net Trade in the Livestock Sector before and after EU-Accession.

Grains

EU-Accession "today" will erase the market price support wheat producers enjoy and trim down the support farmers producing barley receive, whereas support to maize growers will rise. The expected consequences due to the direct price effect should be the same as for livestock. This is also what the simulation gives for wheat. The producer price of wheat drops by 23 percent as the market price support to wheat is abolished. The result is a 16 percent decline in wheat production and an 8 percent increase in total demand. Barley and maize, however, do not behave as expected. The cut in support to barley and the raise in support to maize result in a 6 percent decrease in the producer price of barley and a 7 percent increase in the producer price of maize. The demand for barley behaves accordingly and increases with 8 percent, and so do the production of maize, which increases with 8 percent. But, instead of the expected decrease in the supply of barley, a 3 percent increase is obtained. Similarly, instead of the expected decrease in total demand for maize, there is a 3 percent increase. Figure 15 summarize these findings.

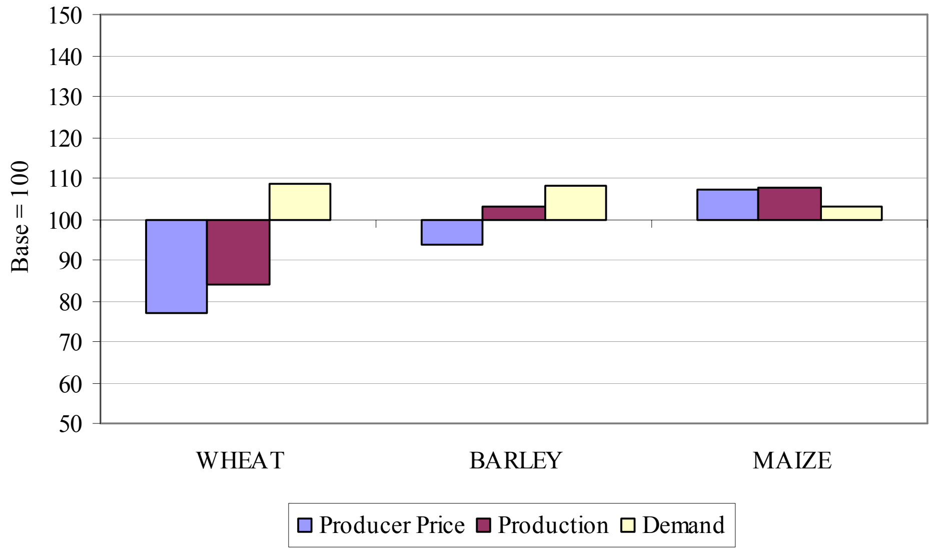

Figure 15. Percentage changes in the Grain Sector due to EU-Accession.

These peculiarities call for an explanation. In the case of barley, the increase in production is explained by the cross-price effect. The price drop facing wheat farmers is relatively larger than the one facing producers of barley. It will thus be relatively more profitable than before to substitute wheat for barley. This substitution effect between wheat and barley is only partly offset by the surge in the price of maize, following the increase in support. The peculiar increase in the demand for maize, however, cannot be explained by any cross-price effect in food demand, as there is none. Table 9 demonstrates that wheat is more of a “food crop”, whereas barley but also maize are typical “feed crops”. The direct price elasticity of food demand is therefore much larger for wheat than for barley and maize. The demand response in terms of food is accordingly larger for wheat. As indicated by figure 16, the demand for food change as expected, and cannot explain the surge in total demand for maize. Wheat, barley and maize for food purposes are simple not deemed by consumers as substitutes for one another.

Table 9. *Disaggregated Demand for Grains*

	BASE	EU	%Δ
WHEAT	**234162**	**253914**	**8.4**
Feed	47412	52526	10.8
Food	186750	201389	7.8
Feed Share	*0.20*	*0.21*	*2.2*
BARLEY	**124119**	**134477**	**8.3**
Feed	113879	124200	9.1
Food	10240	10277	0.4
Feed Share	*0.92*	*0.92*	*0.7*
MAIZE	**169336**	**174525**	**3.1**
Feed	101966	107493	5.4
Food	67370	67032	-0.5
Feed Share	*0.60*	*0.62*	*2.3*

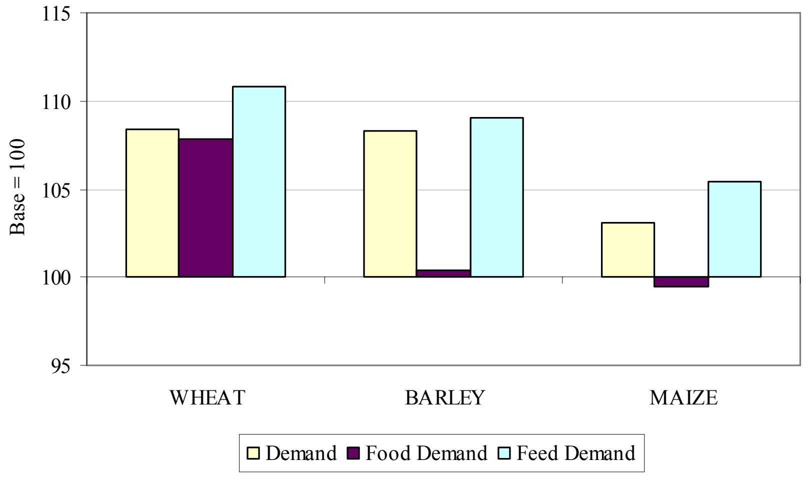

Figure 16. Percentage changes in total, feed, and food demand due to EU-Accession.

The explaining factor behind the surge in demand for maize must be found in the demand for feed. The feed demand for maize can increase for various reasons. The direct price effect, on one hand, will increase demand if the price of maize decreases. The substitution or cross-price effect, on the other hand, will boost demand if the price of grain substitutes goes up, making it relatively more cost efficient to use maize for feed. However, none of this occurs in the EU-Accession scenario. As maize becomes more protected than before, the price will go up, not down. Similarly, as wheat and barley become less protected their prices will go down, not up. The direct and the cross price effect of grain have obviously been overridden by something else. There are two remaining reasons that might be behind this. They both belong to the supply side of livestock. Firstly, there is a quantity effect. To put it simply, if the aggregate livestock herd were to increase so would feed demand. Secondly, there is a price effect. Thus, if the aggregate price of livestock were to increase, making it more profitable to be a livestock producer, the demand for feed would increase. The quantity and price effects of EU-Accession are not uniform but vary depending on livestock. However, taken together the effect of EU-Accession on the livestock side is both an increase in the total livestock herd measured in livestock units, and an increase in the aggregate price of livestock, which in turn explains the peculiar increase in the demand for maize.

In terms of net trade and assuming that net exports is a goal to strive for, EU-Accession will not imply any improvements. As indicated by figure 17, Macedonia will still be a net importer of wheat, barley and maize. The net imports of wheat and barley will even increase. Only in the case of maize is there a decrease in net imports.

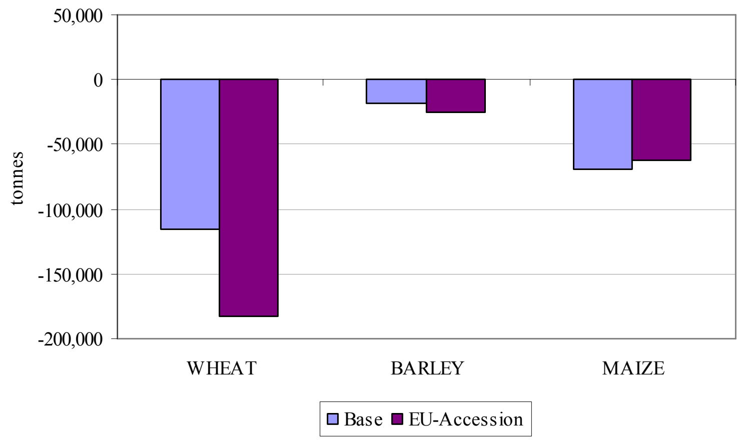

Figure 17. Net Trade in the Grain Sector before and after EU-Accession.

Discussion

The scenario analysis makes it evident that there is not one but a whole range of different impacts of accession that must be considered. Producers of beef and sheep meat, as well as barley and maize producers are the winners on the producer side. The production of pork, eggs, cow milk, and wheat, on the other hand, will decline.

