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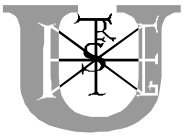

Summary of PhD dissertation

# Structural change and the factors and effects of economic growth in the agricultural sector in Hungary

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# 1. Introduction

The 20th century witnessed spectacular and significant changes in world economy. The structural and employment makeup of former times transformed rapidly, and agriculture lost its leading role. Structural change was the result of the differences in the pace of development across the sectors of economy. Research in growth theory became focused on the differing patterns of development, changes across countries and its reasons, seeking for answers to the emerging problems of the modern era, and outlining possible paths of development for the future.
Economic growth is the top economic and political priority of world leaders. Countries with significant rate of development are higher ranked and serve as models for the developing countries and for the economies in transition.

Researching growth models is one of the oldest disciplines within economics, so there is abundant background literature on the topics of analysing the factors of development and growth models. In the light of this, it is surprising that the number of growth models focusing on the individual sectors themselves is relatively low both in the home and international literature, although the complexity of economic processes would call for the analysis of the sub-areas of the economy as well.

Owing to the natural circumstances, agriculture has always played a significant role in the economic growth of Hungary. Despite the recent decline, the importance of the sector cannot be overlooked or downplayed. The special characteristics of the topic mean that using former models which build on the predominance of agriculture and characterise economy in its entirety could possibly be used for an independent study of growth in present-day agriculture, after changing and refining the sets of preconditions.

The aim of my research is therefore to set up a growth model of agriculture in Hungary for the period after the political changes in 1989, to identify the major factors influencing growth, to calculate their relative weight in the changes, and to characterise in depth their role over time. Factors not fully utilised so far will be identified and introduced after searching for further growth potential. By analysing the period 2000-2003 separately, detailed calculations will be made to estimate the negative economic impact of the failure to utilise SAPARD funds from the EU budget effectively and on time. Finally, the substitutability of the factors influencing growth will be discussed, and thus the most favourable construct of factors outlined. Suggestions will be made for more effective handling of factors promoting further growth.

The relevant national and international literature on growth models was reviewed in depth for the purposes of the study. Statistical data were collected from yearbooks published in Hungary and abroad. The statistical programmes SPSS and EView were used for the statistical analyses in model evaluation.

## 2. Topic and methods

The first part of the description of the topic focuses on models of economic growth from the 18th century, both national and international. After introducing the concept and factors of growth, the models will not be reviewed in the usual thematic breakdown, but along a timeline, subdivided into six periods.

The second part of the literature review outlines the structural changes in the more developed western countries and in the economies in transition in Eastern Europe. Common features and significant differences are pinpointed. Besides the general overview, specific calculations and analyses were conducted about employment and rates of growth starting from 1950. In the case of Hungary, this timeline was extended, and spans the entire 20th century as well as the first three years of the new millennium. This chapter is miscellaneous in character, so it had to precede the proper literature review.

Economic growth is an extremely complex phenomenon; it poses considerable difficulties for modelling. The literature identifies four main problems about generating models: (1) selecting the period of reference; (2) defining the factors in the formula; (3) creating the relevant database; (4) adjusting the set of preconditions and the graph formula.

(1) When choosing the suitable timeframe for developing my model, it had to be considered that the circumstances affecting agriculture in Hungary were quite different in the years before the political changes. Furthermore, the categories used in the relevant statistics before the year 1990 were not identical with the present-day ones or with internationally used categories. In addition, the most recent models and timeline studies developed by OECD also start with the year 1990. Therefore, it was absolutely evident that the present research is based on the period 1991-2003, which is extended enough to draw well-founded conclusions for the present and future.

(2) As for the problem of selecting and defining the factors to be taken into consideration, the main issue is that economic growth is influenced simultaneously by a very large number of factors; therefore, integrating all of them within the scope of a single study is virtually hopeless. After studying the relevant literature on analysing the impact of factors in growth models, the main production factors for agriculture were selected as the following: proportion of employees (workforce), investments, subsidies, land, productivity, and export-import balance (export surplus).

(3) For compiling the database, only the relevant figures in the agricultural sector were taken into consideration, using data from the Agricultural Statistical Yearbooks and the databases of the Central Statistical Office (KSH) and the Tax and Revenues Office (APEH). Thus, the data are from reliable and uniform sources, and use the same frame of reference throughout.

(4) The developed model has a dual character: first of all, it aims to dissolve the ambiguities of the present-day relevance of Solow's 1957 model. An endogeneous growth model was set up based on the current economic situation and set of conditions: it is a development from previous neo-classical models, with the addition of further variables and factors, and with a non-empirical approach.

The statistical programmes SPSS and EView were used in order to analyse the relationships between the factors and for quantifying their weight in the model. In the first step, correlations were calculated to survey the network of relationships between the factors. Subsequently, several methods of regression were used (with differing number of factors and relationships) to map the exact shape and strength of the relationships. The best formula and the values of the corresponding coefficients were chosen based on comparing the data in the matching graphs (correlational coefficient, significance, standard error (overall and for the factors), t-test values, and ease of handling). The Cobb-Douglas procedure was used to survey substitutability over the period, by calculating the logarithm of the factors. In the absence of stable substitutability across factors, the rate can nevertheless be calculated annually. A statistical analysis was conducted based on marginal theory, in which one factor was manipulated at a time, while leaving all the others constant. The resulting sets of data about changed growth in GDP can be converted into a regression line, and the comparative gradients of the two lines correspond to the substitutability of the given factors. This value can be converted into nominal data in the national currency (forints). Using the principles of the theory of marginal utility, potential of additional growth can be calculated by adding further variables or extra values for the previous variables. Thus the years with hidden potential for growth can be identified.

Due to the complex nature of the analyses conducted, the results and the conclusions are difficult to separate. Therefore, the chapters are divided up as follows. The *Results* section discusses growth in the agricultural sector, the factors having an impact, the steps of model construction and the evaluation of versions of the model. The *Analysis and conclusions* section focuses on the growth formula of the agricultural sector, the analysis of the factors, the related analysis of potential for growth, and the quantification of substitutability.
As my statements that can be considered scientific achievements are found throughout these two chapters, following the description of the analysis in question, the *Conclusion* only contains their overall summary and suggestions for the future so as to avoid repetition.

