INVESTIGATING THE EFFECTS OF DYNAMICS AND CRISES ON LIVESTOCK PRODUCTION IN DEVELOPING COUNTRIES BY USING TIME SERIES AND FUTURE FORECASTING WITH ARIMA; A CASE STUDY OF SHEEP PRODUCTION IN TÜRKIYE

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Abstract. In this study, the changes in sheep assets in Türkiye as a developing country were examined under the influence of global and national dynamics and crises. Future forecasts were made with the Box-Jenkins method. Evaluating the post-1980 period, it is was derived that the factors affecting the country's economy negatively affected sheep production until 2010, then as a result of the agricultural policies put into practice, an increasing momentum was achieved in the sheep asset. As a result of the predictions made with the ARIMA (4,2,1) model, it is predicted that this acceleration will continue in the future. However, the governments' failure to give due importance to the agricultural sector in the 42-year period caused the country to not be able to use its current geopolitical advantage, and by 2021, the sheep stock remained at the 1980 level.
Keywords: *sheep production, crises, dynamics, ARIMA, developing countries, Türkiye*

Introduction

The concept of development is mostly considered as economic development, and when the theory of economic development is considered at the macro level, it can be expressed as the economic development of countries. International Monetary Fund (IMF), World Trade Organization (WTO), United Nations Development Programme (UNDP) and World Bank (WB) taxonomies are actively used in determining the economic development levels of countries, which identifies the following 3 groups: developed, developing, and underdeveloped countries (Nielsen, 2013). In this context, the economic policies followed by the countries have a great impact on the economic development.

After the World War II, the dominant policies guiding the economy in the World were based on the Keynesian design. Keynesian economic policies, which dominated Europe and the United Nations in the 1970s were insufficient to solve the problems. In the 1980s, neoliberal economic policies became dominant in the world with globalization. According to the neoliberal movement, the only mechanism to solve the current problems in the economy is the free market phenomenon (Wanwen, 2003).

In economic development, the sectoral distribution of economic activities and the share of these sectors in national income and employment are of great importance. A distinctive feature of economic development in a sectoral sense is the shift of the labor force from the agricultural sector to the service and industry sector (Todaro and Smith, 2012; Timmer, 2002). In underdeveloped countries, it is seen that agriculture is the dominant economic activity and in this respect it has a large share in national income

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and employment (Johnston and Mellor, 1961). On the other hand, it is seen that urbanization and industrialization form the basis of economic growth in developed countries. As a matter of fact, the migration from rural to urban that emerged with economic growth causes the labor force leaving agricultural employment to shift to industrial employment (Li and Lin, 2015). In developed countries, agriculture represents a very small part of employment (Todaro and Smith, 2012).

The negative relationship between the level of development and the agricultural sector is similar in almost every country, except for a few exceptions. The transformation process in the agricultural sector takes place in the form of preferring production activities that are facilitated by the application of technological methods. When evaluated in this context, while there is a rapid transformation in plant production, the process progresses more slowly in livestock production, which depends on the lifestyles of animals.

In this study, the changes of sheep asset in Türkiye as a developing country between 1980-2021 was examined under the influence of global and national dynamics and crises, and then 5-year forecasts were made with the Box-Jenkins (ARIMA) method.

Crises and dynamics effective in Türkiye after 1980

The year 1980 has a great importance in shaping the Turkish economy. The oil crises experienced on a global scale in 1974–78 and the embargoes imposed on Türkiye by the USA and EU countries as a result of the Cyprus Peace Operation in 1974 put the country's economy in a bottleneck and caused the formation of foreign debts that could not be paid against the IMF (Altaşlı and Işık, 2017). As a result of these events, the country's government undersigned the transition to neoliberal economy, which formed the basis of the transition to a new economic policy in 1980 and was engraved in Turkish economic history under the name of "January 24th Decrees". With this step, the introverted economy started to give way to the outward oriented free market economy (Şenses, 2012).

With the announcement of the transition to neoliberal economy, the government received a great reaction throughout the country and started to lose its support in the parliament. The intervention in this situation was not delayed. With the military coup on 12 September 1980, the country's administration taken under control by a regime that supported the neoliberal view. The strict decisions taken by the military administration caused radical changes in the country until 1983. This regime played a key role in the adoption of the neoliberal economy between 1980 and 1989 (Şenses, 2012). The process of globalization and neoliberal economy, which started with 1980, continued with the management of the country's economy for 28 years under the control and supervision of the IMF and WB (Altaşlı and Işık, 2017).

With the neoliberal economy, the liberalization of interest rates in the markets caused the bankers crisis in 1982. The crisis, which emerged as a result of the bankers providing high-interest resources with the interest rates given by some banks below the inflation limit, came to an end in 1983 with the right of the Central Bank to intervene in the interest rate (Fırat, 2009; Altaşlı and Işık, 2017). No matter how positive the atmosphere was in the economy at the beginning of the 1980s, there were long-term economic turbulences afterwards. By 1989, the capital account was liberalized to meet the need for hot money without taking any measures. This move shows itself as the most important factor in the emergence of the economic crises experienced after 1990 (1994, 2000-2001, 2008-2009) (Şenses, 2012).

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The 1980s were not only a period of economic crises in the country. The internal turmoil experienced as a result of the strict practices of the military forces that took over the country's administration with the coup, the regional migration movement as a result of the terrorist acts that broke out in the eastern and southeastern provinces of the country, and the development difference between the regions as a result of the inability to make investments brought along many socio-economic problems.

According to the report prepared by the Human Rights Investigation Commission of the Turkish Grand National Assembly in 2013, as a result of the terrorist incidents that started early 80's, total of 13475 citizens (7918 of whom were soldiers and 5557 civilians) lost their lives between 1984 and 2012. Again in this process, 905 villages and 2523 hamlets had to be abandoned, which resulted in the migration of 386360 citizens. Terrorist incidents became one of the biggest problems of Türkiye in the late 80's and early 90's (TBMM, 2013). The main actor of these terrorist acts was the PKK, which was also recognized as a terrorist organization by the EU, UK and USA.

In 1990, the 1st Gulf War emerged as a factor that negatively affected Türkiye, besides the losses in oil pipeline revenues and exports to Iraq were adversely affected. Along with these, the economic decisions taken in 1989 dragged the country into a bottleneck and put it into a severe economic crisis in 1994. After the crisis, the stability decisions of 5 April 1994 were implemented with the support of the IMF (Fırat, 2009). With the standby agreement, the IMF stated that it would continue to support the country until 2000. The decisions taken in 1994 had a positive impact on the country's economy until 1998 and made a positive contribution to economic development (Toprak, 1996).

Pursuant to the decisions taken at the EU council meeting held in 1995, the work on the customs union agreement with Türkiye was completed on 1 January 1996. As a matter of fact, the emergence of mad cow disease (bovine spongiform encephalopathy) in England in the first year of the agreement adversely affected the import of live animals and animal products into the country. Thereupon, the entry of live animals and animal products into the country was prevented until 2009 with prohibitions and high customs duties (Palabıçak, 2019).

The economic crises experienced in Asian countries in 1997 and in Russia in 1998 also affected the Turkish economy. In 1998, a new standby policy was established to struggle high inflation and a positive note was received from the IMF. The monetary policies followed until the end of 1999 increased the borrowing even more and the earthquake in the Marmara region, where industrial development in the country was intense, dragged the country's economy into a new bottleneck (Fırat, 2009; Şenses, 2012). In Türkiye, the 1990s continued as a period of economic and political turmoil. The period that started with the end of the coup government in 1989 can be described as the period of "10 governments in 10 years" in Turkish political history.

The bad situation in 1999 led to the signing of a new standby agreement with the IMF at the end of the same year. The country's economy, which has entered a bottleneck, has dragged it into a new crisis despite all the measures taken. "Black Wednesday", the first major crisis of the 21st century, took its place in history as one of the biggest crises of the Turkish economy in February 2001. As a result of the tight monetary policies followed during the formation of the crisis and the failure to fulfill the promised commitments, local banks were greatly affected by this crisis (Dufour and Orhangazi, 2009).