Consumers will gain as the level of support to the production of pork, eggs, and cow milk is reduced. To put it simply, as future EU-citizens, Macedonian consumers are expected to increase their consumption of pork, eat more eggs, and drink more cow milk. However, they will eat less beef and sheep meat. Accession is also set to raise the demand for grains. The largest increase will be in the demand for feed grains but there will also be an increase in the food demand for wheat and barley. People will thus eat more bread and drink more beer than before accession. Less maize will be eaten though. A caveat regarding the increase in pork consumption, however, is that this increase may be mitigated if the existence of Macedonia's large Muslim population were better accounted for.

The self-sufficiency ratio, *i.e.*, the share of domestic production in total domestic use, is one measure of a country's trade position. Table 10 reveals that Macedonia will loose ground and become a net importer of eggs instead of net exporter. Accession, however, will not overhaul Macedonia's trade position in terms of livestock and grains. Macedonia will still be a net exporter of sheep milk and continue as a net importer of most livestock products and grains.

Table 10. *Self-Sufficiency Ratios*

Simulated Self- Sufficiency Ratios			
	Base	Accession	Free
BEEF	41%	62%	23%
PORK	48%	20%	22%
SHEEP	222%	427%	289%
EGG	101%	53%	54%
COW MILK	99%	82%	50%
WHEAT	72%	57%	100%
BARLEY	81%	78%	111%
MAIZE	51%	54%	86%

6. Conclusions

The aim of this thesis is to assess the consequences accession may have on Macedonia's agricultural sector in general and the feed-livestock complex in particular. In order to carry out this analysis, a synthetic single-country partial equilibrium model for the feed and livestock complex in Macedonia has been constructed and calibrated. The current situation has thereafter been compared with a scenario where Macedonia joins the European Union "today".

As with any model, the results should be interpreted with caution. A model can never completely resemble reality. Unfortunately, there is not much to compare with either, since the model, as far we know, is the first of its kind for the Macedonian feed and livestock complex.

The model simulation indicates that EU-Accession "today" would have a significant impact on the feed-livestock complex in Macedonia. However, these impacts will vary from one commodity to another in both magnitude and signs as the rates of support in the EU and in Macedonia diverge. To make a judgment of the overall impact, positive or negative, is therefore not easy.

For farmers in general, accession today will imply a higher level of producer support, which will be financed through higher prices and through taxes at the expense of consumers and taxpayers. Then again, the simulation reveals that this might not always be the case for farmers in the feed-livestock complex.

Net trade is one indicator of the potential gains and losses with membership in the union. A positive change in Macedonia's trade position in terms of agricultural goods, that is an increase of exports over imports, would thus be one, for farmers at least, beneficial effect. The Blue Ribbon Commission cited earlier in this thesis, argues that the overall goal for the Macedonian agricultural policy should be to achieve and maintain a trade surplus in agricultural products. The simulation, however, shows that EU-Accession, at least for the feed-livestock sector, will not be helpful in this respect.

However, what is interesting with the results obtained is not so much whether the advantages of EU-membership for the Macedonian feed-livestock complex outweigh the disadvantages or not. If only allowed to, there is simply too much at stake in terms of economy, politics, and security for Macedonia not to join the European Union. The usefulness of these and future simulation results lies instead in the information on specific commodities they may provide to policymakers and the general public as they prepare for membership. A better understanding of the implications of membership might help mitigate potential drawbacks and exploit benefits.

Based on economic theory, the simulation does provide detailed information on the implications for production and demand for each of the most important commodities in the Macedonian feed-livestock complex. Winners and losers can thus be identified. From a purely economic perspective, however, what makes a winner a winner on the producer side seldom does the same at the side of consumers and taxpayers.

More can of course be done to guide policy makers and feed and livestock producers in Macedonia. A model is only as strong as its weakest link and with enough time and resources there is a whole range of improvements that could be made to increase the prediction accuracy of the model. The weakest link is perhaps the elasticities used, *i.e.*, the responsiveness of economic agents to price changes, as they determine the outcome of the simulations. Elasticities based on historical data specific for Macedonia instead of qualified guestimates would thus be an important improvement. Another improvement that might yield interesting insights is to specify feed demand by category of livestock to allow for price responses specific for each category of livestock. More livestock commodities and feedstuffs could also be included in the model in order to get a more complete coverage of the feed-livestock complex. Yet another improvement would be to make the policy representation explicit. Simulations based on detailed information on individual policy measures instead of aggregate estimates are better suited to guide detailed policymaking.

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Annex A: Trading Partners in percentage of total trade value

Table A1: *Top 15 Trading Partners in percentage of total trade value – SITC 2005 (COMTRADE)*

	ALL COMMODITIES SITC 1-9				FOOD AND LIVE ANIMALS SITC 0				BEVERAGES AND TOBACCO SITC 1			
#	Import	%	Export	%	Import	%	Export	%	Import	%	Export	%
1	Russian Federation	13.2	Serbia and Montenegro	22.5	Serbia and Montenegro	15.8	Serbia and Montenegro	33.6	Serbia and Montenegro	21.7	Serbia and Montenegro	22.3
2	Germany	10.4	Germany	17.8	Brazil	9.3	Greece	19.2	Croatia	13.9	Greece	21.4
3	Greece	9.2	Greece	15.3	Greece	8.0	Italy	11.3	Greece	9.7	Belgium	14.5
4	Serbia and Montenegro	8.2	Italy	8.3	Austria	6.3	Croatia	8.2	Switzerland	8.0	Germany	10.6
5	Bulgaria	7.3	Br. Virgin Islands	4.1	Slovenia	6.2	Bosnia Herzegovina	6.2	Austria	6.8	Croatia	5.0
6	Italy	6.0	Croatia	4.0	Turkey	6.0	Slovenia	3.7	Brazil	4.8	Japan	4.8
7	Slovenia	4.0	Bulgaria	3.7	Bulgaria	5.8	Albania	3.2	Spain	4.5	Bosnia Herzegovina	4.3
8	China	3.6	Bosnia Herzegovina	2.5	Croatia	5.8	Bulgaria	2.8	Germany	4.1	France	1.6
9	Turkey	3.5	Turkey	2.3	Poland	5.0	Germany	2.3	United Kingdom	3.1	Netherlands	1.6
10	Poland	2.9	Netherlands	2.2	Germany	4.9	Turkey	1.6	Slovenia	2.9	Mexico	1.3
11	Croatia	2.3	USA	2.2	Italy	2.6	Australia	0.9	Italy	2.6	Argentina	1.0
12	Ukraine	2.2	United Kingdom	2.1	Bosnia Herzegovina	2.5	France	0.8	USA	1.8	Bulgaria	0.9
13	Austria	2.1	Belgium	1.7	Argentina	2.5	USA	0.8	India	1.7	Albania	0.9
14	Romania	2.0	Slovenia	1.6	USA	2.4	Hungary	0.5	China	1.5	Rep. of Korea	0.8
15	Switzerland	2.0	Albania	1.3	Hungary	1.8	Switzerland	0.5	France	1.4	Ukraine	0.8

Note: SITC (Standard International Trade Classification) is a trade classification system recommended by the UN.

Annex B: Exogenous Variables and Base Data

Elasticities

Table B1. *Supply Elasticities of Herd Equations*

		Price							
	Livestock	BEEF	PORK	SHEEP	EGGS	CMILK	WHE	BAR	MAI
Quantity	BEEF	0.94	-0.09	-0.12	0.00	0.12	-0.16	-0.24	-0.16
	PORK	-0.08	1.40	-0.12	0.00	-0.02	0.00	-0.20	-0.51
	SHEEP	-0.08	-0.04	1.13	0.00	-0.02	0.00	0.00	0.00
	EGGS	0.00	0.00	0.00	1.75	0.00	0.00	-0.20	-0.51
	CMILK	0.05	-0.11	-0.02	0.00	0.95	-0.29	-0.16	-0.11

Table B2. *Supply Elasticities of Area Equations*

		Price		
	Grain	WHE	BAR	MAI
Quantity	WHE	0.49	-0.03	-0.04
	BAR	-0.12	0.37	-0.01
	MAI	-0.06	0.00	0.26

Table B3. *Supply Elasticities of Yield Equations*

		Price					
		CMILK	WHE	BAR	MAI	GRAIN	FERTILIZER
Quantity	CMILK	0.11	-0.06	-0.03	-0.02		
	WHE					0.18	-0.18
	BAR					0.14	-0.14
	MAI					0.16	-0.16

