SECTOR ANALYSIS OF DAIRY SECTOR IN THE BALSTIC STATES USING AGMEMOD MODEL BASELINE VALIDATION

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Abstract. Milk is one of the most strategically important food products for the entire world and the dairy industry is one of the most important agricultural industries apart from grain production in the Baltic States - Latvia, Estonia and Lithuania. In general, the dairy sector is very dynamic and responds to various factors (for example, total number of dairy farms, average milk yield per cow, milk price). In view of this fact, it is important to prepare and review the sector's development outlook. Simulation models are often used in the preparation of sector outlooks. There are several simulation models that are used for projecting the agricultural sector (including dairy sector) in the European Union and one of them is the AGMEMOD model. The AGMEMOD model is an econometric and dynamic model with which it is possible to make projections and simulations to assess agricultural support instruments, programs, and policies at the European Union level and at individual Member States level. The regional focus of the AGMEMOD model is built on its representation of the agricultural commodities in each individual European Union member state and neighboring candidate, and other countries. AGMEMOD covers the most important agricultural activities of each country in detail. The purpose of this study is to analyse the dairy sector (including factors affecting the sector) in the Baltic States and using the AGMEMOD model. To reach these purposes, research tasks were set which helped analyse the key factors of the dairy sector in the Baltic States and the operation of the AGMEMOD model.

Keywords: dairy sector, analysis, Baltic States, AGMEMOD.

Introduction

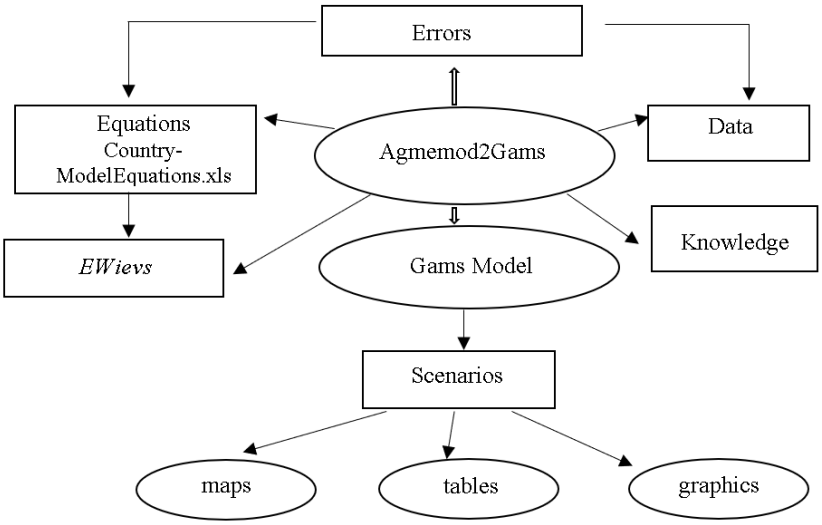
Agricultural production is more complex than other economic activities, as it is highly dependent not only on the market, monetary and political, but also on various meteorological and biological processes [1]. The industry's production processes are closely linked to natural phenomena and are directly dependent on climatic conditions [2]. Agriculture is made up of two interrelated sectors: crop production and animal husbandry [3]. The dairy sector is very dynamic and responds to various factors (for example, total number of dairy farms, average milk yield per cow, milk price). The use of simulation modeling can aid in developing a realistic outlook for agriculture sectors considering various production, market and political factors such as the support measures, for example. A simulation model is developed to study the functioning of a system [4]. There are two main purposes for the development of agricultural models. The first general aim is to develop a scientific understanding of a particular system. The second general aim is to obtain information to justify agricultural policy decisions and predict their implications [5]. To achieve these goals, it is necessary to develop models that reflect the response of the system of agricultural sectors to external environmental and market factors, as well as the planned changes in agricultural and support policies. Users of such models want to find out the possible reactions of the industry that would help in planning, or to find out how the system depicted in the model will react to specific decisions [6].

Research results and discussion

Simulation models are divided into two types – general equilibrium and partial equilibrium models [7]. The general equilibrium theory represents the economy as a selection of economic agents making delivery and demand decisions over goods, labour types and assets, to further interests [8]. Partial equilibrium models represent particular sub-sectors or groups of agricultural sectors and are applied in the detailed analysis of both sides of an equation, namely delivery and demand or policy impact, etc. [9].