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After the 2001 crisis, the central bank switched to a floating exchange rate policy, political turmoil arose in the country and early political elections were held on 3 November 2002. For the first time since the 1950s, a party took over the administration of the country with the largest representation power in the parliament, and this situation lasted until 2017. In July 2016, a coup attempt was made to overthrow the current administration in the country, but it failed. In this attempt, 248 citizens lost their lives and 14 billion dollars of property damage was incurred. After this event, it was submitted to a referendum and the presidential system was accepted, and after 2017 the administration of the country was continued by the same party. If a generalization is made, the period of 2003-2023 can be described as the period of one-party rule. In this process, the party administration directed its economic policies within the framework of "economic liberalism" and went to privatization in public institutions.

Apart from the 2001 crisis, other factors that were effective in the same period; it is the Afghanistan War that started under the leadership of the USA after the terrorist attacks on 11 September 2001, and the 2nd Gulf War in 2003. The negotiations between the USA and Türkiye, which were initiated in 2002 regarding the operation to be carried out against Iraq before the 2nd Gulf War, changed direction with the post-election government change. For the country, which has just recovered from the effects of the 2001 crisis, being involved in a military operation on the border was considered as a risk and the military motion to support the USA was rejected in the parliament. This blocked the way for financial support from the USA (Brown, 2007). The next period was a period in which economic improvements continued in the country, but the crisis that broke out in the real estate markets in the USA in 2008 turned into a global economic crisis that affected many countries around the world, and Türkiye also got its share.

The 2008 crisis has been called the biggest crisis after the 1929 crisis. Regardless of the development level of the countries, it was affected by this crisis and the crisis showed itself with the rapid increase in the unemployment rate (Kaya Bahçe and Memiş, 2013). The effects of the crisis on unemployment in Türkiye were mostly manifested in non-agricultural sectors and resulted in the unemployment of approximately 500 thousand people in the August 2008 – January 2009 period (Aytaç et al., 2015). Measures to reduce the impact of the crisis were implemented by the government in different periods of 2009 with 5 different packages. These policy tools can be summarized as supports and incentives for production and exports (Kibritçioğlu, 2010). The high customs duties of 225%, which started to be applied for the import of live animals and animal products in 1995, were reduced to 25% in this period and imports were allowed. After the 2008 crisis, economic improvements both in the world and in Türkiye showed themselves in the second half of 2010. The fact that the agricultural sector was included more in the economic policies after 2010 showed itself with partial improvements in agriculture.

The "Arab spring" uprising, which started in Tunisia in 2010, caused many hot developments in the Middle East. Although the civil war in Syria in 2011 was the first of these, it still continues today. The Syrian civil war has adversely affected many countries, especially neighboring countries. Türkiye is one of the most affected country by this war due to its border neighbor, sharing the same belief, cultural and political ties from the past, as well as its geographical location (Akçan et al., 2019). As a result of the civil war, millions of people immigrated to many countries, especially neighboring

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countries. Türkiye has been the country receiving the highest number of immigrants, hosting approximately 3.6 million Syrians. This migration brought with it many socio-economic problems, and over time, it also caused the tension between Turks and Syrians to rise (Atar et al., 2022). Although this high tension has divided the society into two opposing views, the opinion that Syrian refugees should be sent from the country has become a very vocal situation in politics.

In the history of the Republic of Türkiye, the main financier of public external debt has been the IMF. Türkiye-IMF relations started in 1947 through membership and ended in terms of foreign debt in May 2013 with the final debt payment. In the process that started with the signing of the first agreement in 1961, a total of 19 standby agreements were signed and as a result of these agreements, a total of 32,817 billion dollars of funds were used (Arpac and Bird, 2009). With the end of the debts to the IMF after 2010, private sector borrowing exceeded the public sector in the external debt deficit.

In August 2018, the growth of the country lost momentum and credit rating agencies gave low scores to Türkiye. This situation soon turned into a new economic crisis with the Turkish lira losing its value against the dollar. The currency crisis made itself felt in the full sense by bringing along the rapidly increasing inflation rate and unemployment. Although foreign capital inflows in 2019 were below the global level, they prevented the country from facing a worse outcome (Orhangazi and Yeldan, 2021).

As the end of 2019 approached, the economy, which moved away from the risk environment, was shaken again by the COVID-19 epidemic in 2020, and the Turkish lira constantly lost value under the influence of this crisis (Orhangazi and Yeldan, 2021). While the USD Dollar- Turkish Lira (USD/TRY) parity increased approximately 4.5 times between 2018 and 2022, the central bank's foreign exchange reserves decreased by 90%.

The military activity that started with Russia's annexation of Crimea in 2014 turned into an effective war on a global scale with Russia's open declaration of war against Ukraine on 24 February 2022. Since both countries realize 40% of world grain exports, sudden increases were experienced in grain prices in global markets. According to the United Nations, the grain crisis that emerged with the COVID-19 and the Russia-Ukraine war has been expressed as the biggest food crisis experienced on a global scale after the World War II (Lin et al., 2023).

Although different interventions were made against the crisis that started in Türkiye in 2018 and exacerbated its effects with COVID-19 and the Russia-Ukraine war, the crisis could not be prevented yet.

Materials and methodology

Research area and data

The main material of the study consists of secondary data on sheep production in Türkiye. In the study, European Union Statistical Regional Units Classification (NUTS) Level 1 regional data were used in order to analyze national and global dynamics and the effects of crises on a regional basis as well as on a national basis (*Table 1; Fig. 1*).

The sheep asset used in the study covers the years 1980-2021 and was obtained from Food and Agriculture Organization Corporate Statistical Database (FAOstat) and Turkish Statistical Institute (Turkstat) on a country basis, and from Turkstat at a regional level.

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Table 1. *Major socio-economic regions of Türkiye according to NUTS1*

Region code	Region name	Region code	Region name
TR1	Istanbul	TR7	Middle Anatolia
TR2	West Marmara	TR8	West Black Sea
TR3	Aegean	TR9	East Black Sea
TR4	East Marmara	TRA	Northeast Anatolia
TR5	West Anatolia	TRB	Middle East Anatolia
TR6	Mediterranean	TRC	Southeastern Anatolia

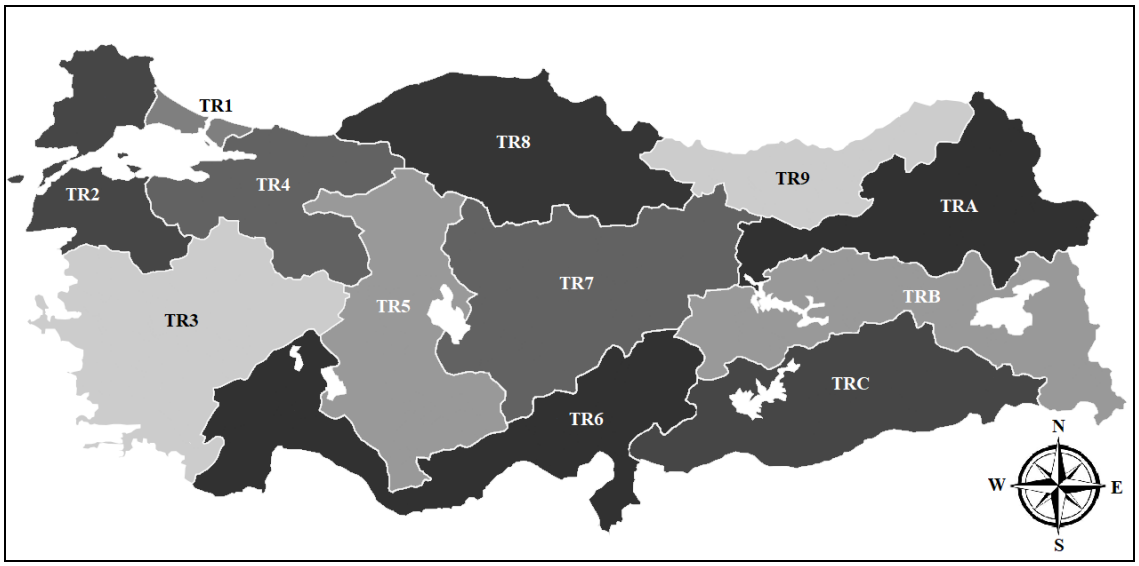

Figure 1. *Major socio-economic regions of Türkiye according to NUTS1. (Source: produced by the authors)*

Theoretical framework

It is possible to examine the shares of sectors in a country in national income and employment by comparing them with the change in the level of development of that country. In this case, although there are some exceptional countries, the general judgments are similar.