# 3. Literature review

## 3.1. Economic growth

The topic of my dissertation was investigating of economic growth, searching for factors influencing and triggering growth, and analysing their interrelationship. In order to achieve this, the extensive literature on economic growth was reviewed. Certain ideas seem to be recurring over the history of the theories.

Growth theories investigating the factors of growth only took off as an independent field of research after the second world war, but growth theories existed even beforehand. Up to the present, they have had several transitory phases of development, scores of models have been set up to quantify growth and its components, but it is by no means a finalised or unambiguous theory yet.

The development of growth models was summarised chronologically.

During the different periods, the researchers intended to find answers to the issues of the given era, and the definitions of the factors and their relationships to each other were constantly changing. Within early growth theories, mercantilists considered state intervention to be the trigger for growth, whereas physiocrats believed capital accumulation to be the key element.

Economists in the classical era, when agriculture was still the dominant sector of the economy, thought that the law of diminishing return was the most important. The group related to Keynesian growth theories investigated the question of achieving economic equilibrium, where intervention was in the form of manipulating the demand by the state. The set of factors having an impact on economic growth also attracted mathematicians' attention. According to the basic laws of the neoclassical school, change in output can be attributed to change in certain input elements: their effects can be separated from each other. In the 1950s and 1960s, growth theories took two different paths of development. The new trend growth models of the 1980s were named endogeneous growth models. One branch focuses on the problems of the developing countries (including the role of the workforce), the other one takes an empirical approach and researches developed countries. The most recent maturity models can be considered a completely new line of research, having the potential to establish an independent line in growth models.

In the subsequent section of my dissertation, the factors of growth were listed and introduced, with the provision that besides the main factors of growth, there is a list of additional factors, perhaps an infinite number of them, though most of them exert influence well below significant.

## 3.2. Structural changes

In the second part of the literature review, the structural changes in economies were traced, and differences and similarities between groups of countries were established. Contrasting the developed (mainly Western European) countries and the Eastern European economies in transition, the reasons for lagging behind were outlined. For surveying structural changes, the economy was subdivided into the three sectors of industry, agriculture and tertiary sector. As a disclaimer, it must be mentioned that these summative data cannot distinguish properly between the service sector and the processing sector, nevertheless, the main trends in changes can be analysed.

Generally speaking, the initial dominance of agriculture was taken over by the industrial sector gradually; subsequently, at the end of the 20th century, developed countries started their transformation into post-industrial countries. The GDP share of the service sector has become the cornerstone of growth, considering both output and the number of jobs.

In the developed countries, the 25 years after the second world war witnessed the spread of the industrial sector (and to certain extent that of the service sector as well), which absorbed much of the capital resources and workforce previously engaged in the agricultural sector. In the 1970s, the industrial sector began to decline gradually, but only after its share in production and employment had achieved or even surpassed 50%.

The same changes took place in Eastern Europe only approximately 20 years later, but the transition took a different path (Figures 1-2). Industry and agriculture both reached a moderately developed level by the 1990s. The share of the industrial sector remained under 40%, and was not capable of supplying the agricultural sector with the necessary means for production. These characteristics slowed down the development of the economies in transition. In general, moderately developed countries can achieve higher rates of development owing to their situation as they are approaching the developed countries. However, the smaller the eventual gap between the two groups, the slower the further rate of development: such is the case of the economies in transition, which made a jump start after the political changes but have slowed down recently.

As for the situation at the turn of the millennium, the growth in the industrial sector is marginally higher in Eastern Europe than in the developed countries, which is a sign of catching up. However, the same does not hold true about agriculture: the gap is not being closed, on the contrary, the slower rate of growth marks continued lagging behind (Figures 3-4.)

In the Eastern European countries, the share and weight of the agricultural sector is not expected to change spectacularly, instead, it will stabilise at a relatively low level. This pattern follows the path taken previously by the Western European countries. The importance of food safety and hygiene, environmental considerations, packing and packaging, and storing require more up-to-date technology (electronics, biotechnology, pharmaceutical industry) to be indispensable on a day-to-day basis. As a consequence, the number of jobs in the industrial sector is expected to rise at the expense of the service sector, in other words, a flowback of resources is expected in the near future between the two sectors (Figures 5-6).

## 4. Survey of growth in the agricultural sector

### 4.1. Factors of growth in the agricultural sector

In this section, the factors having an impact on the agricultural sector in Hungary are outlined and evaluated for the period after the political changes in 1990. As

only growth was in the focus of the study, the state of agriculture and the problems of the sector were not discussed.

The changes in GDP were compared in the EU-15 and in Hungary: the previous conclusion about the economy as a whole catching up but agriculture lagging behind was confirmed (Figure 7). Among the factors, workforce decreased drastically at the beginning of the period, then continued to drop slightly, but productivity increased spectacularly to make up for some of the fall. As for capital input, investments (own funds and investment subsidies) and non-investment subsidies were considered as two separate categories due to the different mechanism of their impact.

Investments decreased at the beginning of the 1990s, but returned to a path of moderate growth in the second half. Overall, an increasing share is funded from investment subsidies. Subsidies are, however, not on the increase every year at current value, and have not reached the sums spent on the same purpose in 1990 at relative value.

As for land area, the fall is due to the decrease in crop area and vineyards: however, the relevant categorisation system has also been changed twice. Assets efficiency increased moderately over the given period; on the other hand, area efficiency dropped initially and then kept stagnating, due to the absence of the necessary agro-technical means and other assets.

The use of fertilisers might emerge as a factor to be considered independently from area efficiency: however, the calculations indicate that the two factors are not related in the period under study, probably because of the very low amounts used. A future increase in fertiliser use, though, could have a statistically significant impact on productivity and thus on growth as well, and then it could emerge as an independent factor.

