Chapter 2
An Approach to the Determinants of the Agricultural Output Dynamics in the USA

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1 Introduction

The USA, indeed, has a different reality across its whole economy and in its agricultural economics being different in several aspects to that of others countries, namely in the European Union and in the BRICS.

For example, in some European Union countries the extension services for agriculture were reduced or closed whereas for the USA, Schimmelpfennig et al. (2006) found that the extension as well the social science research and agricultural R&D have had a considerable impact on agricultural efficiency.

Nowadays, climate change in the USA and food security are the main concerns in policy design (Mukherjee et al. 2013). Water quality is another preoccupation for the USA, but, also, within the European Union. Water quality is affected by economic factors, a lack of good water management systems, agricultural practices, and urban expansion (Zia et al. 2013). Today, with precision agriculture it is possible to manage several variables, using advanced technologies. Maintaining a farm's economic viability while simultaneously preserving the environment, namely the water quality, is a challenge for the USA (Ghebremichael et al. 2013). The paradigm of agricultural practices changed from the twentieth to the twenty-first century; now society is interested in sustainable economic activities that do not damage health or quality of life (Bowman and Zilberman 2013). The interactions between agriculture and the forest can help in the explanations of some environmental problems, namely those related with the greenhouse gas effects in the USA (Latta et al. 2013). The impact of agriculture on air quality is, also, a concern in the USA, for policy makers (Zhang and Wu 2013).

The academy can aid in adjustments to the changes in society. In this way, academics from several areas were mobilized in the 1930s by the Agricultural

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Department in the USA to help in the economic, social, and cultural changes of rural areas (Jewett 2013).

Sometimes, the policies designed for agriculture can have indirect effects within the sector and within society. For example, the agricultural policies in the USA have influenced caloric ingestion, but that effect has decreased over the last few years (Rickard et al. 2013). Another example is the fact that subsidies for agricultural production and export, in the USA and in the European Union, create some distortions in the international trade of agricultural products (Bruno et al. 2012).

Taking into account the influence of the US economy on the emergent world, it seems important to present this original study in order to raise understanding about the USA's agricultural dynamics and about the interrelationship between agricultural output and other sustainable, social and economic variables. For that, the World Bank database (2014) was considered and we used time series econometric instruments, through the Stata (2014) software and taking into account as a base model the Cobb and Douglas (1928) function of production.

2 Data Description

The percentage of land for agriculture in the USA decreased continuously from 49 % in 1961 to about 45 % (Fig. 2.1). This is a phenomena verified in many developed countries where the agricultural sector reduced the percentage of area, due to the increase of the weight of other sectors and because of improvements made to the efficiency of the sector.

On the other hand, the area used for forest increased its weight slightly in the last two decades, from about 32 % in 1990 to around 33 % in 2011 (Fig. 2.2).

Figure 2.3 confirms what was referred to previously in Fig. 2.1. Indeed, the agricultural productivity, at 2005 constant prices, increased from about US$10,000 in 1980 to US$60,000 per worker in 2009 and 2010. This is a significant improvement in the performance in the dynamics of the USA's agricultural economics.

The fossil fuel energy consumption weighed against the total of energy consumed (Fig. 2.4) decreased by about 12 % from 1961 to 2012, from around 96 % to 84 %.

The CO_2 emissions increased slightly in the 1970s and decreased slightly towards the end of the last decade (Fig. 2.5), but, in general, more or less about 20 metric tons per capita.

The percentage of methane emissions (Fig. 2.6) and nitrous oxide emissions (Fig. 2.7) from agriculture increased by about 10 % in both cases, from 1990 to 2010. This again, seems to be in unison with the reduction in land for agriculture and with the rise in agricultural productivity at constant prices.

The rise in the percentage of population in urban clusters, from 1961 to 2012, was of about 10 %, from 40 % to 50 % (Fig. 2.8). The increase in population in large urban centers can help the economic dynamics in some cases, through the number of producers (New Economic Geography) and improvements to the scales of firms (Keynesian theory), but can also be the origin of problems such as urban congestion and regional asymmetries. So, this is a question that requires more careful analysis.