In this study, sheep production in Türkiye was examined. The main reason for this is that there have been great changes in livestock over the years in Türkiye, which has an important place in the world with its animal assets. The main purpose of our study is to examine these changes under the influence of both global and national dynamics and crises and to forecast what the possible sheep asset in the country may be in the future in the axis of these norms. The fact that a similar study has not been done before in the literature review conducted for this purpose adds originality to the theoretical framework of our study.

The main reason for taking 1980 as the starting year in the study; it is the beginning of radical changes in the country with the effect of global and national dynamics and crises. As a matter of fact, the oil crisis that was effective in the world in the 1970s and the economic crises experienced in the country afterward put the country's economy in a bottleneck (Timothy, 2010). Following these, stand-by agreements with the IMF in 1978

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and 1979 made it necessary to adopt a new economic policy (Celâsun and Rodrik, 1989). For this reason, the adoption of neoliberal economic policies with the "January 24th Decrees" in 1980 took its place as a radical change in the Turkish economic history.

Econometric analysis (ARIMA (p,d,q) model)

The ARIMA (p,d,q) model was first developed in 1970 by George Box and Gwilym Jenkins. This method, also known as the Box-Jenkins method in the literature; it is expressed as "Autoregressive Integrated Moving Average", which shows the combination of Autoregressive Model (AR), Moving Average Model (MA) and how many times the difference must be taken for the series to become stationary with Integrated (I). The method generally consists of three stages as identification, estimation and diagnosis (Box and Jenkins, 1970; Makridakis and Hibon, 1997; Cançelik, 2021; Firoiu et al., 2022). As a univariate time series model, ARIMA is widely used to make forecasts for the future. Future forecasting in ARIMA modeling can be defined as a linear function of past observation values and random errors (Tao et al., 2017).

Formulated representation of the ARIMA model;

$$x_t = \theta_0 + \phi_1 x_{t-1} + \cdots + \phi_p x_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \cdots - \theta_q \varepsilon_{t-q} \qquad \text{(Eq.1)}$$

Here x_t is the observation at time t, ε_t is the random error at time t, $\phi_i \ (i = 1, 2, \ldots, p)$ coefficient is the p polynomial representing autoregressive and $\theta_j \ (j = 1, 2, \ldots, q)$ coefficient is the q polynomial representing partial autocorrelation (Creyer and Chan, 2008).

If we examine the application of the ARIMA model and the forecasting of the future according to the Box-Jenkins methodology in stages:

1. Making the series stationary (determining the value of "d" representing "I")
2. Calculation of autocorrelation and partial autocorrelation to determine the appropriate "p" and "q" values
3. Determination of the model and estimation of parameters (estimation of "p" representing "AR" and "q" representing "MA")
4. Diagnosis of the model (deciding on the model by determining whether the residues are "White Noise") (Makridakis and Hibon, 1997).
5. Making forecasts and controlling the forecasting performance can be considered as another criterion in choosing the model with the best forecasting performance.

The flow chart for the application of the ARIMA model and forecasting is given in *Figure 2*. Eviews 10 program was used to run the model.

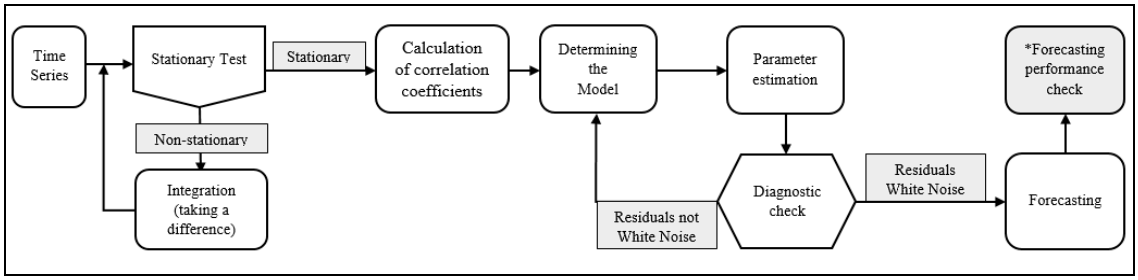

Figure 2. *The flow chart for the application of ARIMA modelling and forecasting. (Source: produced by the authors)*

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Examine the stationary of the series

The clear indication of the stationarity of the series is that it does not contain a unit root. According to the commonly used Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, the null hypothesis "serial contains unit root" should be rejected and the alternative hypothesis "serial contains no unit root" should be accepted. At the same time, examining whether the variances of the series show random distribution and whether there is a correlation in the whole series is used as a secondary method in determining the stationarity. However, for this, first of all, autocorrelation (ACF) values, partial correlation (PACF) values and the results of the Ljung Box Q-test at different lag levels should be calculated. After that, correlograms containing ACF and PACF values and Ljung-Box Q-test results can be examined. According to the null hypothesis of the Ljung-Box Q-test, the assumption that "the data are independently distributed and do not contain correlations (all correlation values must be equal to or close to 0)" should be accepted.

Basically, unit root tests are important in testing stationarity. Although the correlation can be eliminated by using different methods such as taking logarithms in a non-stationary series, these methods cannot eliminate the existing unit root. In order to save the series from unit root, the difference must be taken and the number of times the difference is taken is expressed as "Integrated (d)" in the ARIMA model.

Calculation of autocorrelation and partial autocorrelation values

In the stationary series, the ACF coefficients used for autoregression (AR) and the PACF coefficients used for moving averages (MA) are calculated.

Preference of the ARIMA model and Estimation of parameters

There are different approaches to determine the AR (p) and MA (q) parameters suitable for the ARIMA model. While it can be decided by examining the calculated AC and PAC values, the model in which the F statistic is significant, the R2 and corrected R2 values and Log likelihood value are the highest, the Akaike information criterion (AIC) and Bayesian Information Criterion (BIC) values the lowest can be preferred (Burnham and Anderson, 2004; Ma et al., 2018; Ludden et al., 1994).

Diagnostic check of ARIMA model and deciding on final models

The residues of the preferred ARIMA model are required to be "White Noise". For this, according to the null hypothesis of the Ljung-Box Q-test, the assumption that "residues are distributed independently, that is, there is no correlation (all correlation values must be equal to or close to 0)" should be accepted. Otherwise, the process returns to the 3rd stage and continues with the choice of a new model.

Forecasting and forecasting performance check

Forecasts are made with the ARIMA (p,d,q) models that are decided upon. After this stage, it is desired to control the performance of the forecasts made, to reveal the accuracy of the forecasts that is to be more reliable. To achieve this, the Mean Absolute Percentage Error (MAPE) value must be calculated. MAPE value greater than 50% indicates that the forecast is incorrect, if it is in the range of 20-50%, it is reasonably acceptable, in the range of 10-20% it is a good forecast, and less than 10% represents a highly accurate forecast (Chen et al., 2009; Lewis, 1982).

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Results and discussion

The situation of sheep production in Türkiye after 1980

No matter how important national development is, this situation varies when it is analyzed at the regional and sectoral level. Türkiye is a country suitable for the production of different agricultural products with its current topography and climatic diversity. In the country, where urbanization and industrialization accelerated after 1980, the inability of rural areas to benefit from public investments and income inequality caused great migration movements over time. While the developments in the industrial sector created employment opportunities, the increasing welfare level with urbanization resulted in the migration of agricultural workers from the countryside to the city. This migration movement took place in the form of the shift of labor in agriculture to industry and service sectors as "labor migration" (Sevinç and Kantar Davran, 2022).

Labor migration in the sectoral sense in Türkiye is obvious after 1980. While 53.6% of the total labor force was working in agriculture in 1980, this rate decreased to 17.2% in 2021. It is possible to say that the labor force migration that has taken place with industrial development is also being experienced in Türkiye (Türkstat, 2021; Kaya, 2008).