Table B4. *Demand Elasticities –LIVESTOCK*

		Price					
	Livestock	BEEF	PORK	SHEEP	EGGS	CMILK	INCOME
Quantity	BEEF	-0.56	0.24	0.05	0.00	0.00	0.42
	PORK	0.10	-0.52	0.24	0.00	0.00	0.42
	SHEEP	0.18	0.24	-0.59	0.00	0.00	0.43
	EGGS	0.00	0.00	0.00	-0.29	0.00	0.19
	CMILK	0.00	0.00	0.00	0.00	-0.43	0.24

Table B5. *Demand Elasticities – GRAINS*

		Price							
		FOOD				FEED			
	Grains	WHE	BAR	MAI	INCOME	WHE	BAR	MAI	LIVESTOCK
Quantity	WHE	-0.34			0.42				
	BAR		-0.06		-0.09				
	MAI			-0.07	-0.10				
	WHE					-0.25	0.05	0.05	0.35
	BAR					0.04	-0.34	0.04	0.35
	MAI					0.04	0.04	-0.34	0.35

Miscellaneous

Table B6. *Population and Income*

	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	03-04
Population	Persons	1963000	1975000	1987000	2000000	2012000	2024000	2035000	2046000	2056000	2066000	2061000
GDP	Billion den	170	176	186	195	209	236	234	244	251	265	258
Per Capita Income	den	86358	89339	93618	97490	103882	116793	114910	119243	122318	128392	125355

Source: FAOSTAT and IMF, April 2006 WEO database

Table B7. *Retail Prices*

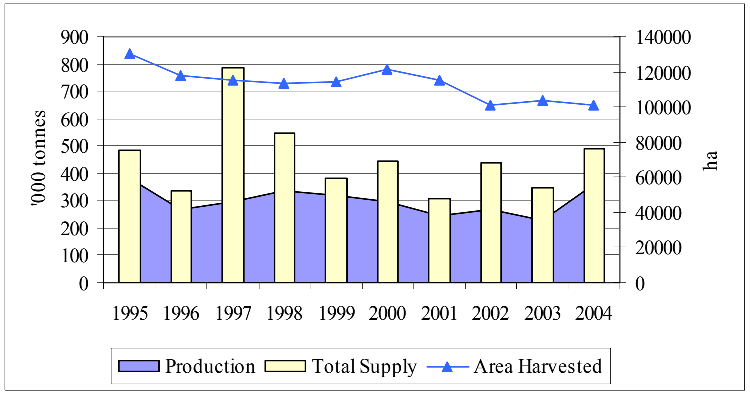
	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	03-04	Item
Beef	den/kg	183.6	185.8	214.9	211.6	209.5	201.8	205.5	209.2	218.9	202.0	210.5	Beef, with bone 1kg
Pork	den/kg	210.7	207.0	241.0	254.0	227.2	209.4	224.0	231.8	222.9	208.8	215.9	Pork, with bone 1kg
Sheep	den/kg	186.6	204.0	163.8	185.2	173.9	226.1	264.7	272.8	276.1	289.7	282.9	Lamb
Eggs	den/kg	99.6	102.1	112.4	110.8	109.4	104.7	103.0	110.4	83.7	107.0	99.6	Chicken eggs, fresh 12 eggs
Cow Milk	den/kg	24.8	25.1	25.7	25.9	25.8	27.9	28.5	28.4	29.0	29.2	24.8	Cow's milk, fresh, whole, not pasteurized 1l
Bread	den/kg	38.3	38.1	38.1	36.1	36.0	37.3	45.8	45.4	44.2	41.4	42.8	Wheat bread, white, unsliced, not wrapped
Fertilizers	den/kg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	15.0	NPK (15:15:15)

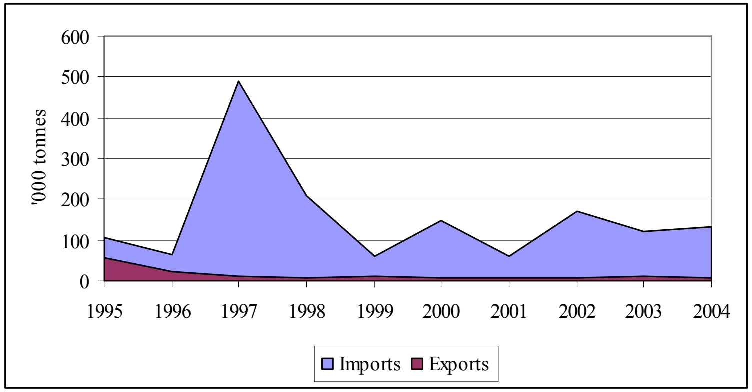
Source: LABORSTA Internet, and the Department of Agricultural Economics & Organization (UKIM)

Supply and Utilization Accounts

Table B8. *Supply and Utilization Account for Wheat in Macedonia*

	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
WHEAT											
Area Harvested	'000 ha	130092	117486	115267	113647	113972	121103	115504	100920	103620	101321
Yield	tonnes/ha	2.9	2.3	2.5	3.0	2.8	2.5	2.1	2.6	2.2	3.5
Total Supply	**'000 tonnes**	**486.8**	**335.6**	**783.8**	**545.4**	**379.4**	**447.1**	**306.8**	**439.6**	**346.7**	**489.5**
Production	'000 tonnes	381.2	269.3	293.8	336.6	319.4	299.0	246.0	267.2	225.5	358.4
Imports	'000 tonnes	105.6	66.3	490.1	208.8	60.0	148.1	60.8	172.4	121.2	131.1
Total Demand	**'000 tonnes**	**486.8**	**335.6**	**783.8**	**545.4**	**379.4**	**447.1**	**306.8**	**439.6**	**346.7**	**489.5**
Feed	'000 tonnes	20.4	14.6	15.8	18.0	29.8	41.6	43.6	71.9	31.2	63.6
Seed	'000 tonnes	29.9	27.0	26.5	26.1	26.2	27.9	26.6	23.2	23.8	23.3
Food	'000 tonnes	220.3	206.8	257.3	259.7	169.8	181.3	198.1	211.8	216.7	156.8
Other Net Uses	'000 tonnes	159.4	65.7	474.6	234.1	141.9	188.3	30.0	124.4	64.5	237.1
Exports	'000 tonnes	56.9	21.5	9.6	7.5	11.7	8.0	8.5	8.3	10.4	8.6
Producer Price	denar/tonne	10250	9924	10055	11357	10117	10124	10210	9990	10024	10605
Reference Price[14]	denar/tonne	6534	8345	8021	6286	5619	7071	7619	7242	7676	8235
Net Trade (X-M)	'000 tonnes	-48.7	-44.8	-480.4	-201.3	-48.3	-140.0	-52.3	-164.1	-110.8	-122.5
Self-sufficiency ratio	%	89%	86%	38%	63%	87%	68%	82%	62%	67%	75%



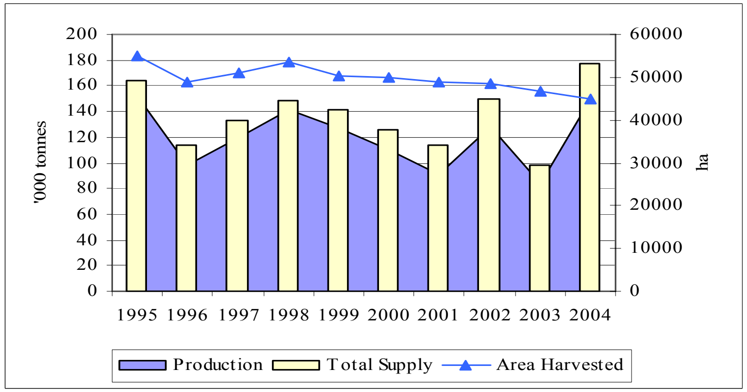


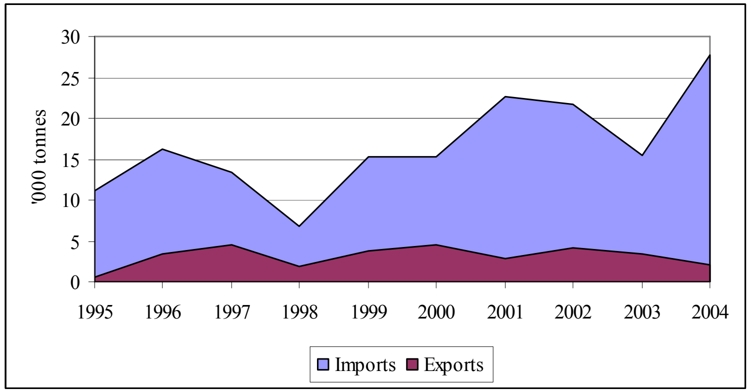
Source: FAOSTAT and State Statistical Office

[14] The reference prices are obtained from Ericsson, Pelling and Surry (2007). The reference price is the border price net of any handling margin.