One of the partial equilibrium models used in the agricultural sector is the AGMEMOD model – **AG**ricultural **ME**mber states **MOD**elling used for multimarket modeling with taking to account important factors of the agricultural sector [10]. The AGMEMOD model was developed for the agricultural, fisheries and food sectors [11]. The model includes EU-28 members (except Malta) and some nonEU countries. The rest of the world is interpreted as exogenous factors such as world prices, tariffs, and subsidies. The model was built at the country level and calibrated for those parameters which

could not be estimated. The model uses a template for each country. Thus, it allows to provide analytical consistency for all countries and simulate the details [10].



Source: Dibrova, Pankratovs, Cheban, 2020 [11]

Fig. 1. **Procedure from data handling to scenario analysis in AGMEMOD**

The regional focus of the AGMEMOD model is built on its representation of the agricultural commodity in each individual EU member state and neighbouring candidate, and other countries. The model captures the interactions between sectors and countries. AGMEMOD is mainly used to generate "Baseline" – business as usual no policy change projections and also in the analysis of the impact of changes in agricultural market policies [12] and then building scenarios on top of the baseline once it has been validated.

The model uses a variety of factors that affect a particular industry. For example, in the dairy sector, these are:

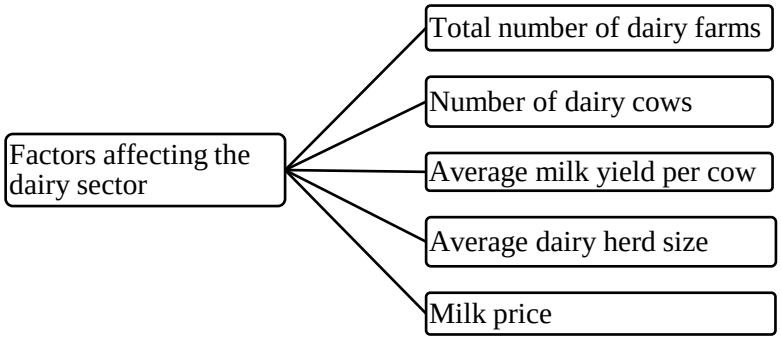


Fig. 2. **Factors affecting the dairy sector [13-15]**

Considering that the AGMEMOD model is used to make outlook also for the dairy sector in EU, the authors aimed to validate the baseline scenario in the AGMEMOD model for the dairy sector in the Baltic States (Lithuania, Latvia and Estonia). These initial results will allow further research to test the equations used in the model to validate the baseline scenario for the Baltic states and make projections for the sector afterwards.

For this research the authors select one of the fundamental factors that influences the dairy sector - the number of dairy cows per farm, the research will be continued to assess and validate other factors influencing the dairy sector.

Figures 3, 4 and 5 show that the projections were made for Latvia, Lithuania and Estonia for the time period from 2014 to 2025. Taking into account that data from 2014 to 2020 are already available, it is possible to assess what was the deviation of the projections from the historic data.

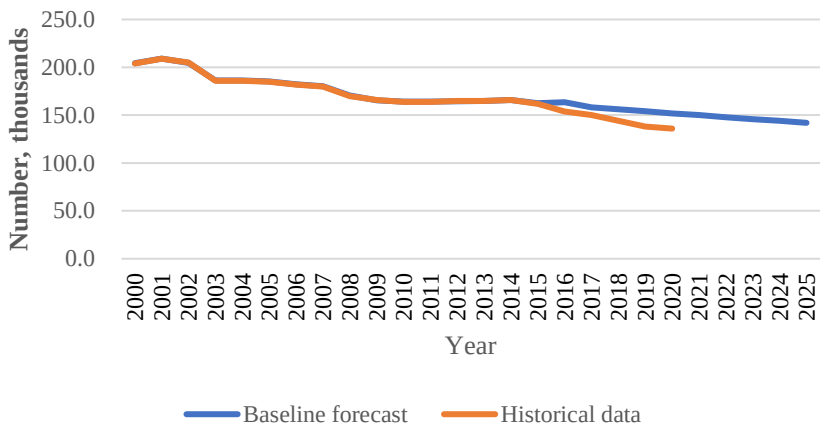


Fig. 3. **Comparison of projected and historical data of dairy cows in Latvia**

In Latvia, there is not a significant difference (the highest was 11.76% in 2020) between the AGMEMOD projection data and historical data. It was projected that in 2014 the number of dairy cows in the farms will increase, but from 2015 it will start to decrease until 2025. According to the projections, in 2020 the number of dairy cows on farms should be 152 thousand, while the historical data indicate that this year it was 136 thousand.