The sub-sector most affected by the migration movement in agriculture has been livestock production. However, livestock production plays an important role in realizing rural and economic development as a whole on a national basis and in preventing excessive migration from rural to urban areas (İkikat Tümer et al., 2020).

Türkiye is suitable for ovine production with its meadows and pastures. While sheep accounted for 56% of the bovine and ovine livestock in Türkiye in 1980, it ranked 4th in the world with its current sheep asset, and ranked 6th in the world with almost the same sheep asset in 2021. Although the sheep asset in the country increased between 1980 and 1983, it started to decline with the terrorist incidents that broke out and the east of the country in the process that started with the transition to the neoliberal economy in 1982. As a matter of fact, due to the increase in terrorist incidents in 1984, the evacuation of villages and hamlets in the eastern provinces of the country dealt a great blow to animal production. The downward trend showed itself with a break in 1985 and there was a 17% decrease in sheep asset compared to the previous year. After the partial recovery period between 1986-1989, it entered a period of long-term decline that started with the effect of the 1st Gulf War in 1990. The decrease in the sheep asset has accelerated from time to time under the influence of global and national dynamics and crises. The ongoing economic crisis and political impotence in the country continued to make its impact felt in almost every sector. During the same period, terrorist incidents in the east of the country continued to damage widespread livestock activities in the region. The customs agreements made with the EU to correct this situation were disrupted due to the mad cow disease that emerged in 1996, and the bad trend could not be prevented. In the period starting with 2011, the policies implemented by the government after the 2008 crisis had a great impact on the improvement of sheep asset. In addition to the subsidies given for livestock production, the high customs duties applied in the importation of live animals and animal products in the 1994-2010 period were reduced and imports were liberalized (Palabıçak, 2019). In 2010, sheep asset decreased by 52.65% compared to 1980 and reached the lowest level. The upward trend, which started with the remedial policies implemented in 2011, resulted in the sheep asset almost reaching the 1980 level in 2021 (*Fig. 3*).

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If the relationship between the change in sheep asset in Türkiye and the world is examined. According to FAOstat data, when the world sheep asset is evaluated for the period 1980-2021; The sheep asset, which was 1 billion 98 million in 1980, showed an average annual change of 1.40% during this period. While the general trend was upward between 1980 and 1990, it showed a continuous downward trend between 1991 and 1997 and fell to its lowest animal asset with 1 billion 35 million head in 2002. The sheep asset, which showed an increasing trend after 2002, reached 1 billion 284 million by 2021. While the change in sheep asset in the world and Türkiye showed a similar decreasing trend only between 1991 and 1997, when examined in terms of change rates, it was determined that the change in sheep asset in Türkiye occurred at much higher rates.

Year	Number of sheep (head)	Index (1980 = 100)	Change in the number of sheep between 1980-2021
1980	46 026 000	100.00	
1985	40 391 008	87.76	
1990	43 647 008	94.83	
1995	35 646 000	77.45	
2000	30 256 000	65.74	
2005	25 201 156	54.75	
2006	25 304 324	54.98	
2007	25 616 912	55.66	
2008	25 462 292	55.32	
2009	23 974 592	52.09	
2010	21 794 508	47.35	
2011	23 089 692	50.17	
2012	25 031 564	54.39	
2013	27 425 232	59.59	
2014	29 284 247	63.63	
2015	31 140 244	67.66	
2016	31 507 934	68.46	
2017	30 983 933	67.32	
2018	35 194 972	76.47	
2019	37 276 050	80.99	
2020	42 126 781	91.53	
2021	45 177 690	98.16	

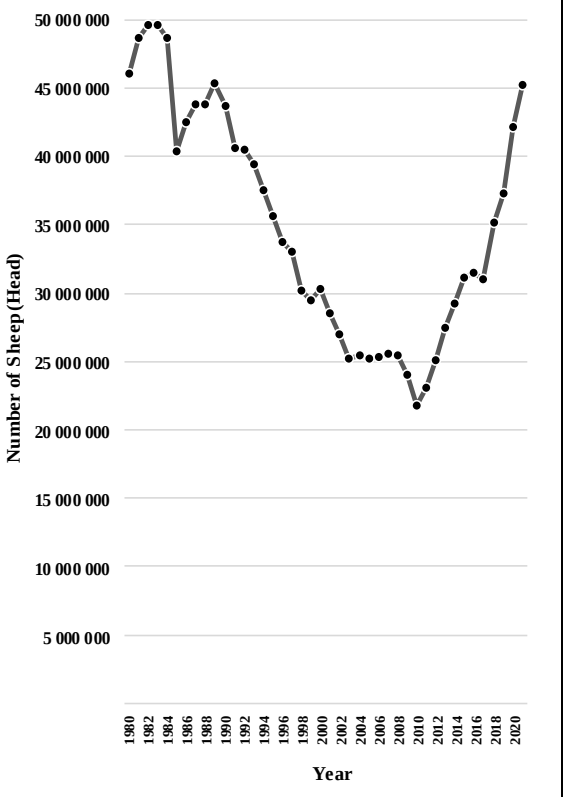

Figure 3. *Number of sheep in Türkiye between 1980-2021. (Source: Own calculations based on FAOstat Database (2023). Produced by the authors)*

When the distribution of sheep asset in Türkiye is examined at the level of NUTS1 regions; TRA, TRB and TRC regions stand out with their dense of sheep asset. While the sheep asset in these regions represented 42.32% of the total sheep asset in 1980, it represented 43.36% with a small increase in 2021. In these regions, there have been regions with intense migration to the west of the country due to the fact that security has become a problem due to the terrorist incidents after 1980, as well as the intense

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immigration from across the border during the Afghanistan war, the Gulf Wars and the Syrian war. As it can be understood from here, it can be said that the problems experienced in these regions have a great effect on the fact that the sheep asset in the country has not progressed in the last 42 years (*Table 2; Fig. 4*).

Table 2. *Proportional distribution of sheep numbers to NUTS1 regions of Türkiye between 1980-2021*

Year	Proportional distribution of sheep numbers to NUTS1 regions between 1980-2021(%)											
	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC
1980	0.31	6.17	8.37	4.62	10.12	5.00	12.22	7.00	3.85	14.91	16.28	11.13
1985	0.44	6.01	8.55	4.67	9.90	5.86	12.17	6.58	3.29	15.77	15.60	11.16
1990	0.37	5.44	7.90	3.98	9.50	6.13	11.70	5.85	2.38	15.13	17.31	14.30
1995	0.33	5.62	9.31	4.15	9.56	6.61	12.24	5.09	2.26	14.65	15.62	14.57
2000	0.27	5.67	9.75	3.97	9.04	6.34	8.54	4.40	2.19	14.74	21.40	13.70
2005	0.19	5.90	10.09	3.70	9.03	6.08	7.86	3.92	1.99	13.57	23.42	14.24
2010	0.31	6.35	11.17	4.00	9.91	6.19	7.25	3.33	1.57	10.76	21.64	17.52
2015	0.32	6.52	11.75	4.39	10.12	7.56	8.33	3.22	1.36	12.13	18.06	16.23
2016	0.31	6.49	11.55	4.24	10.35	7.69	8.14	3.32	1.39	11.98	18.21	16.33
2017	0.33	6.63	10.90	4.11	10.50	7.59	8.33	3.30	1.48	11.64	16.86	18.33
2018	0.33	6.59	10.97	4.31	10.77	7.96	8.51	3.24	1.46	10.80	16.30	18.75
2019	0.36	6.53	10.70	4.94	11.08	8.35	8.44	3.13	1.48	10.83	16.05	18.11
2020	0.34	6.59	10.67	4.87	11.42	8.02	8.83	3.22	1.52	10.48	15.99	18.06
2021	0.34	6.88	10.34	4.80	11.72	8.61	9.04	3.32	1.59	10.52	15.85	16.99

Source: Own calculations based on Turkstat Database (2023). Produced by the author