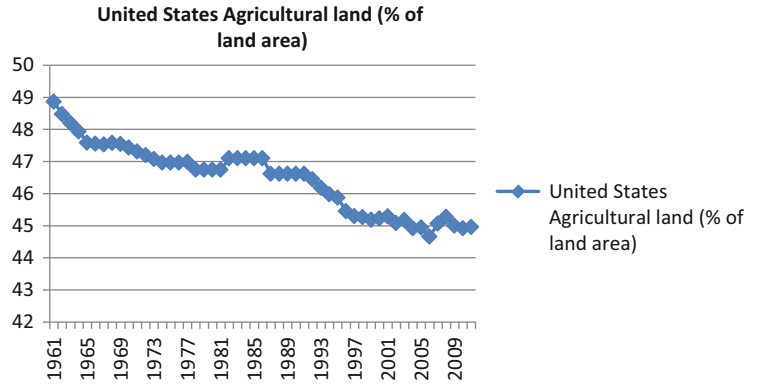

Fig. 2.1 Agricultural land (% of land area) in the USA

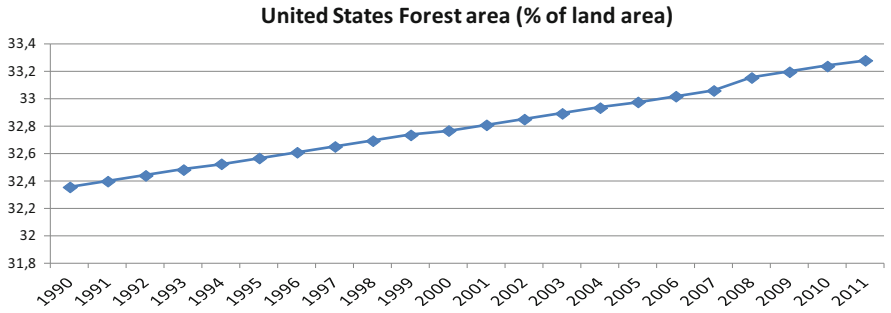

Fig. 2.2 Forest area (% of land area) in the USA

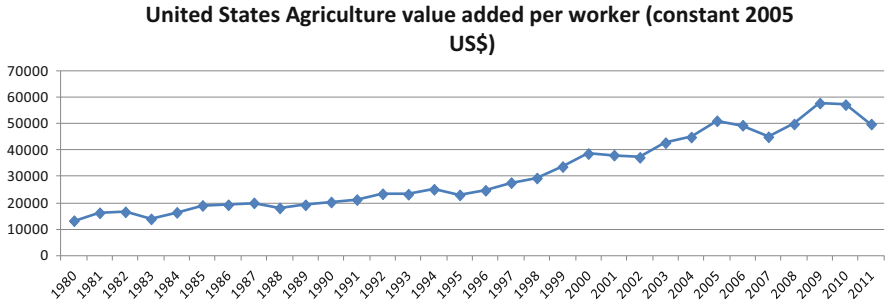

Fig. 2.3 Agriculture value added per worker (constant 2005 US$) in the USA

Again, the percentage of annual freshwater withdrawals for agriculture, which increased about 20 % in the period 1982–2011, seems to confirm the rise in intensity of USA agriculture over the last decades (Fig. 2.9).

Inflation (Fig. 2.10) presented some problems in the 1970s and 1980s, but over the last few years had values of around 2 and 4 %. The lending interest rates