Table B9. *Supply and Utilization Account for Barley in Macedonia*

	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
BARLEY											
Area Harvested	'000 ha	54874	48916	50936	53541	50289	50000	49000	48390	46540	44802
Yield	tonnes/ha	2.8	2.0	2.4	2.6	2.5	2.2	1.9	2.7	1.8	3.3
Total Supply	**'000 tonnes**	**163.6**	**114.0**	**133.4**	**148.6**	**141.9**	**125.2**	**114.1**	**150.2**	**98.7**	**177.7**
Production	'000 tonnes	152.5	97.8	120.0	141.9	126.6	110.0	91.5	128.4	83.3	150.0
Imports	'000 tonnes	11.1	16.2	13.4	6.8	15.3	15.2	22.6	21.7	15.5	27.7
Total Demand	**'000 tonnes**	**163.6**	**114.0**	**133.4**	**148.6**	**141.9**	**125.2**	**114.1**	**150.2**	**98.7**	**177.7**
Feed	'000 tonnes	114.9	64.9	95.9	113.4	100.3	110.4	89.1	99.2	78.6	149.2
Seed	'000 tonnes	11.1	9.9	10.3	10.8	10.2	10.1	9.9	9.8	9.4	9.1
Food	'000 tonnes	12.4	13.2	10.3	12.8	12.1	11.1	10.0	10.5	12.9	7.6
Other Net Uses	'000 tonnes	24.7	22.6	12.4	9.7	15.5	-10.9	2.4	26.4	-5.5	9.7
Exports	'000 tonnes	0.6	3.4	4.5	2.0	3.8	4.5	2.8	4.2	3.4	2.2
Producer Price	denar/tonne	6770	7244	8791	8113	7787	8644	9428	8511	7857	7875
Reference Price	denar/tonne	5168	7120	7036	4627	5272	7399	7663	6899	7239	7393
Net Trade (X-M)	'000 tonnes	-10.5	-12.8	-8.9	-4.8	-11.5	-10.7	-19.9	-17.5	-12.1	-25.5
Self-sufficiency ratio	%	94%	88%	93%	97%	92%	91%	82%	88%	87%	85%

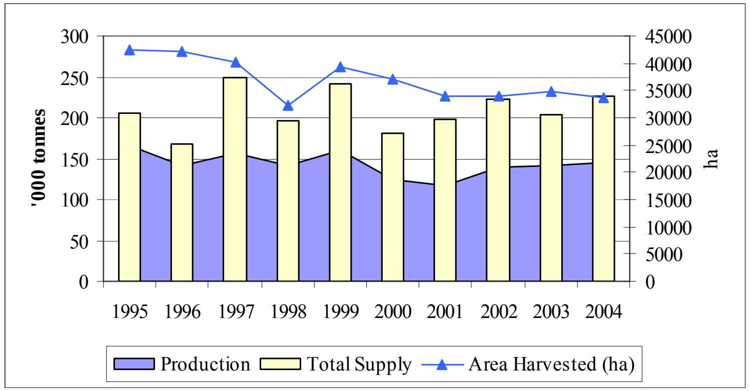


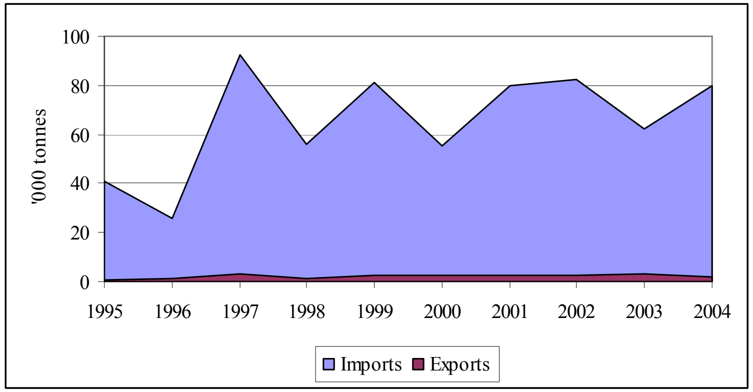


Source: FAOSTAT and State Statistical Office

Table B10. *Supply and Utilization Account for Maize in Macedonia*

	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
MAIZE											
Area Harvested	'000 ha	42454	42031	40158	32229	39229	37000	34000	33850	34837	33772
Yield	tonnes/ha	3.9	3.4	3.9	4.4	4.1	3.4	3.5	4.1	4.1	4.3
Total Supply	**'000 tonnes**	**206.4**	**168.3**	**249.8**	**197.1**	**241.8**	**180.5**	**197.4**	**222.4**	**203.8**	**226.1**
Production	'000 tonnes	165.7	142.4	157.2	141.0	160.6	125.0	117.3	140.2	141.4	146.1
Imports	'000 tonnes	40.7	25.8	92.6	56.2	81.3	55.5	80.1	82.3	62.4	80.0
Total Demand	**'000 tonnes**	**206.4**	**168.3**	**249.8**	**197.1**	**241.8**	**180.5**	**197.4**	**222.4**	**203.8**	**226.1**
Feed	'000 tonnes	132.6	114.4	125.8	112.9	148.1	100.1	100.2	100.2	100.2	103.7
Seed	'000 tonnes	0.7	0.7	0.6	0.5	0.6	0.6	0.5	0.5	0.6	0.5
Food	'000 tonnes	63.9	54.0	65.4	52.0	79.8	68.9	76.5	67.4	73.2	61.6
Other Net Uses	'000 tonnes	8.9	-1.8	55.1	30.2	10.5	8.4	17.8	51.8	27.0	58.5
Exports	'000 tonnes	0.4	1.1	2.9	1.5	2.8	2.5	2.3	2.5	2.9	1.8
Producer Price	denar/tonne	6580	7138	9881	8751	8294	8129	8272	8379	9729	8306
Reference Price	denar/tonne	5834	7852	7125	6646	6465	7551	8070	8480	7564	7249
Net Trade (X-M)	'000 tonnes	-40.4	-24.7	-89.7	-54.6	-78.5	-53.0	-77.7	-79.8	-59.5	-78.3
Self-sufficiency ratio	%	80%	85%	64%	72%	67%	70%	60%	64%	70%	65%