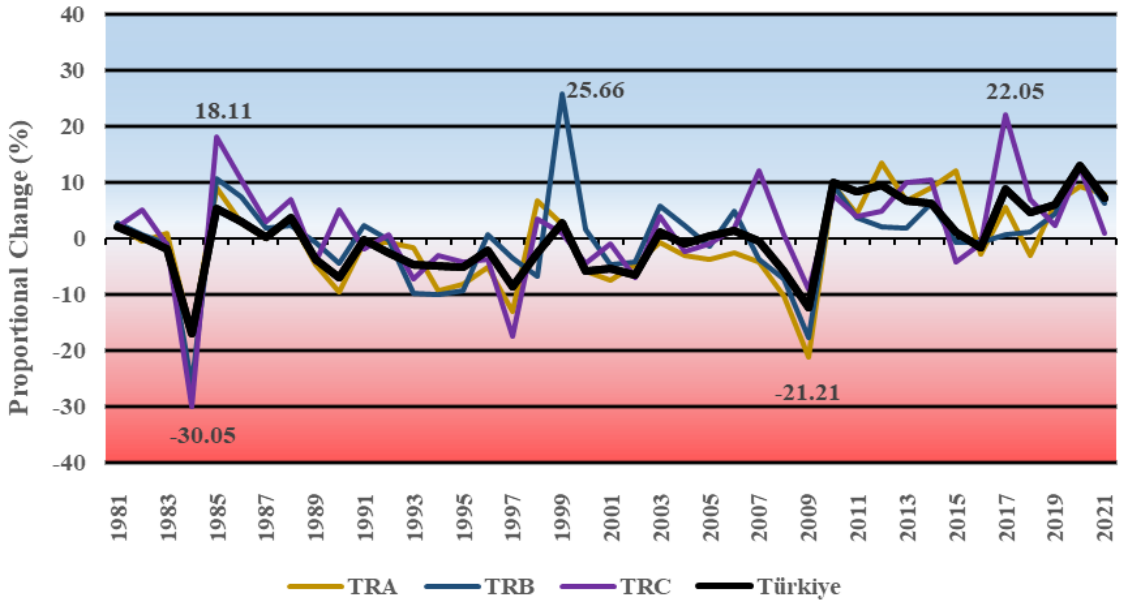

Figure 4. *Proportional change in TRA, TRB, TRC regions and total number of sheep compared to the previous year between 1980-2021. (Source: Own calculations based on FAOstat Database, 2023. Produced by the authors)*

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In the post-1980 period, the changes in the asset of animals in the country were observed mostly with increases in the cattle asset. While the asset of ovine animals followed a fluctuating course in the 1980-2021 period, it did not increase in general terms, however, cattle started to form the main animal asset in the country to meet the need for animal food (Palabıçak, 2019). One of the main reasons for this is the abandonment of ovine production with the migration from rural to urban areas. Ovine production carried out in extensive conditions has lost its appeal and has been replaced by cattle production, where it can be carried out close to the urban areas in intensive conditions, without the need for meadow pasture fields.

Despite all these situations, the ovine asset in Türkiye is still important. In fact, religion can be shown as the main reason for this, since 90% of the country's population is Muslim. According to the Islamic belief, Muslims perform their worship by sacrificing bovine or ovine animal once a year, depending on their economic situation. The fact that sheep and goats are preferred for this worship creates a compulsory need for the society. Similarly, with Türkiye's location in the Islamic geography, it has a great potential for the export of ovine animal. Such that, according to UN comtrade 2022 data, Türkiye has exported total of 541 704 head of sheep and goats and these exports are respectively; It was carried out to Iraq, Qatar, Kuwait, Lebanon, Syria and Azerbaijan. As can be understood from here, it is clear that Türkiye's foreign trade in ovine animals is mostly with countries where the Islamic faith is widespread. As a matter of fact, the Eid al-Adha takes place during the pilgrimage to mecca and large animal sacrifices are carried out in Saudi Arabia. According to 2022 foreign trade data, Saudi Arabia imported 1 439 984 goats and sheep in 2022 to meet this need. Romania, Spain and Georgia are among the leading countries in sheep and goat imports to Saudi Arabia, while Türkiye is not on the list. This information shows that, it would be correct to say that Türkiye's current potential is not well utilized.

Econometric analysis and future forecasting (ARIMA modelling)

ARIMA (p,d,q) modelling, also known as the Box-Jenkins method, was used to forecast the future of Türkiye's sheep asset. In the implementation process of the model, the methodology was adhered to and the future forecasts were realized by determining the appropriate model.

Examine the stationary of the series and calculation of autocorrelation and partial autocorrelation values

Firstly, the stationarity of the data for the years 1980–2021 was tested in 3 different conditions with ADF and PP tests. It has been determined that the series is not stationary in the current situation and contains a unit root. Thereupon, the 1st and 2nd degree differences were taken and it was determined that the series did not contain unit roots at these levels and was stationary. As a second method, correlograms containing ACF and PAC values were examined (*Table 3; Figs. A1* and *A2*).

Preference of the ARIMA model and Estimation of parameters

In the stationary series, a decision was made by examining the correlogram to determine the AR and MA values, and the results of the best 20 models were compared by running automatic search models. In this comparison, the ARIMA (4,2,1) model, which has the highest LL value and the lowest AIC and BIC values, was preferred

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(*Figs. A4–A6*). When the outputs of the ARIMA (4,2,1) model were analyzed, it was concluded that the model was significant at the 0.1% significance level and the R2 value was 0.518 (*Fig. A7*). Information about model parameters are presented in *Table 4*.

Table 3. *Unit root tests*

Variables	ADF (Augmented Dickey–Fuller)			PP (Phillips–Perron)			Integration
	Intercept	Trend and Int.	None	Intercept	Trend and Int.	None	
Base level	-1.453 (0.546)	1.485 (1.000)	-0.493 (0.496)	-1.151 (0.686)	2.355 (1.000)	-0.317 (0.565)	I(0)
First difference	-4.410 (0.001)***	-5.492 (0.000)***	-4.463 (0.000)***	-4.481 (0.000)***	-5.476 (0.000)***	-4.535 (0.000)***	I(1)
Second difference	-9.582 (0.000)***	-9.581 (0.000)***	-9.704 (0.000)***	-15.098 (0.000)***	-31.421 (0.000)***	-14.960 (0.000)***	I(2)

*** indicates that the null hypothesis was rejected at the 0,01% significance level in the unit root tests. That is, it does not contain a unit root

Table 4. *Results of the ARIMA (4,2,1) model used in the future forecasting of animal numbers*

R-squared	0.518497	**Adj. R-squared**	0.430951
F-statistic	5.922564	**p value (F-statistic)**	0.000280***
Variable	**Coefficient**	**t-Statistic**	**Probability**
C	87922.13	1.182123	0.2456
AR(1)	-0.280615	-1.462022	0.1532
AR(2)	-0.391526	-1.297737	0.2034
AR(3)	-0.313639	-1.260686	0.2163
AR(4)	-0.568664	-3.056687	0.0044***
MA(1)	-0.555901	-1.941457	0.0608
SIGMASQ	3.32E + 12	4.119986	0.0002***

***Significant at 0.01%

Diagnostic check of ARIMA (4,2,1) model

The correlogram including ACF, PAC and Q'test results were examined to determine whether the residues of the preferred model were "White Noise". According to the results of the Ljung-Box Q-test, the residues of the model are distributed independently and do not contain correlation (*Fig. A3*). This means that our model is suitable for predicting the future. In addition, the existing series, compatible series and series of residues were examined and it was checked whether the errors showed normal distribution. (*Figs. A8* and *A9*).

Forecasting and forecasting performance check

With the ARIMA (4,2,1) model, 5-year forecasts are made for the future. "Mean Absolute Percentage Error (MAPE)" value results were examined to test the performance of future forecasts. The MAPE value of 21% represents a reasonably

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acceptable estimate (*Fig. 5*). As a matter of fact, the fact that the values for 2022 were obtained from Turkstat during the study period allowed us to perform another test. In this test, the proportional difference between the value of the 2022 future forecast and the actual value was examined. The fact that the difference between the two values was very low at 1.84% was the last step in our acceptance of the ARIMA (4,2,1) model (*Table 5*).