Besides the traditional list of factors having an effect on growth, a new factor has to be separated from the "miscellaneous" group: export surplus, which is exported from Hungary, has a direct effect on growth. The previous factors are from the "supply" side, but export is from the "demand" half. It is a logical question to ask about consumption of agricultural products as the other outlet for demand. However, it did not become a factor effecting growth in the new model because it remained constant over the given period.

Hungary has managed to keep up a positive trade balance in agriculture (it is on the increase slightly calculated in euros), but it is decreasingly capable of compensating for the increasing negative trade balance of the economy as a whole.

Miscellaneous factors include regulations and other related variables, such as the budget, taxes, foreign trade, the finance sector, the monetary, investment, integration and regional politics, and the degree and direction of state intervention. Furthermore, factors affecting the global economy also belong here, such as recession, natural disasters, and technological improvements.

## 4.2. Modelling growth

Firstly, the difficulties of modelling, ranging from selecting the relevant factors to choosing the period of reference were discussed. Studies focusing on the effect of certain variables and the impact values of factors were summarised, with special attention to studies in the field of agriculture, such as the models by Pillis and Andrássy. It is to be noted that some of the factors in their studies showed strong autocorrelations, thus questioning their calculated relative weight in the models and the integrity of the models themselves. However, there was a single independent factor which showed very similar values in Andrássy's model and the model developed in this study, thus strengthening the validity of the findings about this component: capital.

Based on Solow's growth model, in which the annual variation of the factors was used to determine the impact of the factors on the output for any given year, the overall formula for the changes in the agricultural sector in Hungary in the period 1991-2003 was set up. The approach used was identical with that of Solow. For input, wages, other personal expenses and taxes were considered for the labour-related costs; on the other side of the balance, profit, income after taxes and dividends were used to estimate capital available for future investments. Data were taken from businesses required to do double-entry bookkeeping in the field of agriculture and food processing. However, as the given period was characterised by constant growth in the economy overall, to which the performance of the agricultural sector contributed as well, it was advisable only to work with data produced by profitable businesses. The rough results indicated a 78% - 22% breakdown of labour costs and resources available as capital for future investments, suggesting the greater impact (and expense) of labour and the workforce compared to the original study, with a 70% - 30% ratio.

## 4.3. Setting up the model

The dissertation describes the steps of constructing a new model relevant for the agricultural sector, including the discarded elements and the decisions made. The starting point was to justify the "miscellaneous" origins of the model. In summary, the framework of endogeneous models was used to answer the questions generated by neo-classical models. In other words, a more "ancient" sector with a relatively simple framework was described with the help of a simpler framework of thinking and modelling from earlier times, but adapted to the special, contemporary circumstances. For the factor analysis, the numerical values were compared across the years and the changes taken into consideration.

Several factors appear in clusters in the final formula: overall, the impact of five components (plus miscellaneous other factors) can be studied independently: labour (percentage of workforce employed in the agricultural sector), investments, land, subsidies, export surplus (trade balance). Operationalising the concept of "technological advance" is one of the central and most difficult issues of formula construction. As technology cannot be quantified readily, it appears through

factors such as productivity and efficiency, feeding in to one (or several) of the main variables. Changes over the years were calculated; however, in the case of workforce, investments and area efficiency, the values were indexed with productivity to gain the final figures. The above quantifying procedure was necessary for the comparability of data.
The graph drawn about the changes in the factors reflected well the trends in the GDP curve: the summative impact of the factors was evident. However, surveying the curves for each of the factors independently revealed a more complicated picture: impact was detected but seemed more of complementary, rather than explanatory, character. Apparently, the changes in the independent variables followed the GDP pattern more closely in the second half of the period surveyed (Figures 8-12).

Therefore, the following hypotheses were set up before the eventual analysis:

(1) All five variables in the formula have an impact on economic growth.
(2) Lower impact was expected in the case of land area due to the complex nature of the variable.
(3) Export surplus, subsidies, investment and labour are expected to have a greater effect on GDP, the above order is predicted from strongest to weakest factor.
(4) Numerical substitutability was expected between the variables.

The above complex variables and their effect on GDP were submitted to statistical analysis. The aim of the procedure was to determine the weighing if the factors in the formula, and justifying the results with the help of further statistical analyses.

## 4.4. Assessing the results

This chapter focused on giving a detailed description of the model of the agricultural sector and of the role of the variables.
The correlational analysis revealed that contrary to the expectations, only one of the independent variables shows a moderately strong but clear positive relationship with the dependent variable: the coefficient for investments was 0.652.
Several approaches were taken for the further regression analyses:
(1) regression analysis for all variables, but with a focus on important ones only; (2) regression analysis in pairs of variables, underlining the impact of variables on GDP independently; (3) analysis of all variables; (4) linear regression for the above analyses 1 to 3, with a number of graph variations (Table 1); (5) separate analysis for the strongest variables, as revealed in the previous steps.

The analyses show that the strongest single factor is investments, accounting for 40% in the change of GDP as a single variable or 26% in the presence of all variables. In the absence of this factor, export surplus takes over in covering 23% of the remaining variation. When both investments and export surplus are considered, however, the latter is less significant. Overall, these two variables have the strongest impact, and it is important to note that they are independent

from each other (show no correlation), so they exert their influence on the dependent variable at different times and in different ways.

In the case of subsidies, a linear graph with GDP covers a mere 8% of variation; however, an analysis in the presence of all factors yields 18% for the linear graph. The inverse graph maps the dependent variable the most accurately. There is a weak negative relationship between export surplus and subsidies, which was predictable from the tendency of decreasing export subsidies over the surveyed period.

Land area does not have a direct independent impact on changes in GDP. It is important to consider that land is a complex variable which absorbs the impact of changes in land area and land efficiency. Instead, land area affects GDP via investments in the first half of the given period, most probably as an effect of area efficiency.