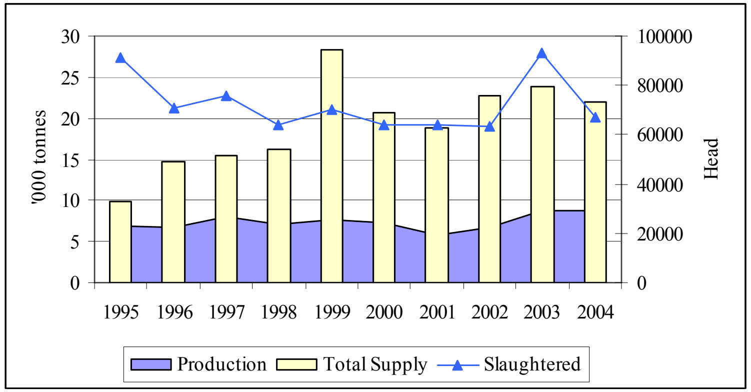




Source: FAOSTAT and State Statistical Office

Table B11. *Supply and Utilization Account for Beef and Veal in Macedonia*

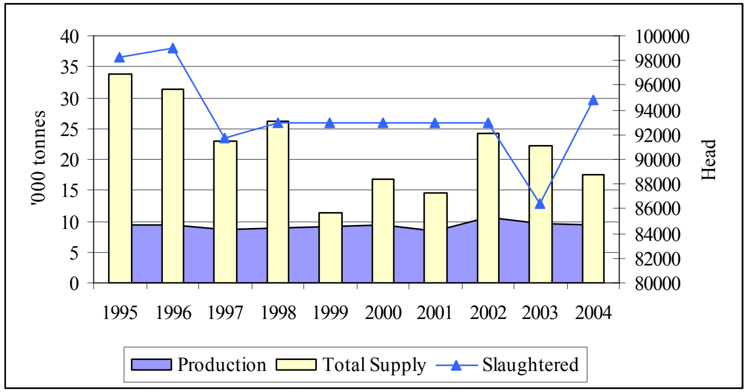
	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
BEEF & VEAL											
Slaughtered	heads	91000	71000	76000	64000	70000	64000	64000	63183	93000	67000
Carcass Weight	kg/animal	75.8	94.4	105.1	110.8	110.5	113.9	91.2	106.6	93.5	131.7
Total Supply	**'000 tonnes**	**9.9**	**14.7**	**15.4**	**16.1**	**28.4**	**20.7**	**18.8**	**22.7**	**23.8**	**21.9**
Production	'000 tonnes	6.9	6.7	8.0	7.1	7.7	7.3	5.8	6.7	8.7	8.8
Imports	'000 tonnes	3.0	8.0	7.4	9.1	20.6	13.4	13.0	16.0	15.1	13.1
Total Demand	**'000 tonnes**	**9.9**	**14.7**	**14.7**	**14.9**	**27.4**	**19.8**	**19.9**	**22.7**	**21.4**	**21.9**
Food	'000 tonnes	9.9	14.7	14.6	14.9	27.2	19.7	19.9	22.6	21.2	22.7
Other Net Uses	'000 tonnes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.0
Exports	'000 tonnes	0.1	0.1	0.1	0.0	0.2	0.1	0.0	0.1	0.2	0.2
Producer Price	denar/tonne	113498	126334	131881	155795	140445	139268	146344	171281	145311	146996
Reference Price	denar/tonne	98812	94312	81502	86691	79056	88686	74529	72337	71970	92373
Net Trade (X-M)	'000 tonnes	-2.9	-8.0	-7.3	-9.1	-20.5	-13.3	-13.0	-15.9	-14.9	-12.9
Self-sufficiency ratio	%	70%	46%	55%	48%	28%	37%	29%	30%	41%	41%

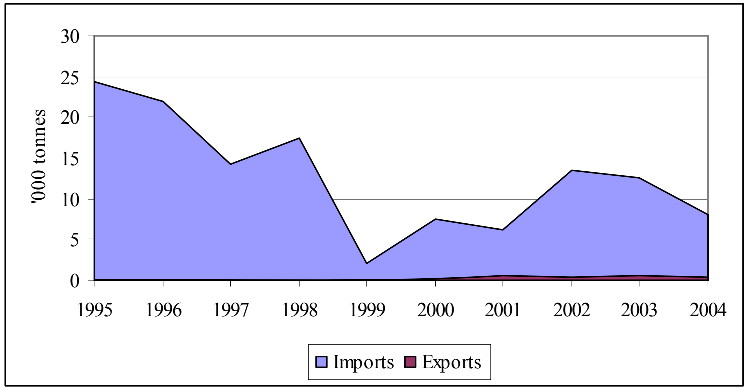


Source: FAOSTAT and State Statistical Office

Table B12. *Supply and Utilization Account for Pork in Macedonia*

	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
PORK											
Slaughtered	heads	98260	99000	91700	93000	93000	93000	93000	93000	86400	94820
Carcass Weight	kg/animal	95.0	94.9	95.0	95.0	98.8	100.2	90.5	114.3	111.2	98.9
Total Supply	**'000 tonnes**	**33.8**	**31.4**	**22.9**	**26.2**	**11.2**	**16.8**	**14.5**	**24.1**	**22.1**	**17.4**
Production	'000 tonnes	9.3	9.4	8.7	8.8	9.2	9.3	8.4	10.6	9.6	9.4
Imports	'000 tonnes	24.4	22.0	14.2	17.4	2.1	7.5	6.1	13.5	12.5	8.1
Total Demand	**'000 tonnes**	**33.8**	**31.4**	**22.9**	**26.2**	**11.3**	**16.8**	**14.5**	**24.1**	**22.0**	**17.4**
Food	'000 tonnes	33.8	31.4	22.8	26.1	11.2	16.5	14.0	23.7	21.5	17.9
Other Net Uses	'000 tonnes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.9
Exports	'000 tonnes	0.0	0.0	0.1	0.1	0.0	0.3	0.6	0.4	0.5	0.4
Producer Price	denar/tonne	139628	122164	154544	183339	166996	144081	145775	151379	136498	128849
Reference Price	denar/tonne	66254	78115	90192	68413	47406	73814	91199	77286	71177	77198
Net Trade (X-M)	'000 tonnes	-24.4	-22.0	-14.1	-17.3	-2.1	-7.2	-5.6	-13.1	-12.0	-7.6
Self-sufficiency ratio	%	28%	30%	38%	34%	82%	56%	60%	45%	45%	55%

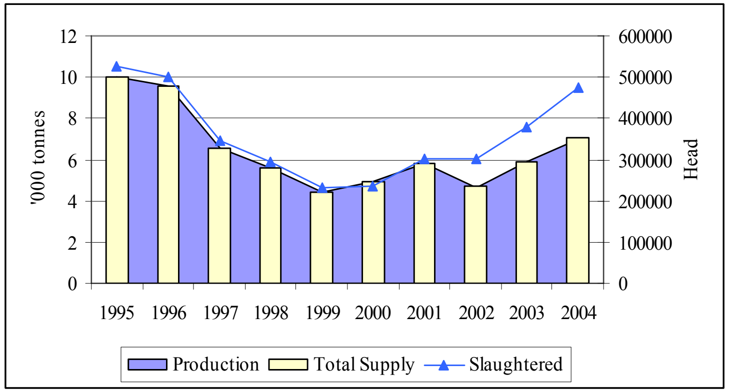


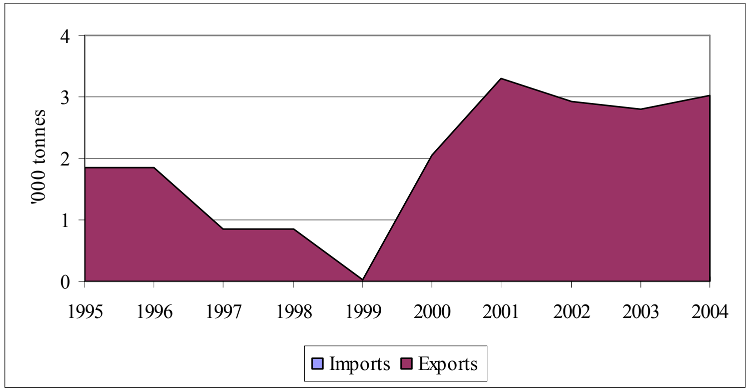


Source: FAOSTAT and State Statistical Office

Table B13. *Supply and Utilization Account for Sheep Meat in Macedonia*

	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
SHEEP MEAT											
Slaughtered	heads	525000	502000	346700	295400	231000	237000	300000	300000	380000	476000
Carcass Weight	kg/animal	19.0	19.0	19.0	19.0	19.0	20.8	19.3	15.5	15.5	14.8
Total Supply	**'000 tonnes**	**10.0**	**9.5**	**6.6**	**5.6**	**4.4**	**4.9**	**5.8**	**4.7**	**5.9**	**7.1**
Production	'000 tonnes	10.0	9.5	6.6	5.6	4.4	4.9	5.8	4.6	5.9	7.0
Imports	'000 tonnes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Demand	**'000 tonnes**	**10.0**	**9.5**	**6.6**	**5.6**	**4.4**	**4.5**	**5.9**	**4.7**	**4.5**	**7.1**
Food	'000 tonnes	8.1	7.7	5.8	4.8	4.4	2.5	2.6	1.8	1.7	4.2
Other Net Uses	'000 tonnes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Exports	'000 tonnes	1.8	1.8	0.8	0.8	0.0	2.0	3.3	2.9	2.8	3.0
Producer Price	denar/tonne	n/a	128179	113982	134791	119060	168252	194878	217663	201084	193468
Reference Price	denar/tonne	n/a	159638	113778	124560	114729	216130	228520	208509	220433	240361
Net Trade (X-M)	'000 tonnes	1.8	1.8	0.8	0.8	0.0	2.0	3.3	2.9	2.8	3.0
Self-sufficiency ratio	%	123%	124%	115%	118%	101%	199%	224%	263%	347%	172%