It is predicted that the sheep asset, which was 45 177 690 heads in 2021, will increase according to the results of ARIMA (4,2,1) and will reach 58 197 688 heads by 2026 (*Table 5*).

Table 5. *Future forecasting of sheep numbers according to the ARIMA (4,2,1) model between 2022-2026*

Year	Actual (Head)	Lower bound (-2 s.e.)	Forecast (Head)	Upper bound (+2 s.e.)	Relative error (%)
2022	44 879 284*	41 330 332	45 705 995	50 081 660	1.84
2023	-	41 494 680	48 214 011	54 933 344	-
2024	-	41 679 862	50 368 241	59 056 620	-
2025	-	43 318 593	53 885 912	64 453 232	-
2026	-	46 254 902	58 197 688	70 140 475	-

Source: Own calculations based on FAOstat Database (2023) and *data from Turkstat (2023) was used

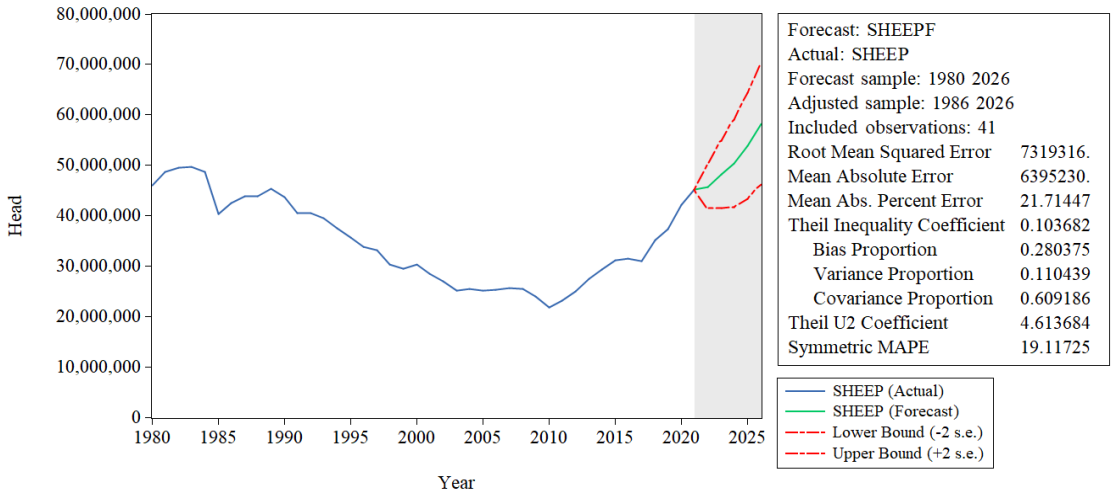

Figure 5. *Forecast of ARIMA (4,2,1)*

Conclusion

The reflections of the positive and negative factors in the countries on a sectoral basis vary. When these factors are associated with the level of development, it is appropriate to say that their activities have observable different results depending on the level of development of the countries. As a matter of fact, the fact that economic development acts in coordination with the industry and service sectors has negative results in the agricultural sector in general. As Türkiye is a country where industrialization is gaining momentum, it is getting further and further away from its identity as an agricultural country. As a matter of fact, the globalization and open

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economic process that started in 1980 brought serious changes in the livestock sector in the country. It is seen that the meadows and pastures that are suitable for ovine production are not utilized sufficiently at the point of making the best use of existing resources, and ovine production is rapidly abandoned in coordination with the migration from rural to urban areas. Although the livestock policies that changed with 2010 partially corrected the bad course, livestock production remained far behind the self-sufficient level when it was associated with the increasing population. As a matter of fact, Türkiye is experiencing problems as it is a country that shows an annual population increase of 2.5% and is subjected to an influx of asylum seekers and refugees due to the wars in the region. With the 2018 crisis, the biggest reflections of the inflation in the country showed itself on the food sector and the price increases in animal origin foods increased by 5 times. This clearly reveals how agricultural production, which has undergone a foreign-dependent process, is affected by exchange rate increases.

As a result of this study, it seems that it is possible to examine the effects of the global and national dynamics and crises on different sectors, depending on the level of development of the countries. Considering that especially industry and service sectors are dominant in developed countries and the share of agriculture sector in employment has decreased to 1%, it is possible to say that the current course of Türkiye is similar. However, in a country rich in geographical conditions, climate diversity and usable agricultural areas, what kind of results will it have in the future to develop industrially rather than as an agricultural country? This issue is open to discussion. When evaluated in terms of effective use of resources, it would be appropriate to say that it is essential to give more importance to improvements in agriculture in the country.

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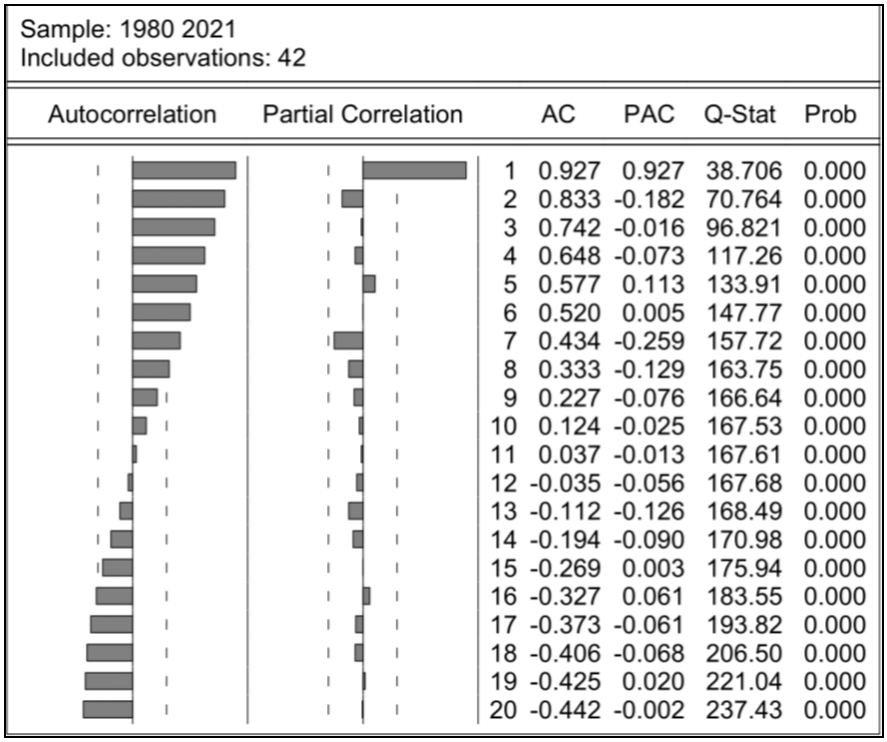
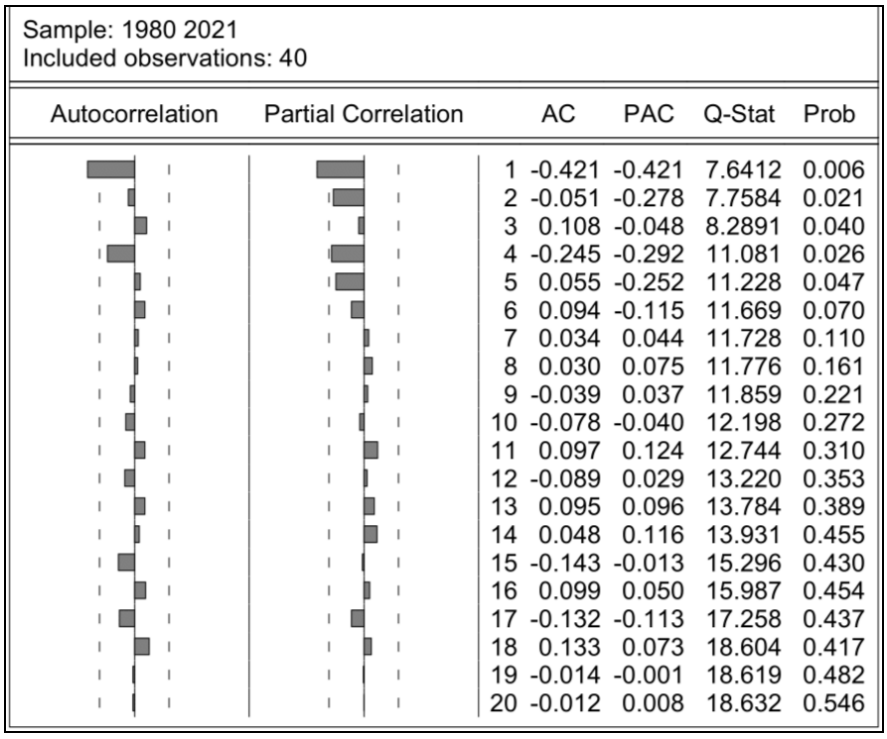
APPENDIX