Similarly, no relationship was detected between workforce and GDP; furthermore, it does not even have an impact via any of the other factors either. It is important to note, however, that the lack of relationship in this study relates to the complex factor under the collective name workforce. It would not be probable that the effect of labour and efficiency on GDP could be discarded altogether, as there is likely to be strong correlation in a different framework. For example, labour costs or wages would definitely yield a different result, as reflected by the 0.948 correlation between wages and sector GDP. The analysis and the graphs considering workforce and area revealed that the mechanism of these two variables acts opposite to the other three factors.

All of the above, together with comparative analysis of the parameters of the two best-fitting equations (with all the factors; with the three significant factors), summarised in Table 2, lead to the conclusion that the impact of labour and land area are negligible, and their inclusion in the study decreases reliability and increases deviation. The two variables do not exert significant influence on GDP, as 80% of variation can be accounted for by investments, export surplus and subsidies. Therefore, labour and land area were not considered in the finalisation of the model.

Miscellaneous factors (and standard error) cover the remaining impact on the GDP in the calculations, their presence over the years is stable. However, there is a negative correlation, suggesting that the given variables "over-explain" GDP, and the miscellaneous factors actually decrease GDP, i.e., slow down economic growth. As the model focuses on agriculture, it is evident to suspect that the negative effect of weather could be significant. Therefore, further analyses were conducted to check whether this impact can be detected statistically: average temperature and precipitation (annual rainfall) were the two sets of data focused on. It was concluded that temperature does not correlate with the miscellaneous variables; however, precipitation accounts for 30% of the variation, with acceptable reliability. Consequently, weather was proven to be a significant element in the miscellaneous variables influencing economic growth.

As the number of variables was significantly reduced (from five + miscellaneous to three plus miscellaneous), the possibility of introducing further variables or breaking up the remaining ones was studied. Accordingly, the introduction of amortisation was examined; and the split-up of investments by establishing investment subsidies as a separate variable. However, neither of the two possibilities yielded any significant results. In summary, no further change was found which could result in a better formula at the end.

Further statistical analyses were conducted to check the autocorrelation and the multicollinearity of the variables. The resulting Durbin-Watson values indicated that there was negative relationship between the independent variables. Previous correlational calculations indicated the same, as mentioned above: investments and land area are negatively related. Land area was dropped from the second round of analysis, which lead to favourable indicators, i.e., no further correlations were found among the remaining variables.

The Cobb-Douglas production function was used to study the elasticity between the dependent and independent variables. For reliable results, only investments, subsidies and export surplus were considered. The results indicate that a 1% modification in investments results in 0.26% change in GDP; a 1% change in subsidies leads to 0.18% in GDP, and a 1% variation in export surplus has 0.23% impact; the best-fitting function covers 80% of all change. All this indicates that the remaining variation is due to other factors, most probably indefinable or unquantifiable ones. An important conclusion from this calculation is that the most increase in GDP can be achieved through input in the form of investments. Numerically, in order to achieve the same positive effect in GDP, 1.4 times more capital needs to be invested in the form of subsidies than in the form of investments. Therefore, investments are the key to long-term development in the agricultural sector.

# 5. Analyis and conclusions

The calculations explained in the previous chapters aimed at setting up the most relevant model for growth in the agricultural sector. This chapter analyses the resulting model and its implications.

## 5.1. Growth formula for the agricultural sector

Increase in GDP in agriculture is determined by the following factors:

- investments (including investment subsidies), in million Ft, **I**
- assets efficiency (million Ft/million Ft), **Aa**
- subsidies (million Ft), **S**
- export surplus (million Ft), **X**
- miscellaneous factors, **H**

In any given year, output can be expressed within the framework of the following function:

**$Y = f\{I; Aa; S; X; H\}$**

Analysing the possible versions, the best regression function showed that economic growth in the given period in Hungary can be summarised in the following formula:

$$\Delta Y_{t-e} / Y_e \approx 0{,}217 \{(I_t \times Aa_t - I_e \times Aa_e) / I_e \times Aa_e\}$$

$$+ \ 0{,}195 \{(S_t - S_e) / S_e\} + 0{,}236 \{(X_t - X_e) / X_e\} - 0{,}0197$$

Explanations for the variables:

- all variables were considered at a value deflated by the agricultural price index;
- the constant value of – 0.0197 is attributed to the miscellaneous variables;
- it is hypothesised that savings remained constant.

Examining the impact of the factors in detail (Table 13), the following conclusions can be drawn. (1) Investments are outstanding and have a positive effect, except for the years 1992, 1999 and 2000, when their relative value decreased. (2) Contrary to investments, subsidies only had a positive effect in four years within the given period. (3) Export surplus is even less favourable, positive contribution to GDP in the agricultural sector can only be detected in one year. (4) 1994 and 2001 were the only two years in which a positive effect of the miscellaneous factors could be determined. (5) Change in agricultural GDP only had a positive value in three years, named "odd years". GDP decreased in all the other years in the researched period.

Analysing each of the three "odd years" closely, statistical data give explanations to the differences in GDP. In 1995, the outstanding export surplus accounts for the positive change in GDP; whereas the miscellaneous factors have an extra 2% impact in 1994 and 2001. These years are exceptional in all respects of the economy and the agricultural sector, so it is important to establish the underlying effects and impacts contributing to the success.

1994 was the first year in the period after the political changes when the economy took a positive turn. After a slight decrease in the following year, there was again significant increase until 2000; when there was a sudden halt in 2001.

In the case of the agricultural sector, the outstanding years can be justified relatively easily. Heavy droughts hit the sector in 1992, 1993, 2000, 2002 and 2003; in addition, the years 1996, 1997 and 1999 were also hotter than average. In the "odd years", the weather was favourable for agriculture, especially compared to the previous years, which resulted in an increase in GDP.