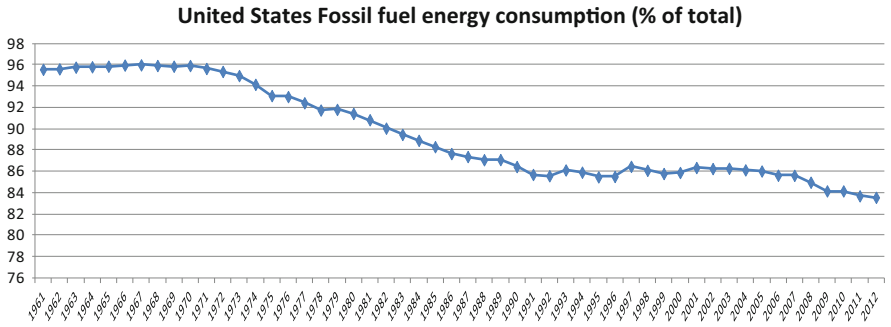

Fig. 2.4 Fossil fuel energy consumption (% of total) in the USA

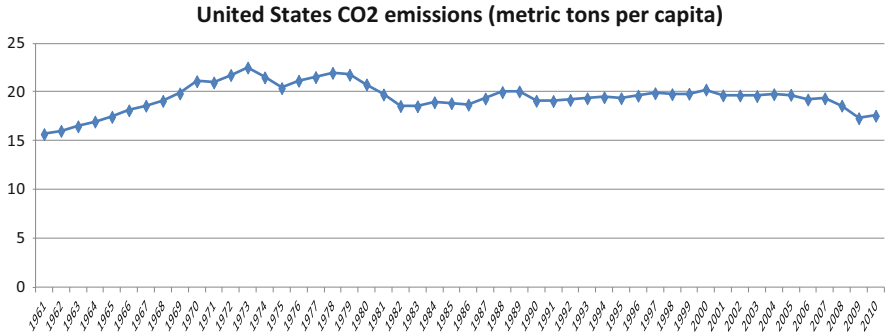

Fig. 2.5 CO_2 emissions (metric tons per capita) in the USA

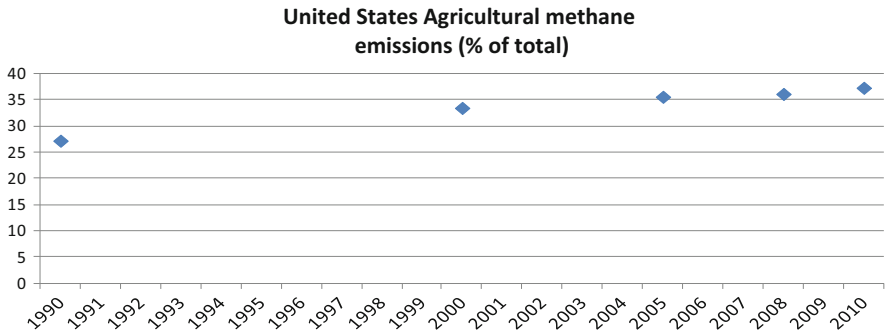

Fig. 2.6 Agricultural methane emissions (% of total) in the USA

(Fig. 2.11) return in 2009, 2010, 2011, and 2012 to the values of the beginning of the 1960s at about 4 %.

The central government debt in percentage of the GDP increased drastically from about 30 % in 2001 to 80 % in 2011 (Fig. 2.12). In reality, the financial crisis

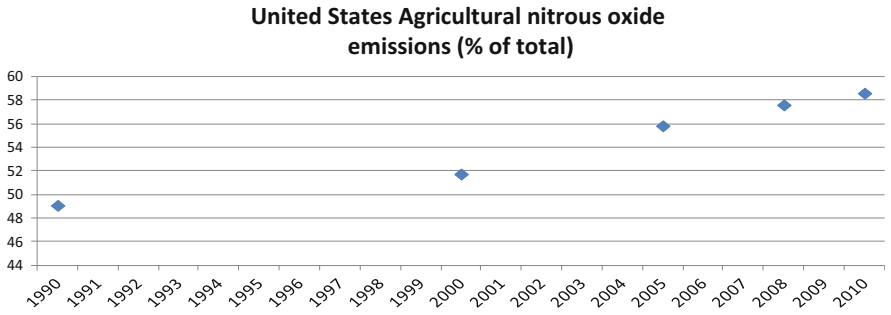

Fig. 2.7 Agricultural nitrous oxide emissions (% of total) in the USA

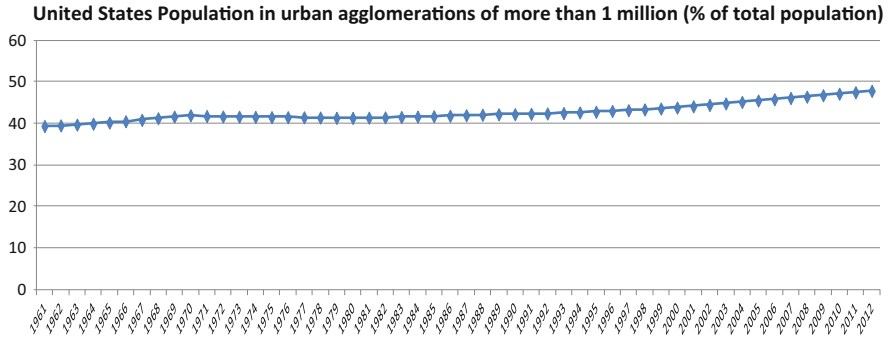

Fig. 2.8 Population in urban agglomerations of more than one million (% of total population) in the USA

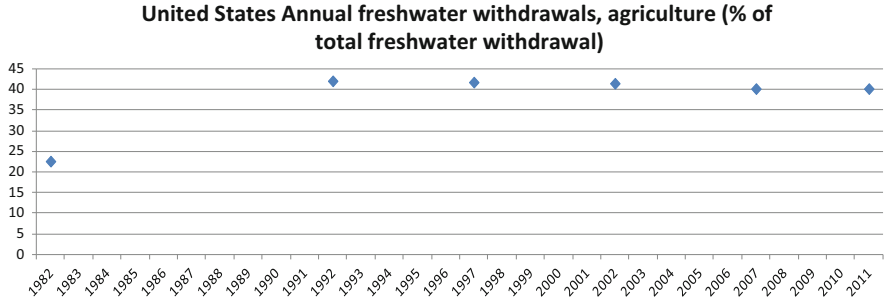

Fig. 2.9 Annual freshwater withdrawals, agriculture (% of total freshwater withdrawal) in the USA

of 2008 in the USA leaves its mark in many economic and social indicators and in many countries, not only in the USA.

Curiously, or not, the number of motor vehicles per 1,000 persons diminished from 2008, from about 820 in 2007 to about 800 in 2010 (Fig. 2.13).