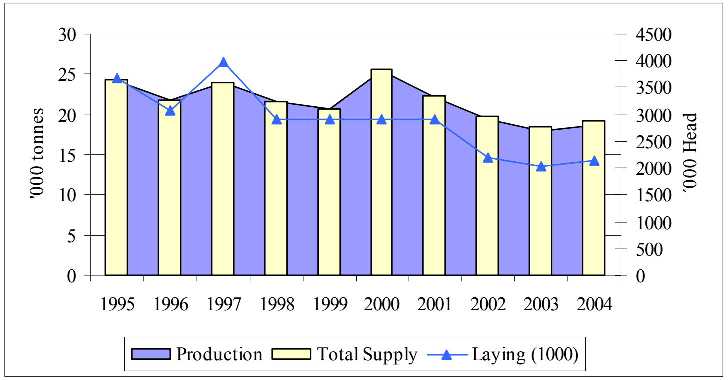


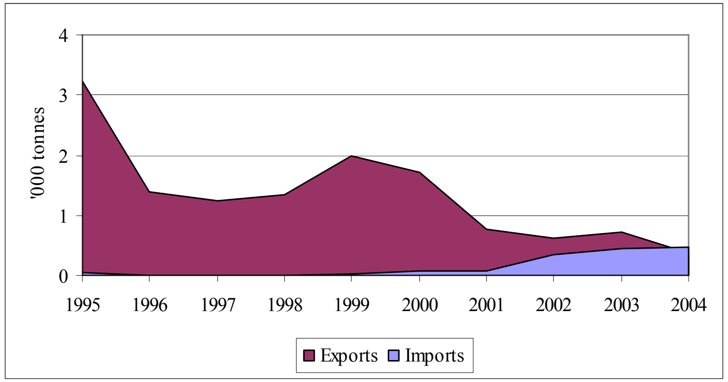


Source: FAOSTAT and State Statistical Office

Table B14. *Supply and Utilization Account for Eggs in Macedonia*

	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
EGGS											
Laying	'000 heads	3685	3060	3978	2900	2900	2900	2900	2189	2029	2151
Yield	number/animal	132	142	107	162	153	156	136	158	136	155
Total Supply	**'000 tonnes**	**24.2**	**21.7**	**23.9**	**21.5**	**20.7**	**25.6**	**22.3**	**19.8**	**18.4**	**19.2**
Production	'000 tonnes	24.2	21.73	23.9	21.5	20.7	25.5	22.2	19.4	18	18.7
Imports	'000 tonnes	0.04	0	0	0	0.02	0.07	0.08	0.36	0.44	0.48
Total Demand	**'000 tonnes**	**24.2**	**21.7**	**23.9**	**21.5**	**20.7**	**25.6**	**22.3**	**19.8**	**18.4**	**19.2**
Food	'000 tonnes	0.32	0.29	0.35	0.24	0.27	0.01	0.20	0.24	0.24	0.00
Feed	'000 tonnes	20.7	20.06	22.31	19.93	18.46	23.83	21.32	18.91	17.48	18.81
Exports	'000 tonnes	0	0	0	0	0	0	0	0	0	0.01
Producer Price	denar/tonne	56547	66147	74727	72987	66733	64271	69266	66744	62180	71193
Reference Price	denar/tonne	30100	39187	42794	36076	25068	42848	47346	48518	60208	43812
Net Trade (X-M)	'000 tonnes	3.18	1.39	1.24	1.33	1.97	1.65	0.69	0.25	0.28	-0.11
Self-sufficiency ratio	%	115%	107%	105%	107%	111%	107%	103%	101%	102%	99%

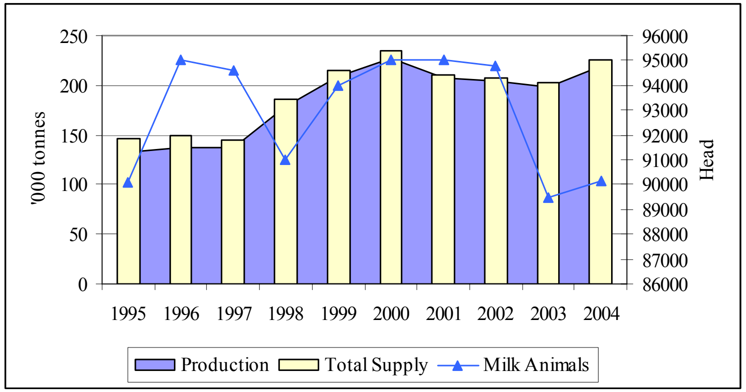


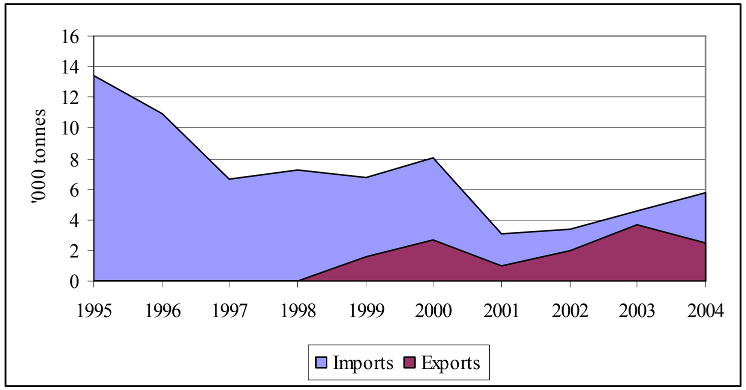


Source: FAOSTAT and State Statistical Office

Table B15. *Supply and Utilization Account for Cow Milk in Macedonia*

	Unit	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
COW MILK											
Milk Animals	heads	90110	95050	94574	91000	94000	95000	95000	94780	89490	90138
Yield	kg/animal	1474	1450	1453	1966	2220	2390	2180	2158	2207	2435
Total Supply	**'000 tonnes**	**146.3**	**148.8**	**144.1**	**186.2**	**215.5**	**235.2**	**210.2**	**207.9**	**202.0**	**225.3**
Production	'000 tonnes	132.8	137.8	137.4	178.9	208.7	227.1	207.1	204.6	197.5	219.5
Imports	'000 tonnes	13.4	11.0	6.7	7.3	6.8	8.1	3.1	3.4	4.5	5.8
Total Demand	**'000 tonnes**	**146.3**	**148.8**	**144.1**	**186.2**	**215.5**	**235.2**	**210.2**	**207.9**	**202.0**	**225.3**
Domestic use	'000 tonnes	146.3	148.8	144.1	186.2	213.8	232.5	209.2	206.0	198.4	222.8
Exports	'000 tonnes			0.0		1.6	2.7	1.0	1.9	3.7	2.5
Producer Price	denar/tonne	16731	15220	15343	16606	16840	16530	16805	17062	16887	16838
Reference Price	denar/tonne	6576	7251	8082	7382	8105	10241	11081	9574	8804	7770
Net Trade (X-M)	'000 tonnes	-13.4	-11.0	-6.7	-7.3	-5.2	-5.4	-2.1	-1.4	-0.9	-3.3
Self-sufficiency ratio	%	91%	93%	95%	96%	98%	98%	99%	99%	100%	99%