## 5.2. Factors accounting for growth

Calculations were made about the potential effect of changes in capital input on GDP. The results shed light on the efficiency of directing extra input into agriculture in different forms: investments, subsidies and export surplus. The analysis revealed the degree of substitutability between the factors. The chosen statistical method was marginal analysis: the data in the basic table was modified for one of the three variables only at a time, leaving all other variables unchanged. The capital input was increased by 10 to 200,000 million forints in steps. The results indicated that spectacular improvements cannot be achieved merely through increased capital input. An unexpected result was that in half of the cases of increased capital input, the GDP actually declined; leading to the tentative conclusion that in itself, extra capital does not result in increased GDP, but the additional effect and the combined impact in all variables is necessary, especially productivity and efficiency. In other words, leaving other factors unchanged poses a barrier for the effective utilisation of extra capital.

Out of the three forms of capital, changes in subsidies had the most favourable impact. In the years when extra growth could have been achieved both through increased subsidies and investments, subsidies had the best short-term impact. A closer look at the data and the favourable years, it can be concluded that in the case of variables with values lower than in the previous years, extra input has a favourable effect. However, if the factor was increased in the previous year, then extra input cannot influence the GDP, indicating that in the presence of the other variables left unchanged, the maximum possible increase in economy was reached through the given variable.

In the case of subsidies, the following years had additional potential: 1995, 1996, 1997, 2000, 2002, 2003. In 1995-1996, debt consolidation had a positive effect on agriculture; 1997 saw the introduction of loan subsidies; and in 2003, financial consolidation and a new system of subsidies were introduced. The nominal value of agricultural subsidies decreased in 2000 and 2002, which could have resulted in missing opportunities for growth for these years.
In the case of 1993, 1994 and 1998, neither of the factors hide additional growth.

In the case of export surplus, further increase in GDP could have been achieved in some years; however, certain practical limitations apply, so there was room only for theoretical growth in the years 1993, 1996, 1998, 1999 and 2002. Potential for extra growth is smaller in the case of increasing exports than by added funds for investments or subsidies, for the years 1999 and 2002, when both factors were on the increase. Consequently, only the effect of extra funds for investments and subsidies were examined in the subsequent analyses, and the role of export surplus was not considered.

## 5.3. The new millennium

In the years 2000-2003, data on the effect of hypothetical factor growth were opposite to the results in the previous years: an optimal range was formed. In

other words, a small increase in the value of a given variable had a slight positive / negative effect on GDP, but a further increase reversed this trend and had an opposite effect on the GDP.
2001 demonstrated the smallest extra capital input. The most favourable increase in GDP was the result of an extra 10 million forints funds, amounting to 0.013% unused growth potential. Any further funds show a negative effect on GDP. In 2003, the range has a negative effect initially, and turns over into positive change upwards from extra 35 million forints funds. However, growth is not spectacular: extra 100 million capital input means 0.0005% increase, extra 3 billion results in 0.04% growth, and 200 billion in a mere 0.2%. Economic growth for the year, however, would still be -7%. A similar turnover point can be detected for the years 2000 and 2002, but for higher sums of capital input (700 and 600 million respectively). Extra funds over these benchmarks could have achieved further growth in GDP (e.g., 200 billion capital results in +2% theoretically).
The changes after 2000 are due to the decreased funding in the form of investments and subsidies. However, there was a constant increase in assets efficiency. The available technological background makes further increase in GDP possible with the help of additional funds: there is potential for further development. This gap was the biggest in 2001, when a mere 10 million forints funds would have resulted in increased GDP; for the other years, much larger sums were calculated.
In conjunction with the data for the years before and after 2000, it was possible to analyse the results that the SAPARD funds could have achieved. The funds were readily available but only accessed late or partially; it is possible to analyse the amount and composition of the capital that could have achieved the most increase in the economy. The analysis serves as an indication about the possible impact of EU and local funds for the development of the agricultural sector.

The technological level did not pose a limitation in the years 2001-2003, not even given the large amount of extra funds. This indicates that capital input into the sector did not keep up with technological advance, and there was significant unused potential in the sector. Setting the amount of unused SAPARD funds at 20 billion forints in 2000, for example, the extra capital could have resulted in 0.9% increase in GDP. The corresponding percentages are 0.6% in 2002 and 0.2% in 2003.

## 5.4. Quantifying substitutability

Substitutability was analysed for the entire period for two of the variables, investments and subsidies. Extra capital input of a fixed value does not achieve the same impact in the different forms; favourable results can only be expected in the years with unused potentials. The impact of subsidies outweighs that of investments in a ratio of 7 to 5. However, distinct periods can be identified after more detailed analysis. From the viewpoint of subsidies, 1996-1997 is a low point, whereas in the case of investments the same plunge is in the previous and subsequent years. The beginning and end of the 1990s can be identified as the

"years of investments", whereas the middle of the decade and the first years of the new millennium are the "years of improving liquidity". The second is, however, most probably the direct effect of earlier investments, when further investments could not possibly have produced further improvement. Following the same tendencies, 2005 could mark the beginning of a new period of investments, when the sector would need more funds in the form of extra capital in order to improve GDP. An increased proportion of the EU and local funds should be directed towards supporting investments.

The substitutability of the two factors were calculated in the following way: the ratio of the gradients of the two regression formulas for the data for investments and subsidies yielded a figure, which was then converted back to a nominal value in forints (Table 3). The ratios were not applicable in the case of four years, when the curves had opposite gradients, meaning that the increase in only one of the variables has a positive effect on the GDP. The ratios varied greatly, but were more constant in the distinct periods. Overall, there is a bell-shape curve: the ratio of substitutability was highest in the middle of the decade, with lower ratios at the beginning and at the end (Table 4).

In the "years of investment" (1992-1994, 1999-2000), the ratio of substitutability was well over 1; therefore, the positive impact of investments could only have been achieved with much higher sums in the form of subsidies. Out of the two factors, neither can be picked as the "more useful" overall, this designation is only relevant for the given periods. The data support the existence and alternation of two kinds of periods, when there are different needs in agriculture. These findings could prove to be useful when determining the forms and means of capital input into the sector.