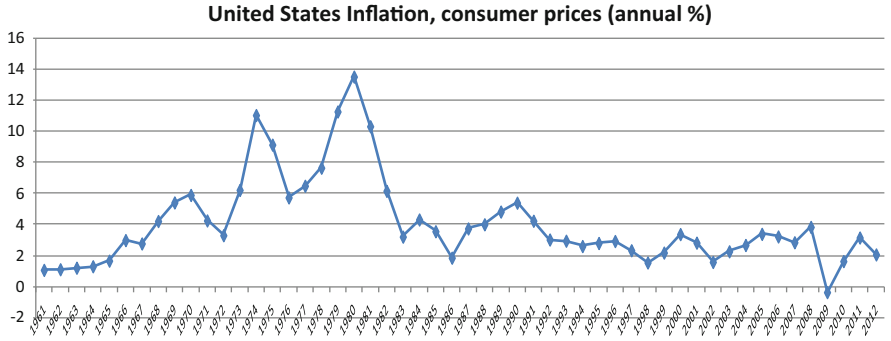

Fig. 2.10 Inflation, consumer prices (annual %) in the USA

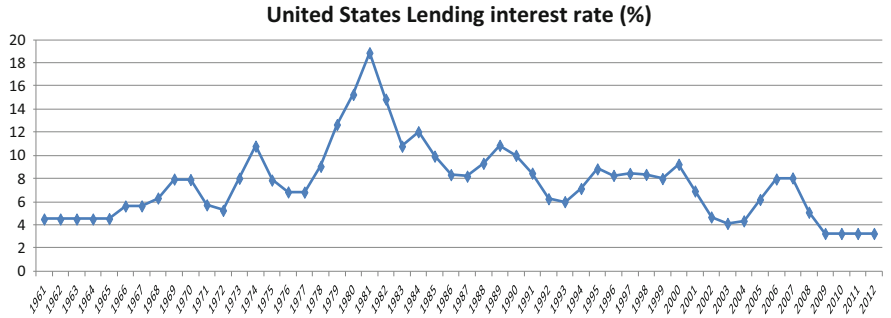

Fig. 2.11 Lending interest rate (%) in the USA

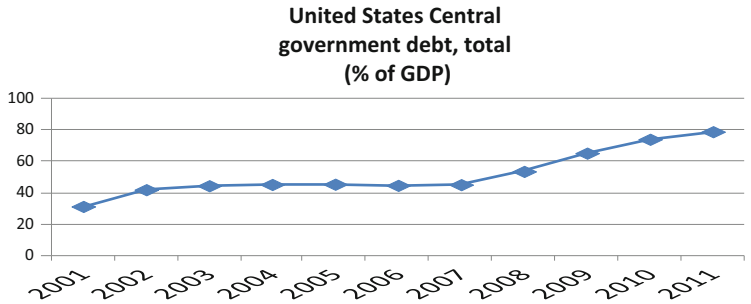

Fig. 2.12 Central government debt, total (% of GDP) in the USA

The percentage of exports relative to the GDP increased significantly, in the period 1961–2012, from around 5 % in 1961 to about 14 % in 2012 (Fig. 2.14). This shows great economic dynamics and great perspectives for the future, considering that the external demand is one the most important engines for the economy (Keynesian theory).

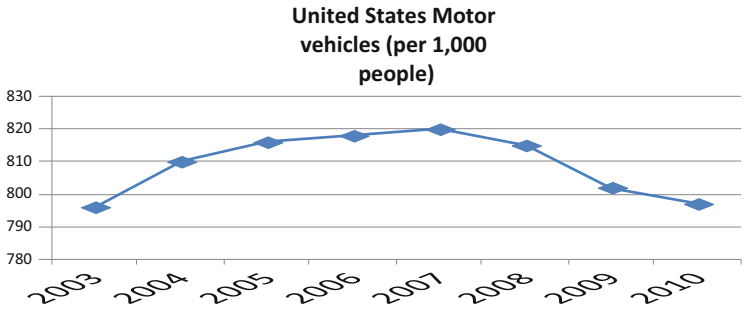

Fig. 2.13 Motor vehicles (per 1,000 people) in the USA

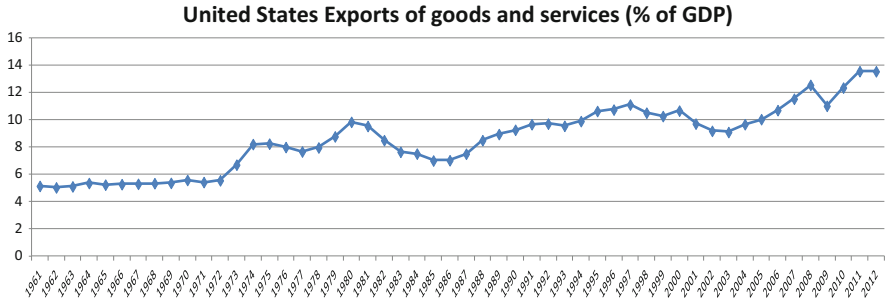

Fig. 2.14 Exports of goods and services (% of GDP) in the USA

The investment in percentage of the GDP has been more or less situated in the interval of around 20–25 % since the 1960s until 2012 (Fig. 2.15). The financial crisis of 2008 also had an influence on the performance for investment in percentage of the GDP.