Sample: 1980 2021
Included observations: 42

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.927	0.927	38.706	0.000
		2	0.833	-0.182	70.764	0.000
		3	0.742	-0.016	96.821	0.000
		4	0.648	-0.073	117.26	0.000
		5	0.577	0.113	133.91	0.000
		6	0.520	0.005	147.77	0.000
		7	0.434	-0.259	157.72	0.000
		8	0.333	-0.129	163.75	0.000
		9	0.227	-0.076	166.64	0.000
		10	0.124	-0.025	167.53	0.000
		11	0.037	-0.013	167.61	0.000
		12	-0.035	-0.056	167.68	0.000
		13	-0.112	-0.126	168.49	0.000
		14	-0.194	-0.090	170.98	0.000
		15	-0.269	0.003	175.94	0.000
		16	-0.327	0.061	183.55	0.000
		17	-0.373	-0.061	193.82	0.000
		18	-0.406	-0.068	206.50	0.000
		19	-0.425	0.020	221.04	0.000
		20	-0.442	-0.002	237.43	0.000

Figure A1. *Correlogram of sheep number series (base level)*


Sample: 1980 2021
Included observations: 40

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.421	-0.421	7.6412	0.006
		2	-0.051	-0.278	7.7584	0.021
		3	0.108	-0.048	8.2891	0.040
		4	-0.245	-0.292	11.081	0.026
		5	0.055	-0.252	11.228	0.047
		6	0.094	-0.115	11.669	0.070
		7	0.034	0.044	11.728	0.110
		8	0.030	0.075	11.776	0.161
		9	-0.039	0.037	11.859	0.221
		10	-0.078	-0.040	12.198	0.272
		11	0.097	0.124	12.744	0.310
		12	-0.089	0.029	13.220	0.353
		13	0.095	0.096	13.784	0.389
		14	0.048	0.116	13.931	0.455
		15	-0.143	-0.013	15.296	0.430
		16	0.099	0.050	15.987	0.454
		17	-0.132	-0.113	17.258	0.437
		18	0.133	0.073	18.604	0.417
		19	-0.014	-0.001	18.619	0.482
		20	-0.012	0.008	18.632	0.546

Figure A2. *Correlogram of sheep number series (2. difference)*

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Sample: 1980 2021
Included observations: 40
Q-statistic probabilities adjusted for 5 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.016	-0.016	0.0111	
		2	0.044	0.044	0.0961	
		3	0.133	0.135	0.8982	
		4	0.153	0.159	1.9945	
		5	-0.135	-0.143	2.8657	
		6	0.014	-0.027	2.8756	0.090
		7	0.190	0.172	4.7082	0.095
		8	-0.003	0.022	4.7085	0.194
		9	0.071	0.099	4.9832	0.289
		10	0.070	0.008	5.2550	0.386
		11	0.088	0.025	5.7007	0.458
		12	0.006	0.037	5.7032	0.575
		13	0.049	0.017	5.8550	0.663
		14	0.135	0.115	7.0354	0.633
		15	-0.057	-0.074	7.2558	0.701
		16	0.021	-0.023	7.2867	0.775
		17	-0.100	-0.152	8.0100	0.784
		18	0.031	-0.011	8.0814	0.838
		19	-0.150	-0.107	9.8878	0.770
		20	-0.119	-0.161	11.076	0.747

Figure A3. *Correlogram of Residuals ARIMA (4,2,1)*

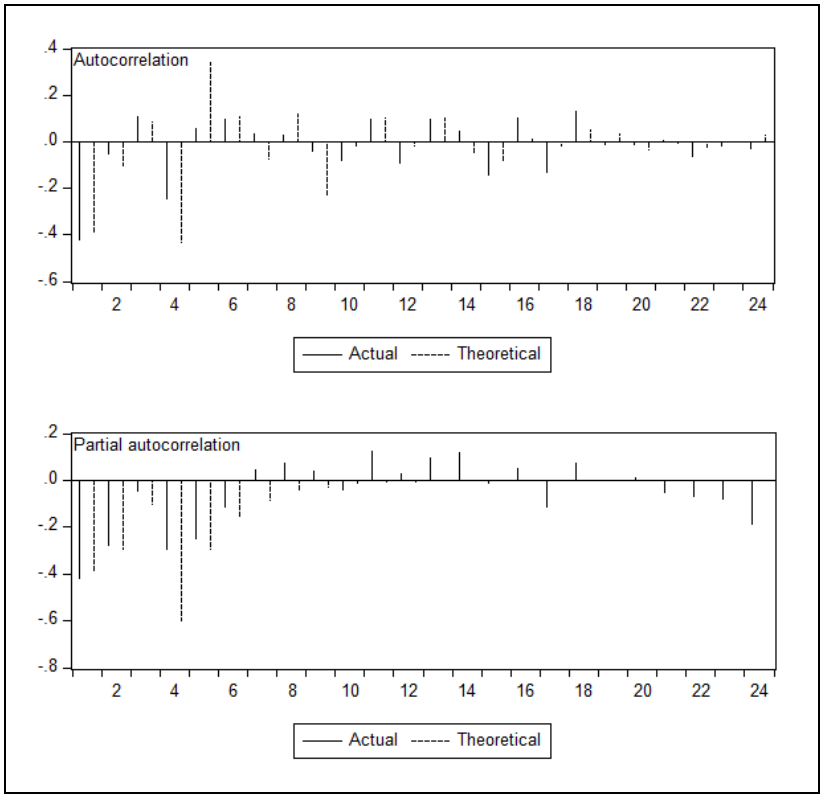

Figure A4. *Correlogram of ARIMA (4,2,1)*

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Model Selection Criteria Table
Dependent Variable: D(SHEEP, 2)
Sample: 1980 2021
Included observations: 40

Model	LogL	AIC*	BIC	HQ
(4,1)(0,0)	-634.813797	32.090690	32.386244	32.197553
(4,2)(0,0)	-633.902224	32.095111	32.432887	32.217240
(4,3)(0,0)	-633.839178	32.141959	32.521957	32.279354
(0,1)(0,0)	-639.866460	32.143323	32.269989	32.189121
(4,0)(0,0)	-637.307535	32.165377	32.418709	32.256974
(0,3)(0,0)	-638.597074	32.179854	32.390964	32.256184
(0,2)(0,0)	-639.734016	32.186701	32.355589	32.247765
(1,1)(0,0)	-639.751615	32.187581	32.356469	32.248645
(4,4)(0,0)	-633.827867	32.191393	32.613613	32.344055
(1,2)(0,0)	-639.168286	32.208414	32.419524	32.284745
(3,3)(0,0)	-636.548365	32.227418	32.565194	32.349547
(2,1)(0,0)	-639.668357	32.233418	32.444528	32.309749
(2,3)(0,0)	-638.101498	32.255075	32.550629	32.361938
(2,2)(0,0)	-639.124615	32.256231	32.509563	32.347828
(1,3)(0,0)	-639.129436	32.256472	32.509804	32.348069
(3,1)(0,0)	-639.510269	32.275513	32.528845	32.367110
(0,4)(0,0)	-639.724724	32.286236	32.539568	32.377833
(1,4)(0,0)	-638.861481	32.293074	32.588628	32.399937
(3,2)(0,0)	-639.117516	32.305876	32.601430	32.412739
(2,4)(0,0)	-638.241213	32.312061	32.649837	32.434190