Irrespective of the alternating periods, the gradients established in the statistical analyses and the results from the study of elasticity along the period justify one of the basic tenets of modern economics: in order to achieve the same growth, the funds in the form of investments have multiple effects compared to subsidies. In other words, support for the agricultural sector is more effective in the form of investments. The alternation of the periods as described above are relevant as far as the changes in substitutability over the years is concerned, which must be considered when deciding about dividing up the available funds into investments and subsidies.

Growth formulas for the agricultural sector might be possible with several different approaches and methods; the ones presented in this study are sketches of some of the alternatives. The aim of the research was to identify tendencies and factors that characterise and justify changes in the sector. In the future, agricultural models could arrive at conclusions with well-founded practical implications, which could set agriculture on a path of growth once again. The analysis of the data in the coming years, including the study of the impact of EU membership, could trace the importance and impact of the factors. Accordingly, the first question resulting from this study is whether the conclusions hold true in

the changed circumstances, and when and how further variables need to be introduced into the model.
According to my predictions for the future, investments will continue to have a decisive effect on growth in agriculture. Agricultural output cannot be kept up successfully with the present infrastructure. In order to catch up with the average of the sector in the EU, growth in the GDP through improving efficiency and productivity would be essential, as the present stagnation is due to the low levels in these factors. In order to achieve this aim of increasing both assets efficiency and land area efficiency, several improvements are necessary: better technology, more favourable basis of production, advances in agrotechnology, hygiene and crop protection, as well as the concentration of land. These aspects should be the priorities for investments and projects. Furthermore, better infrastructure, transportation capacities, maintenance, information and data exchange are necessary for increased efficiency. As a member of the EU, Hungary has to face a fiercer competition in the market, and being left behind in the field of agriculture has a negative effect on the economy overall.

## Summary of professional achievements

Based on growth models for the economy, a new model focusing on agriculture only for the period 1991-2003 in Hungary was set up in this study. The model is of mixed character, seeking answers to the questions raised by neoclassical models with the help of the framework of endogeneous models.
The analyses are based on calculations performed with the help of the constructed models, and are justified by previous studies on the factors effecting economic growth. The special circumstances and potentials only relevant to the agricultural sector in the given period at the given location were underlined throughout the study.

*The achievements were summarised in the following points*

1. Changes in the factors affecting economic growth

- Factors having an impact on growth in agriculture had changed by the end of the 20th century: the role of the original means of production (especially labour) decreased in importance, and capital investment and exports took over as key elements. The role of the factors is determined by the limitations of the market and demand.

2. Identifying and quantifying the factors influencing the agricultural sector:

- Capital-related factors (investments, subsidies, export surplus) have an impact on increasing GDP. In the circumstances under study, investments have the key role, they exert the most influence.
- In order to have the same effect on GDP, 1.4 times more subsidies are necessary than investments. This figure marks the most efficient way of using capital input directed into the sector.

- The three variables that appear in the growth model are independent, and their impact can be determined and quantified. A 1% increase in the additional funds achieves 0.26% increase in the GDP in the form of investments, 0.18% as subsidies, and 0.23% as export surplus. The best-fitting formula accounts for 80% in the variation of GDP. It is to be noted though that export had a greater role at the beginning of the period, in the form of significant amounts of export subsidies. As a result of WTO and EU membership, however, the correlation of subsidies and exports to GDP is expected to decrease.
- Land area and area efficiency only had an effect on GDP at the beginning of the 1990s, and have been stagnating since, so their impact cannot be quantified. The expected decrease in agricultural land area, plot concentration, and technological improvements could result in increased area efficiency and an increased role for land area in agricultural growth.
- The group of miscellaneous factors have a negative effect on GDP and slow down the economy. As it is an agricultural model, weather can be identified as a significant factor in decreasing growth. 30% of the impact of the miscellaneous factors can be attributed to precipitation.

3. The effect of extra capital on growth:

- Additional funds do not automatically result in increased GDP, as the remaining variables left unchanged can form a barrier. A complex positive change aimed at increasing efficiency is needed instead. Extra funds were shown to have a positive impact in the years when other variables exert a negative influence, and not when GDP is decreasing. This implies that in a year with unfavourable weather conditions, capital input could affect the GDP positively. However, the change cannot be significant, which indicates the extent to which the sector is susceptible to the weather.
- Technology did not limit output in the years 2000-2003. Extra funds to the sector did not measure up to technological advance, and significant potential was left unused. A room for further increase in GDP was present: increases of 0.9% (2000), 0.6% (2002) and 0.2% (2003) would have been possible.
- As for effective forms of capital input, alternating periods were identified. The beginning and the end of the 1990s were "years of investments", whereas the middle of the 1990s and the first years of the new millennium, were the "years of improving liquidity". Following the tendency, a new period of investments can be predicted from 2005; more EU and local funds should be directed into the sector in the form of investments for optimal results. However, current EU regulations limit increasing production capacity, so growth in the sector is only possible by improving technology, efficiency, and the development of services.

## Connecting list of publication

*Foraign language learned journal:*

- Czárl, Adrienn – Gyenge, Balázs (2004): An opportunity of advance for EU candidate countries: SAPARD as a learning programme. In: Gazdálkodás, XLVIII. évfolyam 8. különszám, Special English Edition. 160.p., 17-25.p.

*Hungarian learned journals:*

- Czárl Adrienn (2001): A SAPARD pályázatok eltérései az EU-ban és Magyarországon. In: Gazdálkodás, XLV. évfolyam 4. szám, 96p., 69-74.p.
- Czárl Adrienn (2002): A SAPARD Tervek összehasonlítása. In: Gazdálkodás, XLVI. évfolyam 2. szám, 97p., 37-41.p.