The weight of the value added from agriculture to the GDP diminished from about 3.5 % in the 1970s to around 1 % in 2011 (Fig. 2.16). This loss of weight in the contribution of agriculture to the GDP was common in many developed countries, because of improvements in the dynamics of other sectors.

The evolution of industry's contribution to the GDP follows, more or less, the pattern for agriculture and decreased its percentage from about 35 to 20 % (Fig. 2.17).

On the other hand, the weight of services rose considerably from more or less 60 to 80 % (Fig. 2.18), in the period considered (1970–2011). This is a phenomenon which has also been verified in several developed countries.

The evolution of the GDP growth rates, from 1961 to 2012, was extremely volatile, but in 2010, 2011, and 2012 was situated in values around the 2 % mark, which is a good sign of recuperation from the financial crisis verified in 2008 (Fig. 2.19).

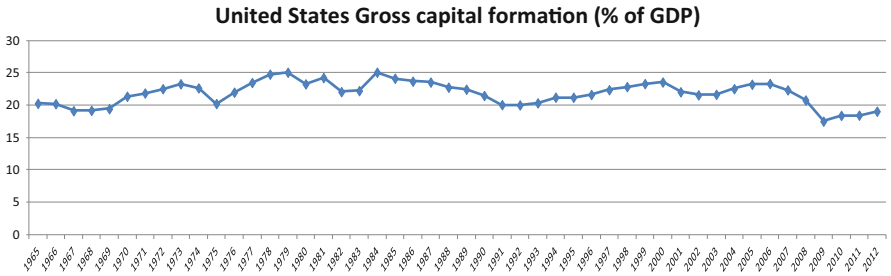

Fig. 2.15 Gross capital formation (% of GDP) in the USA

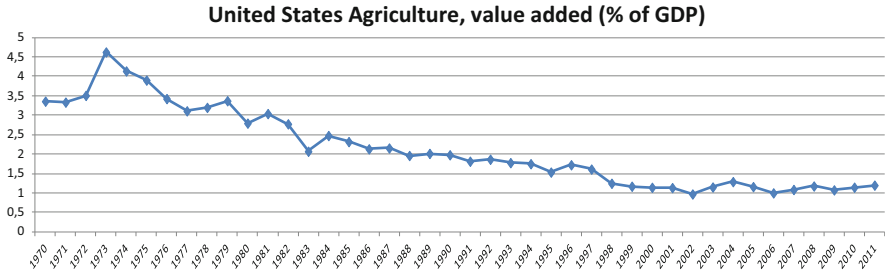

Fig. 2.16 Agriculture, value added (% of GDP) in the USA

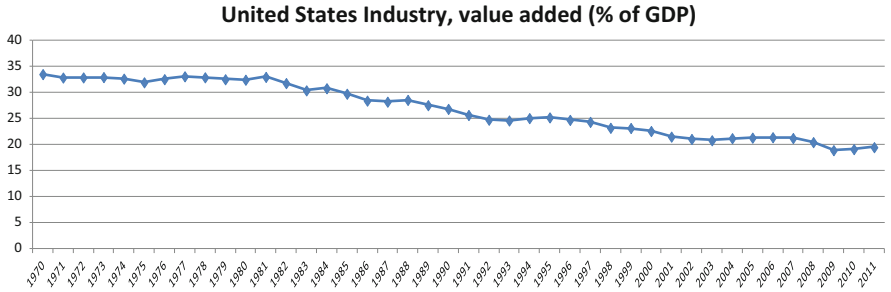

Fig. 2.17 Industry, value added (% of GDP) in the USA

The GDP per capita, at current prices, rose continuously in the last five decades (Fig. 2.20). These values need other approaches, because of the effects of inflation upon this evolution.

The weight of employment in agriculture decreased significantly in the last three decades, from about 3.5 % in 1980 to 1.5 % in 2010 (Fig. 2.21). This is in concordance with other previous analysis for others variables.

The unemployment rates changed after the financial crisis of 2008 from about 4–6 % in the previous decade to about 8–10 % (Fig. 2.22).