Figure A5. *Model selection criteria table of the top 20 models*

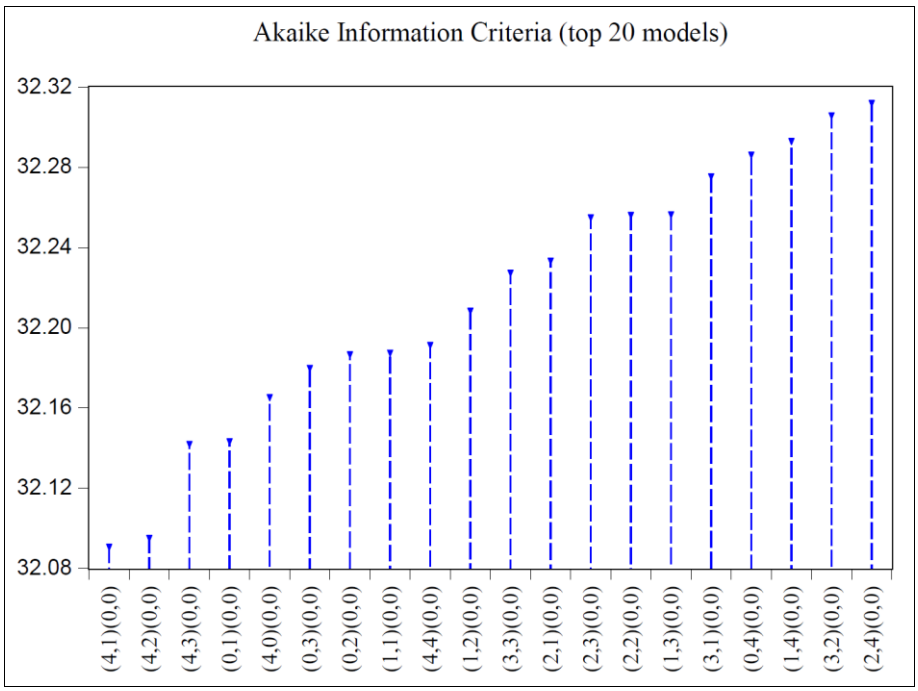

Figure A6. *AIC (Akaike Information Criteria) values of the top 20 models*

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Dependent Variable: D(SHEEP,2)
Method: ARMA Maximum Likelihood (BFGS)
Sample: 1982 2021
Included observations: 40
Convergence achieved after 11 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	87922.13	74376.47	1.182123	0.2456
AR(1)	-0.280615	0.191936	-1.462022	0.1532
AR(2)	-0.391526	0.301699	-1.297737	0.2034
AR(3)	-0.313639	0.248784	-1.260686	0.2163
AR(4)	-0.568664	0.186039	-3.056687	0.0044
MA(1)	-0.555901	0.286332	-1.941457	0.0608
SIGMASQ	3.32E+12	8.06E+11	4.119986	0.0002

R-squared	0.518497	Mean dependent var	11172.73
Adjusted R-squared	0.430951	S.D. dependent var	2659869.
S.E. of regression	2006481.	Akaike info criterion	32.09069
Sum squared resid	1.33E+14	Schwarz criterion	32.38624
Log likelihood	-634.8138	Hannan-Quinn criter.	32.19755
F-statistic	5.922564	Durbin-Watson stat	2.008245
Prob(F-statistic)	0.000280		

Inverted AR Roots	.46-.77i	.46+.77i	-.60-.59i	-.60+.59i
Inverted MA Roots	.56			

Figure A7. *Model results of ARIMA (4,2,1)*

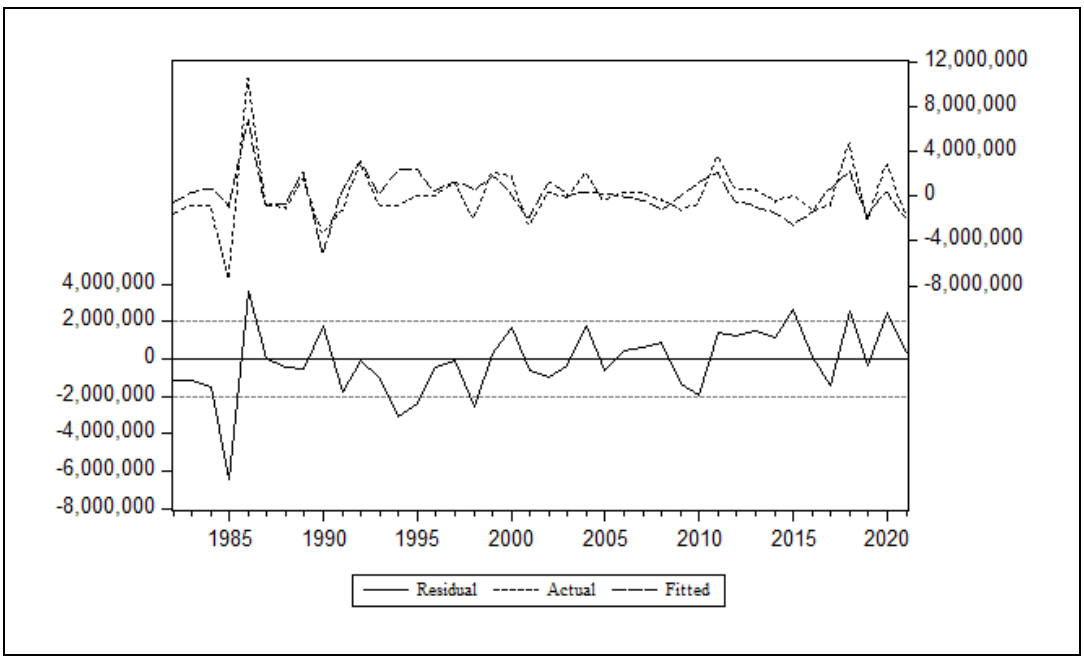

Figure A8. *Actual series, fitted series and residual series of the ARIMA (4,2,1) model*

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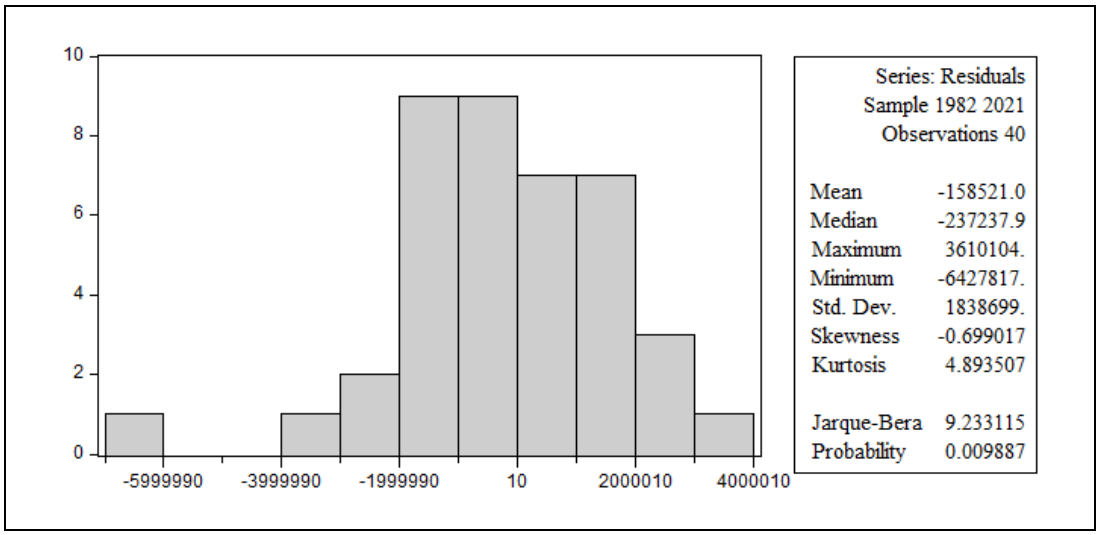

Figure A9. *Normality test for residuals of the ARIMA (4,2,1) model*

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