*Chapter of books:*

- Czárl Adrienn (2002): A SAPARD program. In: Gazdálkodók kézikönyve, 28. kiegészítő kötet, 2002. február, ISBN 963 85181 4 6 I. K, RAABE Tanácsadó és Kiadó Kft, Budapest, N 2.3 / 1-18.p.
- Czárl Adrienn (2002): A SAPARD program. (folytatás) In: Gazdálkodók kézikönyve, 28. kiegészítő kötet, 2002. május, ISBN 963 85181 4 6 I. K, RAABE Tanácsadó és Kiadó Kft, Budapest, N 2.3 / 19-38.p.
- Czárl Adrienn (2002): SAPARD pályázatok In: Gazdálkodók kézikönyve, 31. kiegészítő kötet, 2002. október, ISBN 963 85181 4 6 I. K, RAABE Tanácsadó és Kiadó Kft, Budapest, G 3.1 / 1-8.p.

*Conferences:*

- 1st International Conference for Young Researchers (Szent István University, Gödöllő, Hungary, 2001. 4-5 of September) „Czárl Adrienn: The SAPARD Plan as the means for agricultural and rural development" poster. ISBN 963 9256 501; 419p., 84-87.p.
- XLIII. Georgikon Napok (Veszprémi Egyetem, Keszthely, 2001. szeptember 20-21.) „Czárl Adrienn: A SAPARD Program végrehajtásának elemzése és tanulságai az Uniós csatlakozás tükrében" ISBN 963 9096 792; Vidékfejlesztés – Környezetgazdálkodás - Mezőgazdaság tudományos konferencia kiadvány, I. kötet, 1168.p., 22-26.p.
- VIII. Nemzetközi Agrárökonómiai Tudományos Napok, A mezőgazdasági termelés és erőforrás hasznosítás ökonómiája, (Gyöngyös, 2002. március 26-27.) „Czárl Adrienn: A SAPARD Tervek összehasonlítása" rezümé kötet: ISBN 963 9256-75-7-Ö, 208.p., 11.p. Konferencia kiadvány 1. kötet: ISBN 963 9256 76 5, 414.p., 146-151.p.
- Economics and Management of Enterprises in the Progress of Globalisation (International Scientific Days Nitra, 2002, 16-17 of May). „Czárl Adrienn –

Széles Zsuzsanna: Questions of the hour for the Hungarian smallholders ahead of the accession to the EU" Ecomonics, 4th volume, 1st part, ISBN 80-8069-030-8, 857-1208.p., 935-939.p.

- XLIV. Georgikon Napok (Veszprémi Egyetem, Keszthely, 2002. szeptember 26-27.) „Czárl Adrienn: Uniós csatlakozás előtt – hasonló problémák?" poszter. Stabilitás és intézményrendszer az agrárgazdaságban tudományos konferencia resümé kiadványa, szerkesztette: Palkovics Miklós és Kondorosyné Varga Erika, 148.p., 91.p., CD kiadvány
- Slovak Agricultural University in Nitra, Faculty of Economics and Management, New Science 2002 "Pre-accession Strategies in the National Economy of Accession Countries Towards the EU" (International Scientific Days Rackova Dolina, 3. - 4. October, 2002) „Czárl Adrienn – Gyenge Balázs: Marketing elements in the SAPARD Plans" 1st part ISBN 80-89162-02-9, 246.p., 84-88.p.
- 2nd International Conference for Young Researchers (Szent István University, Gödöllő, Hungary, 2002. 17-18 of October) „Czárl Adrienn: Comparison of the measures of the SAPARD Plans" poster. ISBN 963 9483 05 2ö; ISBN 963 9483 06 0; Volume I. 372p., 52-57.p. lektorált anyag
- Conference on European Studies - Perspectives on the future of the European Union enlargement process. International Conference in Spain, Universidad Europea de Madrid, Villaviciosa de Odon, Madrid, 28-29 of November, 2002. „Czárl, Adrienn - Gyenge, Balázs: Introduction of the SAPARD Plans by comparison analysis of the candidate countries." CD proceeding
- Sborník prispevkü z conference atudentü doktorského studia Mendelova zemedeiská a lesnická univerzita v Brné. International Conference in Bruno, Czech Republic, – MendetNet 2002/3, 23-24 of January, 2003. "Czárl, Adrienn – Gyenge, Balázs: Comparison analysis of the SAPARD Plans of Czech Republic and Hungary." ISBN 80-7302-045-9, (soubor) ISBN 80-7302-046-7 (1.díl) – Sekce ekonomie, 333.p., 36-41.p.
- IX. Ifjúsági Tudományos Fórum (Veszprémi Egyetem, Georgikon Mezőgazdaságtudományi Kar, Keszthely, 2003. március 20.). „Czárl Adrienn: Mit is jelent a vidékfejlesztés?" CD kiadvány
- Gazdálkodók esélyei az Európai Unióban – EU napi konferencia. (Nyugat-Magyarországi Egyetem, Mezőgazdaság- és Élelmiszertudományi Kar, Európai Uniós Oktatási Központ, Mosonmagyaróvár, 2003. május 8-9.) „Czárl Adrienn: A vidékfejlesztés szerepe a világ különböző tájain és az Európai Unióban." CD kiadvány.
- A vidéki Magyarország az EU-csatlakozás előtt. VI. Falukonferencia. 2003. június 12-13. Pécs, MTA Regionális Kutatások Központja. „Czárl Adrienn: Az agrárágazat EU érettsége" ISBN 963 9052 35 3 lektorált anyag. 513.p., 106-113.p.