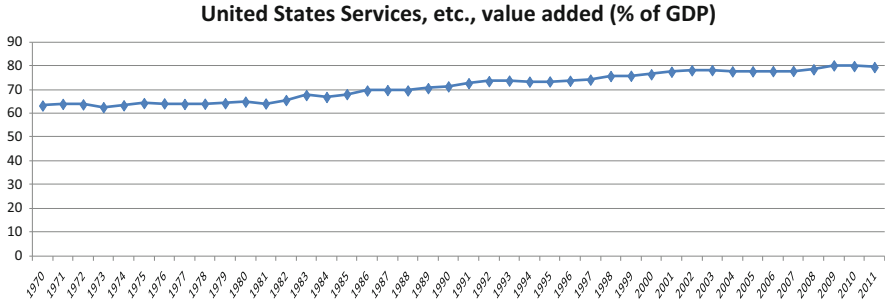

Fig. 2.18 Services, etc., value added (% of GDP) in the USA

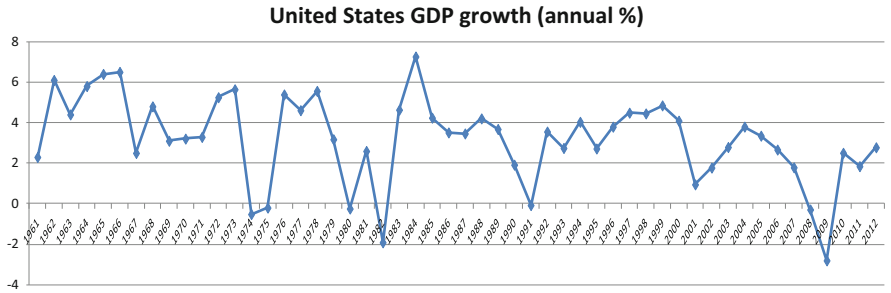

Fig. 2.19 GDP growth (annual %) in the USA

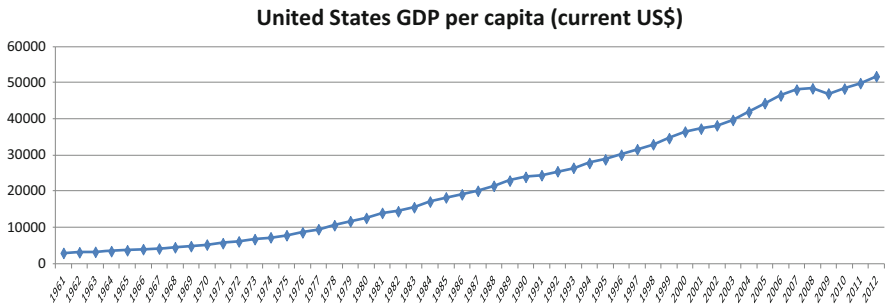

Fig. 2.20 GDP per capita (current US$) in the USA

The rural population changed from 30 % in 1961 to about 15 % in 2012. This is an expected evolution, considering the reduction of employment in agriculture and the increase in the weight of services (Fig. 2.23).