Table 1

Difference between historical data and projection data of dairy cows in Latvia

Year	Deviation from historical data, thousand	Deviation from historical data, %
2014	0.13	0.06
2015	-0.41	0.25
2016	-9.44	6.1
2017	-8.21	5.47
2018	-12.17	8.47
2019	-16.08	11.67
2020	-15.96	11.76

Table 1 shows that according to AGMEMOD projections, the number of dairy cows should have been higher than it actually was. In general, from 2014 to 2020, the projection data and historical data differed, and the gap is growing every year. In this case, it would be necessary to conduct further research and study the equation to find out why the gap between the projected and historical data is increasing every year.

Figure 4 shows that with the projections of dairy cows the situation is different in Lithuania.

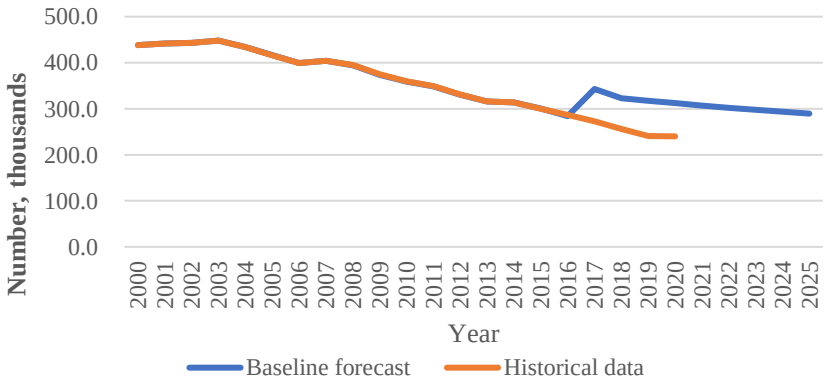


Fig. 4. **Comparison of projected and historical data of dairy cows in Lithuania**

In Lithuania, there is a significant difference between the AGMEMOD projection data and historical data. The projections indicated that starting from 2014 to 2016 the number of dairy cows will decrease, then in 2017 there will be a slight increase and starting from 2018 to 2020 a decrease was projected. According to the projections, in 2020 the number of dairy cows on farms should be 312.6 thousand, while the historical data indicate that this year it was 240 thousand.

Table 2

Difference between historical data and projection data of dairy cows in Lithuania

Year	Deviation from historical data, thousand	Deviation from historical data, %
2014	0.0	0
2015	-0.5	0.2
2016	2.9	1.01
2017	-70.3	25.75
2018	-67.0	26.17
2019	-75.9	31.49
2020	-72.6	30.25

Table 2 shows that the historical data of dairy cows have been lower than projected and the difference is rather large (30.25% in 2020). Until 2017, the difference was as significant, but in 2017, according to the AGMEMOD projections, the number of cows should have been 343.3 thousand, while the historical data show that the number of cows in Lithuania in 2017 was 273 thousand. To understand why such a difference has happened, it is necessary to make a further research and look at the equation used.

Figure 5 shows that in Estonia the situation with the projected and historical data differed from that in Latvia and Lithuania, as the historical data in Estonia were higher as projected.