Source: FAOSTAT and State Statistical Office

Annex C: Simulation Results – LIVESTOCK

Table C1. *Simulation Results for the Livestock Module*

LIVESTOCK		BASE	EU-ACCESSION		FREE TRADE	
	Unit	#	#	%-change	#	%-change
Producer Price (PR)						
PRBF	*den/t*	146153	182040	**24.6**	80962	**-44.6**
PRPK	*den/t*	132673	96163	**-27.5**	73979	**-44.2**
PRSH	*den/t*	197276	274784	**39.3**	197276	**0.0**
PREG	*den/t*	66687	50182	**-24.7**	50182	**-24.7**
PRMK	*den/t*	16862	13418	**-20.4**	8255	**-51.0**
Retail Price (P)						
PBF	*den/kg*	210.49	262.17	**24.6**	116.60	**-44.6**
PPK	*den/kg*	215.85	156.45	**-27.5**	120.36	**-44.2**
PSH	*den/kg*	282.89	394.03	**39.3**	282.89	**0.0**
PEG	*den/kg*	95.32	71.73	**-24.7**	71.73	**-24.7**
PMK	*den/kg*	29.05	23.12	**-20.4**	14.22	**-51.0**
Domestic Supply						
QBF	*tonnes*	9006	11025	**22.4**	5781	**-35.8**
QPK	*tonnes*	9517	5016	**-47.3**	5048	**-47.0**
QSH	*tonnes*	6480	9323	**43.9**	6892	**6.4**
QEG	*tonnes*	18355	10415	**-43.3**	10435	**-43.2**
QMK	*tonnes*	208446	187962	**-9.8**	127286	**-38.9**
Herd						
HERDBF	*heads*	80000	97931	**22.4**	51348	**-35.8**
HERDPK	*heads*	90610	47761	**-47.3**	48064	**-47.0**
HERDSH	*heads*	428000	615761	**43.9**	455202	**6.4**
HERDEG	*heads*	2090000	1185867	**-43.3**	1188118	**-43.2**
HERDMK	*heads*	89814	81724	**-9.0**	56977	**-36.6**
Milk Yield						
YMK	*t/head*	2.32	2.30	**-0.9**	2.23	**-3.7**
Demand						
DBF	*tonnes*	21980	17917	**-18.5**	25133	**14.3**
DPK	*tonnes*	19720	24899	**26.3**	23382	**18.6**
DSH	*tonnes*	2925	2185	**-25.3**	2383	**-18.5**
DEG	*tonnes*	18145	19468	**7.3**	19468	**7.3**
DMK	*tonnes*	210566	229150	**8.8**	257007	**22.1**
Per Capita Demand						
PCDBF	*kg*	10.66	8.69	**-18.5**	12.19	**14.3**
PCDPK	*kg*	9.57	12.08	**26.3**	11.34	**18.6**
PCDSH	*kg*	1.42	1.06	**-25.3**	1.16	**-18.5**
PCDEG	*kg*	8.80	9.45	**7.3**	9.45	**7.3**
PCDMK	*kg*	102.17	111.18	**8.8**	124.70	**22.1**
Net Trade						
NTBF	*tonnes*	-12974	-6892	**-46.9**	-19352	**49.2**
NTPK	*tonnes*	-10203	-19883	**94.9**	-18334	**79.7**
NTSH	*tonnes*	3555	7139	**100.8**	4509	**26.8**
NTEG	*tonnes*	210	-9054	**4402.6**	-9034	**4393.2**
NTMK	*tonnes*	-2119	-41188	**1843.4**	-129721	**6020.6**

Annex D: Simulation Results – GRAINS

Table D1. *Simulation Results for the Grain Module*

GRAINS		BASE	EU-ACCESSION		FREE TRADE	
	Unit	#	#	%-change	#	%-change
Producer Price (PR)						
PRWH	*den/t*	10315	7922	**-23.2**	7954	**-22.9**
PRBA	*den/t*	7866	7373	**-6.3**	7316	**-7.0**
PRMA	*den/t*	9017	9670	**7.2**	7416	**-17.8**
Retail Price (P)						
PBREAD	*den/kg*	42.8	33	**-23.2**	33.00	**-22.9**
Domestic Supply						
QWH	*tonnes*	292702	246167	**-15.9**	241135	**-17.6**
QBA	*tonnes*	117282	121082	**3.2**	122259	**4.2**
QMA	*tonnes*	143841	154974	**7.7**	139414	**-3.1**
Area						
AWH	*ha*	102470	89685	**-12.5**	88556	**-13.6**
ABA	*ha*	45671	47554	**4.1**	48064	**5.2**
AMA	*ha*	34305	36526	**6.5**	34246	**-0.2**
Yield						
YWH	*t/ha*	2.86	2.74	**-3.9**	2.72	**-4.7**
YBA	*t/ha*	2.57	2.55	**-0.8**	2.54	**-0.9**
YMA	*t/ha*	4.19	4.24	**1.2**	4.07	**-2.9**
Unit Return						
URWH	*den/ha*	30888	23114	**-25.2**	21658	**-29.9**
URBA	*den/ha*	20200	18774	**-7.1**	18609	**-7.9**
URMA	*den/ha*	37810	41027	**8.5**	30188	**-20.2**
Feed Demand						
DFWH	*tonnes*	47412	52526	**10.8**	38873	**-18.0**
DFBA	*tonnes*	113879	124200	**9.1**	99737	**-12.4**
DFMA	*tonnes*	101966	107493	**5.4**	93976	**-7.8**
HERDLU	*tonnes*	188241	193168	**2.6**	134412	**-28.6**
PLIV	*tonnes*	110323	155401	**40.9**	98516	**-10.7**
PLIVW	*tonnes*	77774	105338	**35.4**	42720	**-45.1**
Food Demand						
DWH	*tonnes*	186750	201389	**7.8**	201197	**7.7**
DBA	*tonnes*	10240	10277	**0.4**	10281	**0.4**
DMA	*tonnes*	67370	67032	**-0.5**	68200	**1.2**
Per Capita Demand						
PCDWH	*kg*	90.61	97.71	**7.8**	97.62	**7.7**
PCDBA	*kg*	4.97	4.99	**0.4**	4.99	**0.4**
PCDMA	*kg*	32.69	32.52	**-0.5**	33.09	**1.2**
Net Trade						
NTWH	*tonnes*	-115848	-182136	**57.2**	-173323	**49.6**
NTBA	*tonnes*	-18143	-24700	**36.1**	935	**-105.2**
NTMA	*tonnes*	-68789	-62845	**-8.6**	-66056	**-4.0**

Annex E: Feed and Livestock Model for Macedonia

Software
TSP and Microsoft Excel

Commodities

WH:	Wheat	PK:	Pork
BA:	Barley	SH:	Sheep meat
MA:	Maize	MK:	Milk
EG:	Eggs	BF:	Beef

Endogenous variables

AWH	Wheat Area	URWH	Unit gross returns for wheat
ABA	Barley Area	URBA	Unit gross returns for barley
AMA	Maize Area	URMA	Unit gross returns for maize
YWH	Wheat yields	PREAD	Retail Price of bread
YBA	Barley yields	HERDEG	Laying hen flock (heads)
YMA	Maize yields	HERDPK	Pig herd (heads)
QWHat	Domestic supply of wheat	HERDSH	Sheep herd (heads)
QBA	Domestic supply of barley	HERDMK	Dairy cow herd (heads)
QMA	Domestic supply of Maize	HERDBF	Beef herd (heads)
DWH	Food demand for wheat	YMK	Milk yields
DBA	Food demand for maize	QBF	Beef production
DFWH	Feed demand for wheat	QMK	Milk production
DFBA	Feed demand for barley	QPK	Pig production
DFMA	Feed demand for maize	QSH	Sheep meat production
PCDWH	Per capita food demand for wheat	QEG	Egg production
PCDBA	Per capita food demand for barley	PCDMK	Per capita demand for milk
PCDMA	Per capita food demand for maize	PCDBF	Per capita demand for beef
NTWH	Net trade wheat	PCDPK	Per capita demand for pork
NTBA	Net trade barley	PCDSHt	Per capita demand for sheep meat
NTMA	Net trade maize	PCDEG	Per capita demand for egg
PBREAD	Retail price of bread	DMK	Total demand for milk
PPK	Retail price of pork	DBF	Total demand for beef meat
PSH	Retail price of sheep meat	DPK	Total demand for pork meat
PMK	Retail price of milk	DEG	Total demand for eggs
PBF	Retail price of beef	DSH	Total demand for sheep meat
PRWH	Producer price of wheat	NTBF	Net trade of beef
PRBA	Producer price of barley	NTPK	Net trade of pork
PRMA	Producer price of maize	NTMK	Net trade of milk
PREG	Producer price of eggs	NTEG	Net trade of eggs
PRPK	Producer price of pork	NTSH	Net trade of sheep meat
PRSH	Producer price of sheep meat	NTEG	Net trade of eggs
PRMK	Producer price of milk	NTSH	Net trade of sheep meat
PRBF	Producer price of beef		

Exogenous variables		**Policy variables**	
POP	Population	SUBF	Output subsidy beef
PIWH	Import price of wheat	SUPK	Output subsidy pig
PIBA	Import price of barley	SUSH	Output subsidy sheep meat
PIMA	Import price of maize	SUEG	Output subsidy eggs
PIEG	Import price of eggs	SUMK	Output subsidy milk
PIPK	Import price of pork	SUWH	Output subsidy wheat
PISH	Import price of sheep meat	SUBA	Output subsidy barley
PIMK	Import price of milk	SUMA	Output subsidy maize
PIBF	Import price of beef	TARBF	Market price support beef
YBFt	Beef slaughter weigh	TARPK	Market price support pig
YPK	Pig slaughter weight	TARSH	Market price support sheep

YSH	Sheep weight	TAREG	Market price support egg
YEG	Egg weight	TARMK	Market price support milk
PCINC	Per capita income	TARWH	Market price support wheat
DOWH	Other demand for wheat	TARBA	Market price support barley
DOBA	Other demand for barley	TARMA	Market price support maize
DOMA	Other demand for maize		