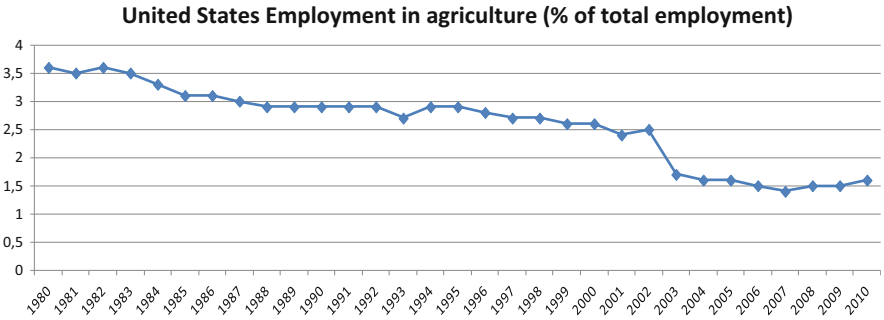

Fig. 2.21 Employment in agriculture (% of total employment) in the USA

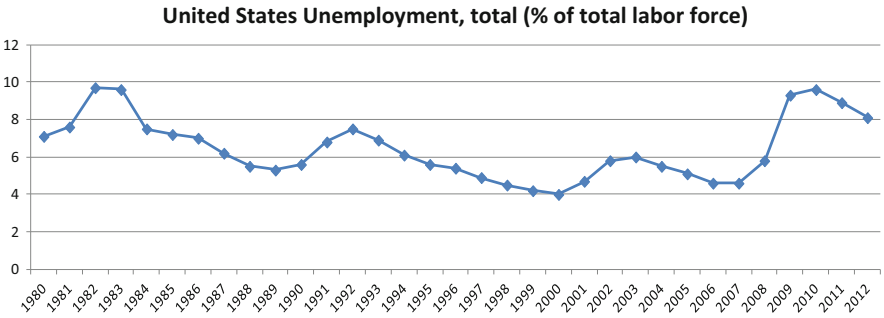

Fig. 2.22 Unemployment, total (% of total labor force) in the USA

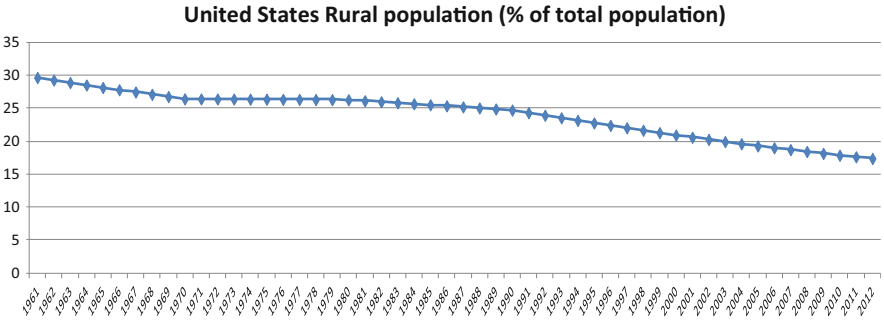

Fig. 2.23 Rural population (% of total population) in the USA

3 Results

The results presented in Table 2.1, about the correlation among the variables considered, namely those with a sufficient number of observations to run a statistically acceptable analysis, show that there are negative and strong correlations between the dependent variable (the agricultural output represented by the

Table 2.1 Correlate matrix between the variables considered, from 1961 to 2012

	Agriculture, value added (% of GDP)	Agriculture value added per worker (constant 2005 US$)	Employment in agriculture (% of total employment)	Inflation, consumer prices (annual %)	Agricultural land (% of land area)	Fossil fuel energy consumption (% of total)	CO_2 emissions (metric tons per capita)	Population in urban agglomerations of more than one million (% of total population)	Lending interest rate (%)	Exports of goods and services (% of GDP)	Gross capital formation (% of GDP)	GDP growth (annual %)	GDP per capita (current US$)	Rural population (% of total population)
Agriculture, value added (% of GDP)	1.000													
Agriculture value added per worker (constant 2005 US$)	−0.913	1.000												
Employment in agriculture (% of total employment)	0.771	−0.905	1.000											
Inflation, consumer prices (annual %)	0.636	−0.504	0.342	1.000										
Agricultural land (% of land area	0.920	−0.933	0.796	0.509	1.000									
Fossil fuel energy consumption (% of total)	0.742	−0.725	0.600	0.618	0.725	1.000								
CO_2 emissions (metric tons per capita)	−0.141	0.039	0.062	0.214	−0.232	0.005	1.000							
Population in urban agglomerations of more than 1 million (% of total population)	−0.877	0.967	−0.945	−0.484	−0.893	−0.693	−0.102	1.000						
Lending interest rate (%)	0.667	−0.720	0.653	0.715	0.613	0.713	0.243	−0.708	1.000					

(continued)

Table 2.1 (continued)

	Agriculture, value added (% of GDP)	Agriculture value added per worker (constant 2005 US$)	Employment in agriculture (% of total employment)	Inflation, consumer prices (annual %)	Agricultural land (% of land area)	Fossil fuel energy consumption (% of total)	CO_2 emissions (metric tons per capita)	Population in urban agglomerations of more than one million (% of total population)	Lending interest rate (%)	Exports of goods and services (% of GDP)	Gross capital formation (% of GDP)	GDP growth (annual %)	GDP per capita (current US$)	Rural population (% of total population)
Exports of goods and services (% of GDP)	−0.633	0.673	−0.550	−0.251	−0.792	−0.700	0.154	0.679	−0.340	1.000				
Gross capital formation (% of GDP)	0.289	−0.297	0.245	0.399	0.275	0.632	0.391	−0.356	0.646	−0.500	1.000			
GDP growth (annual %)	0.397	−0.391	0.355	0.033	0.330	0.264	0.042	−0.402	0.275	−0.299	0.366	1.000		
GDP per capita (current US$)	−0.945	0.964	−0.869	−0.566	−0.952	−0.839	0.113	0.939	−0.718	0.745	−0.383	−0.389	1.000	
Rural population (% of total population)	0.928	−0.982	0.907	0.537	0.949	0.728	−0.000	−0.984	0.707	−0.726	0.345	0.394	−0.970	1.000

Table 2.2 Results obtained with time series econometric techniques, based on the function of production model (linear model obtained with logarithms), for agricultural output in the period 1961–2012