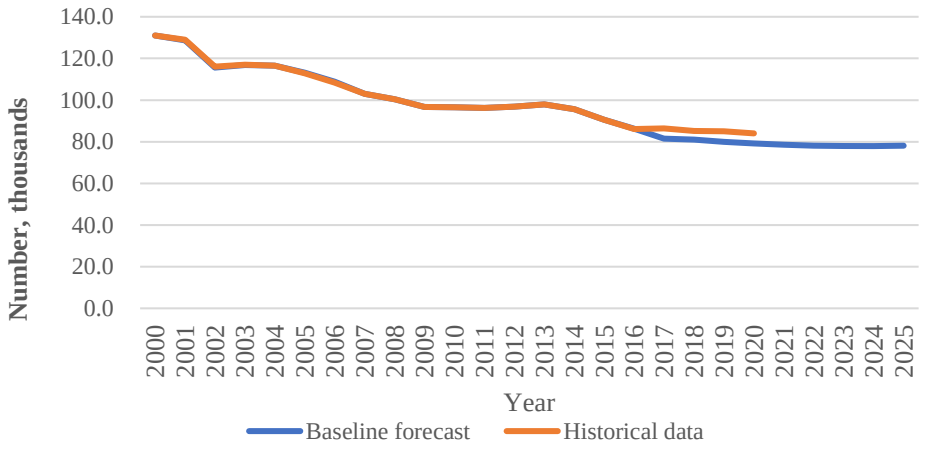


Fig. 5. **Comparison of projected and historical data of dairy cows in Estonia**

In Estonia the historical data were higher than the projections by the AGMEMOD model. The AGMEMOD projections indicated that starting from 2013, the number of dairy cows in the farm will start to decline and will continue to do so until 2025. In reality, this was also the case, namely, the number of cows decreased from 2014, but the decrease was lower than expected. According to AGMEMOD projections, the number of cows in 2020 should have been lower - 79.2 thousand, but in reality, there were – 84 thousand cows.

Table 3 shows that in Estonia, compared to Latvia and Lithuania, the difference between the historical and projected data of dairy cows is even smaller. This may indicate that the equation used to make the AGMEMOD projection was made correctly.

However, given that, unlike in Lithuania and Latvia, the historical data of dairy cows in Estonia are higher than projected, the equation should be studied to find out how it was developed for Estonia.

Table 3

Difference between historical data and projection data of dairy cows in Estonia

Year	Deviation from historical data, thousand	Deviation from historical data, %
2014	0.4	0.42
2015	0.4	0.42
2016	-0.20	0.35
2017	4.8	5.52
2018	4.21	4.71
2019	5.03	5.88
2020	4.83	5.71

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Author contributions

Conceptualization, A.R., S.Z.; methodology, A.R., S.Z.; validation, A.R., S.Z.; formal analysis, A.R.; investigation, A.R., S.Z.; writing – original draft preparation, A.R.; writing – review and editing, S.Z.; visualization, A.R.; supervision, S.Z.; project administration, S.Z.; funding acquisition, S.Z. All authors have read and agreed to the published version of the manuscript.

Conclusions

1. Simulation models are divided into two types - general equilibrium and partial equilibrium models and one of the main partial equilibrium models used in the agricultural sector is the AGMEMOD model. AGMEMOD was developed for the agricultural, fisheries and food sectors. The regional focus of the AGMEMOD model is built on its representation of the agricultural commodity in each individual EU member state and neighbouring candidate, and other countries.
2. AGMEMOD model uses a variety of factors that affect a particular industry and in the dairy sector the authors consider the main factors are: the total number of dairy farms, number of dairy cows, average milk yield per cow, average dairy herd size and the milk price.
3. In Latvia, there is no significant difference between the AGMEMOD projection data and historical data. In general, from 2014 to 2020, the projection data and the historical data differed, and the gap is growing every year. In this case, it would be necessary to conduct further research and study the equation to find out why the gap between the projected and historical data exists.
4. In Lithuania, there is a large difference between the AGMEMOD projection data and historical data. According to the projections, in 2020 the number of dairy cows on farms should be 312.6 thousand, while the historical data indicate that it was 240 thousand in 2020. To understand why such a difference is made, it is necessary to make a further research and look at the equation used.
5. In Estonia the historical data were higher than the projection by the AGMEMOD model. In Estonia, compared to Latvia and Lithuania, the difference between the historical and projected data of dairy cows is even smaller. This may indicate that the equation used to calculate the AGMEMOD projections is sufficiently describing the existing trend for this indicator and is applicable further on. However, given that, unlike in Lithuania and Latvia, the historical data of dairy cows in Estonia are higher than projected, the equation should be studied to find out how it was developed for Estonia and what the baseline calculation differences among the Baltic states are.

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