GRAINS

Area equations

EQ1: AWH=AWH_0+AWH_1*URWH+AWH_2*URBA+AWH_3*URMA;
EQ2: ABA=ABA_0+ABA_1*URWH+ABA_2*URBA+ABA_3*URMA;
EQ3: AMA=AMA_0+AMA_1*URWH+AMA_2*URBA+AMA_3*URMA;

Yield equations

EQ4: YWH=YWH_0+YWH_1*(PRWH+SUWH)+YWH_2*PFERT;
EQ5: YBA=YBA_0+YBA_1*(PRBA+SUBA)+YBA_2*PFERT;
EQ6: YMA=YMA_0+YMA_1*(PRMA+SUMA)+YMA_2*PFERT;

Supply equations

IDENT1: QWH=AWH*YWH;
IDENT2: QBA=ABA*YBA;
IDENT3: QMA=AMA*YMA;

Unit gross return equations

IDENT4: URWH=YWH*(PRWH+SUWH);
IDENT5: URBA=YBA*(PRBA+SUBA);
IDENT6: URMA=YMA*(PRMA+SUMA);

Feed demand equations

EQ7:
DFWH=DFWH_0+DFWH_1*PRWH/PLIVW+DFWH_2*PRBA/PLIVW+DFWH_3*PRMA/PLIVW+DFWH_4*0.6*(HERDBF+HERDMK);
EQ8:
DFBA=DFBA_0+DFBA_1*PRWH/PLIV+DFBA_2*PRBA/PLIV+DFBA_3*PRMA/PLIV+DFBA_4*HERDLU;
EQ9:
DFMA=DFMA_0+DFMA_1*PRWH/PLIV+DFMA_2*PRBA/PLIV+DFMA_3*PRMA/PLIV+DFMA_4*HERDLU;

Livestock feed unit equation

IDENT7: HERDLU=0.6*HERDBF+0.6*HERDMK+0.25*HERDPK+0.1*HERDSH+0.01*HERDEG;

Agregate livestock price equations

IDENT8A:
PLIV=(0.6*HERDBF*(PRBF+SUBF)+0.6*HERDMK*(PRMK+SUMK)+0.25*HERDPK*(PRPK+SUPK)
+0.1*HERDSH*(PRSH+SUSH)+0.01*HERDEG*(PREG+SUEG))/HERDLU;
IDENT8B:
PLIVW=0.6*(HERDBF*(PRBF+SUBF)+HERDMK*(PRMK+SUMK))/(0.6*(HERDBF+HERDMK));

Per capita food demand equations

EQ10: PCDWH=PCDWH_0+PCDWH_1*PBREAD+PCDWH_2*PCINC;
EQ11: PCDBA=PCDBA_0+PCDBA_1*PRBA+PCDBA_2*PCINC;
EQ12: PCDMA=PCDMA_0+PCDMA_1*PRMA+PCDMA_2*PCINC;

Total food demand equations

IDENT9: DWH=PCDWH*POP/1000;
IDENT10: DBA= PCDBA*POP/1000;
IDENT11: DMA=PCDMA*POP/1000;

Net trade equations

IDENT12: NTWH=QWH-DWH-DFWH-DOWH;
IDENT13: NTBA=QBA-DBA-DFBA-DOBA;
IDENT14: NTMA=QMA-DMA-DFMA-DOMA;

Producer-retail price transmission equations for wheat

EQ13: PBREAD=PWH_0+PWH_1*PRWH;

Producer price equations

IDENT15: PRWH=PIWH*(1+TARWH);
IDENT16: PRBA=PIBA*(1+TARBA);
IDENT17: PRMA=PIMA*(1+TARMA);

LIVESTOCK

Herd equations

EQ14:
HERDBF=HERDBF_0+HERDBF_1*(PRBF+SUBF)+HERDBF_2*(PRPK+SUPK)+HERDBF_3*(PRSH+SUSH)
+HERDBF_4*(PREG+SUEG)+HERDBF_5*(PRMK+SUMK)
+HERDBF_6*PRWH+HERDBF_7*PRBA+HERDBF_8*PRMA;

EQ15:
HERDMK=HERDMK_0+HERDMK_1*(PRBF+SUBF)+HERDMK_2*(PRPK+SUPK)+HERDMK_3*(PRSH+SUSH)
+HERDMK_4*(PREG+SUEG)+HERDMK_5*(PRMK+SUMK)
+HERDMK_6*PRWH+HERDMK_7*PRBA+HERDMK_8*PRMA;

EQ16:
HERDPK=HERDPK_0+HERDPK_1*(PRBF+SUBF)+HERDPK_2*(PRPK+SUPK)+HERDPK_3*(PRSH+SUSH)
+HERDPK_4*(PREG+SUEG)+HERDPK_5*(PRMK+SUMK)
+HERDPK_6*PRWH+HERDPK_7*PRBA+HERDPK_8*PRMA;

EQ17:
HERDSH=HERDSH_0+HERDSH_1*(PRBF+SUBF)+HERDSH_2*(PRPK+SUPK)+HERDSH_3*(PRSH+SUSH)
+HERDSH_4*(PREG+SUEG)+HERDSH_5*(PRMK+SUMK)
+HERDSH_6*PRWH+HERDSH_7*PRBA+HERDSH_8*PRMA;

EQ18:
HERDEG=HERDEG_0+HERDEG_1*(PRBF+SUBF)+HERDEG_2*(PRPK+SUPK)+HERDEG_3*(PRSH+SUSH)
+HERDEG_4*(PREG+SUEG)+HERDEG_5*(PRMK+SUMK)
+HERDEG_6*PRWH+HERDEG_7*PRBA+HERDEG_8*PRMA;

Supply equations

IDENT18: QBF=HERDBF*YBF;
IDENT19: QMK=HERDMK*YMK;
IDENT20: QPK=HERDPK*YPK;
IDENT21: QSH=HERDSH*YSH;
IDENT22: QEG=HERDEG*YEG;

Milk yield equation

EQ19: YMK=YMK_0+YMK_1*(PRMK+SUMK)+YMK_2*PRWH+YMK_3*PRBA+YMK_4*PRMA;

Per capita demand equations

EQ20:
PCDBF=PCDBF_0+PCDBF_1*PBF+PCDBF_2*PPK+PCDBF_3*PSH+PCDBF_4*PEG+PCDBF_5*PMK+PCDBF_6*PCINC;

EQ21:
PCDPK=PCDPK_0+PCDPK_1*PBF+PCDPK_2*PPK+PCDPK_3*PSH+PCDPK_4*PEG+PCDPK_5*PMK+PCDPK_6*PCINC;

EQ22:
PCDSH=PCDSH_0+PCDSH_1*PBF+PCDSH_2*PPK+PCDSH_3*PSH+PCDSH_4*PEG+PCDSH_5*PMK+PCDSH_6*PCINC;

EQ23:
PCDMK=PCDMK_0+PCDMK_1*PBF+PCDMK_2*PPK+PCDMK_3*PSH+PCDMK_4*PEG+PCDMK_5*PMK+PCDMK_6*PCINC;

EQ24:
PCDEG=PCDEG_0+PCDEG_1*PBF+PCDEG_2*PPK+PCDEG_3*PSH+PCDEG_4*PEG+PCDEG_5*PMK+PCDEG_6*PCINC;

Price transmission equations

EQ25: PMK=PMK_0+PMK_1*PRMK;
EQ26: PBF=PBF_0+PBF_1*PRBF;
EQ27: PPK=PPK_0+PPK_1*PRPK;
EQ28: PEG=PEG_0+PEG_1*PREG;
EQ29: PSH=PSH_0+PSH_1*PRSH;

Total demand equations

IDENT23: DBF=PCDBF*POP/1000;
IDENT24: DPK=PCDPK*POP/1000;
IDENT25: DSH=PCDSH*POP/1000;
IDENT26: DMK=PCDMK*POP/1000;
IDENT27: DEG=PCDEG*POP/1000;

Net trade equations

IDENT28: NTBF=QBF-DBF;
IDENT29: NTPK=QPK-DPK;
IDENT30: NTSH=QSH-DSH;
IDENT31: NTMK=QMK-DMK;
IDENT32: NTEG=QEG-DEG;

Producer price equations

IDENT33: PRBF=PIBF*(1+TARBF);
IDENT34: PRPK=PIPK*(1+TARPK);
IDENT35: PRSH=PISH*(1+TARSH);
IDENT36: PRMK=PIMK*(1+TARMK);
IDENT37: PREG=PIEG*(1+TAREG);

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