Model	Prais–Winsten
Constant	9.626* (5.570) [0.000]
Agriculture value added per worker (constant 2005 US$)	−0.870* (−5.770) [0.000]
Employment in agriculture (% of total employment)	
Augmented Dickey–Fuller test for unit root	−6.311* [0.000]
EG-ADF test for co-integration	−1.809 [0.376]
Portmanteau test for white noise for autocorrelation	224.764* [0.000]
Durbin's alternative test for autocorrelation	0.342 [0.558]
Breusch–Godfrey LM test for autocorrelation	0.388 [0.533]
Breusch–Pagan/Cook–Weisberg test for heteroskedasticity	0.710 [0.398]
Ramsey RESET test using powers of the fitted values	3.720* [0.024]
LM test for autoregressive conditional heteroskedasticity (ARCH)	1.362 [0.243]

Note: *Statistically significant at 5 %

agricultural value added in percentage of the GDP), farming productivity (Agriculture value added per worker at constant 2005 prices), the population in urban agglomeration, and the GDP per capita. On the other hand, there is a strong, positive relationship between the dependent variable and, namely, the agricultural land percentage and the weight of the rural population.

The results obtained in Table 2.2 with the econometric time series estimations show that there is, indeed, a negative and strong, statistically significant, relationship between agricultural output and farming productivity. Considering the form as the values of the variables presented (the output in the percentage relative to others sectors) and the productivity in absolute values, these results only mean that the improvements in productivity were not enough to reduce the decrease in the weight of the agricultural GDP in the whole US economy. The results for the several tests considered to evaluate the autocorrelation, the co-integration of the variables, and the heteroskedasticity confirm the absence of these statistic infractions. The Ramsey RESET test, using powers of the fitted values, shows a lack of variables and because of this finding the model was again estimated with other variables,

Table 2.3 Results obtained with time series econometric techniques, considering the function of production model extended with others variables (linear model obtained with logarithms), for the agricultural output in the period 1961–2012

Model	Prais–Winsten
Constant	6.425* (3.390) [0.002]
Agriculture value added per worker (constant 2005 US$)	−0.598* (−3.650) [0.001]
Employment in agriculture (% of total employment)	
Inflation, consumer prices (annual %)	0.172* (2.870) [0.008]
Breusch–Pagan/Cook–Weisberg test for heteroskedasticity	0.010 [0.909]
Ramsey RESET test using powers of the fitted values	3.240* [0.040]
LM test for autoregressive conditional heteroskedasticity (ARCH)	0.732 [0.392]

Note: *Statistically significant at 5 %

extending the original model base in the well-known Cobb–Douglas function of production.

Table 2.3 reveals that from all the additional independent variables, despite agricultural employment and productivity, only the inflation of consumer price rates improve the model and show a positive influence towards agricultural output, with a coefficient statistically significant of 0.172. This shows the interrelationship between all the economies of the USA. All the results of the statistical tests reveal that there are no problems with the autocorrelation and with the heteroskedasticity, but the Ramsey RESET test, using powers of the fitted values, maintains evidence of a lack in independent variables, which may be an interesting finding for future research.

Finally, referring that all the results presented in the three tables are in agreement with each other and with the data description made in the previous section.

Conclusions

The preoccupation with climate changes, the environment, sustainability, water management, the consequences of agricultural policies in society, the changes in social patterns, and the design of adjusted agricultural policies are the order of the day in many countries, namely in developed countries, when we speak about the agricultural economics in the context of globalized

(continued)

economies, where the pressures of the rules from the negotiations of the World Trade Organization are a reality.

From the data description it was possible to conclude that in agriculture, despite the increase in productivity, this was not sufficient to avoid the reduction in the weight of the farming output in the economy. On the other hand, as expected, the percentage of agricultural employment in farming diminished. This is a tendency verified by many developed countries, namely in North America and in West Europe. The reduction in fossil fuel energy consumption reveals concerns with the environment and sustainability. There are, however, some environmental problems in agriculture, because the levels of methane and nitrous oxide are emitted by this sector. The percentage augmentation of population in urban agglomerations and the reduction of the rural population need microanalysis, because this can be good for economic dynamics and/or bad for regional asymmetries, for example. The performance of exports seems to confirm these apparently good economic dynamics. However, the financial crisis of 2008 had consequences in many economic indicators such as the central government debt in percentage of the GDP, the investment in percentage of the GDP, and the GDP growth rates.

The econometric results reveal that there are negative and strong correlations between the percentage of agricultural output, the agricultural productivity, the population in large urban centers, and the gross domestic product per capita. On the other hand, there is a positive a strong relationship between the level of agricultural output and the percentage of agricultural land and rural population. The results obtained from the estimations confirm these findings and show that despite agricultural productivity, in the USA, the inflation of consumer price rates, also, influences the percentage of the agricultural output. All statistic tests reveal an absence of problems with the autocorrelation, the co-integration of the variables, and the heteroskedasticity. The Ramsey RESET test, using powers of the fitted values, shows a lack of variables in all models. This may be an interesting finding to develop in future research related with these issues.

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