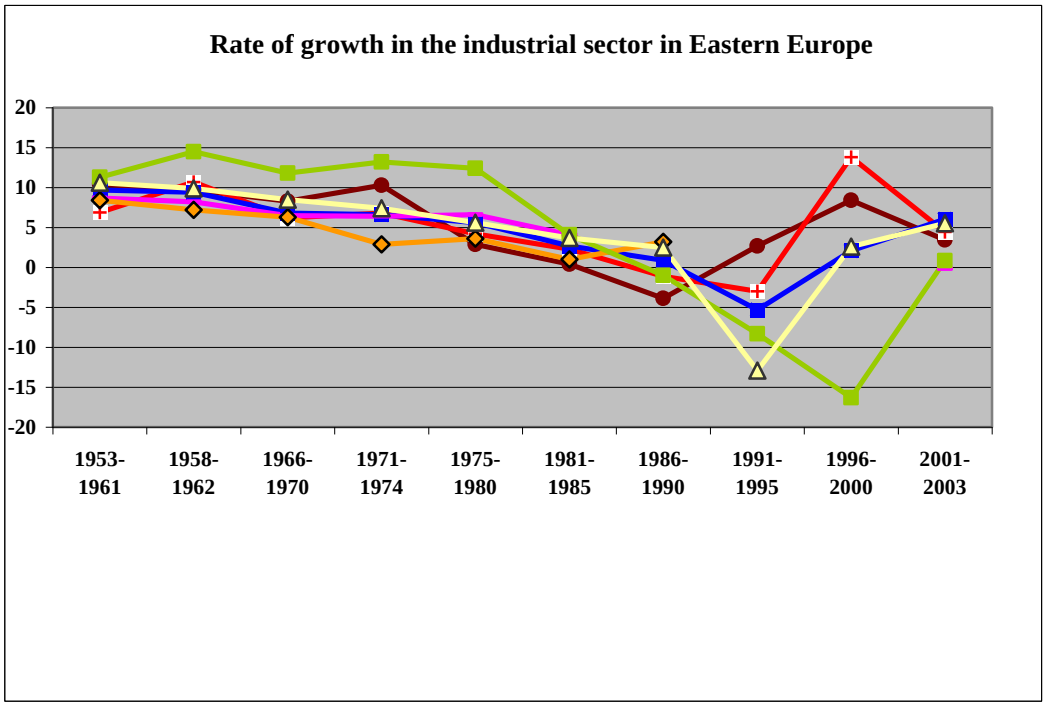
- Doktoranduszok a számvitel és a pénzügy területén – Tudományos tanácskozás. SZIE Napok 2003. (Szent István Egyetem, Gödöllő, 2003. augusztus 27.) „Czárl Adrienn: Az agrárágazat gazdasági növekedése és meghatározó tényezői.” ISBN 963 9483 346 lektorált anyag. 154.p., 22-34.p.
- XLV. Georgikon Napok (Veszprémi Egyetem, Keszthely, 2003. szeptember 25-26.) „Czárl Adrienn – Orlovits Zsolt: A SAPARD Hivatal akkreditációs eljárásának tanulságai a Mezőgazdasági és Vidékfejlesztési Hivatal felállítása során.” Új stratégiák az agrárgazdaságban – EU csatlakozás 2004 tudományos konferencia lektorált resümé kiadványa, ISBN 963 9096 81 4, 177.p.,, 160.p., és CD kiadvány ISBN 693 9495 26 3
- 5th International Conference of Young Researchers "Challenges of Sustainable Development in the National Economy" Slovak Academy of Agricultural Sciences Young Scientists Association Advisory, 2–3 of October 2003, Slovakia. „Czárl, Adrienn – Gyenge, Balázs: Changes in the Economic Structure in the last centuries” ISBN 80-89162-03-7, 303.p., 44-49.p.
- IX. Nemzetközi Agrárökonómiai Tudományos Napok (Gyöngyös, 2004. március 25-26.) „Czárl Adrienn – Orlovits Zsolt: A Föld mint a gazdasági növekedést meghatározó termelési tényező” rezümé kötet (Szerk. Dr. Magda Sándor) 366.p., 34.p. cd kiadvány
- The XI. International Conference on Economic Cybernetics „The Cybernetics of Makroeconomics and Microeconomics” Academy of Economic Studies, Department of Economic Cybernetics, 22-24 of April, 2004, Romania, Bucharest. „Czárl, Adrienn – Belovecz, Mária: The impact of Economic Development on each of the Three Sectors”. Abstracts 75.p., 29.p. Paper: http://www.asecib.ase.ro/simpozion/simpozion.htm
- 3rd International Conference for Young Researchers (Szent István University, Gödöllő, Hungary, 28-29 of September, 2004.) „Czárl Adrienn: A Model of Economic Growth in the Agricultural Sector” poster. ISBN 963 9483 42 7ö; ISBN 963 9483 43 5; Volume I. total pages 448p., 63-66.p. with reader opinion
- 40. Croatian Symposium on Agriculture (University of J.J. Strossmayer in Osijek, Opatija, Croatia, 15-18 of February, 2005.) “Czárl Adrienn: Different ways and reasons for the decreasing role of the Agriculture in Europe - Structural changes in the 20th century”. ISBN 953-6331-31-4 Agricultural economics section, 776.p., 47-48.p.
- The Seventh International Conference on Informatics in Economy (Academy of Economics Studies, Faculty of Economics cybernetics, Statistics and Informatics; Information and Knowledge Age, May 19-20, 2005, Bucharest, Romania). „Belovecz, Mária – Czárl, Adrienn: Information fluctuation in the Agriculture.” ISBN 973-8360-014-8, K-Management section, 702-707.p., 1430.p.

*Other academic activities:*

- Az agrárfinanszírozás alakulása, a mezőgazdasági vállalkozások forrásszerkezetének változása, az agrárágazat tulajdonosi szerkezetének finanszírozási összefüggései című, 33001 OTKA 32949 számú pályázat résztvevője.
- A Felsőoktatási Kutatási és Fejlesztési Pályázat 0463/2000. számú, „Agrárfinanszírozás alakulása, a mezőgazdasági vállalkozások forrásszerkezetének változása, az ágazat tulajdonosi és termelési szerkezetének finanszírozási összefüggései az EU csatlakozásra felkészülés során." című pályázat résztvevője.
- Szervező Bizottsági tagja a 2nd International Conference for Young Researchers, Szent István University, Gödöllő, Hungary, 2002. 17-18 of October rendezvénynek
- Szervezője a „Doktoranduszok a számvitel és a pénzügy területén" – Tudományos tanácskozás. SZIE Napok 2003. (Szent István Egyetem, Gödöllő, 2003. augusztus 27.) rendezvénynek, valamint a konferencia kiadvány szerkesztője ISBN 963 9483 346 lektorált anyag. 154.p.

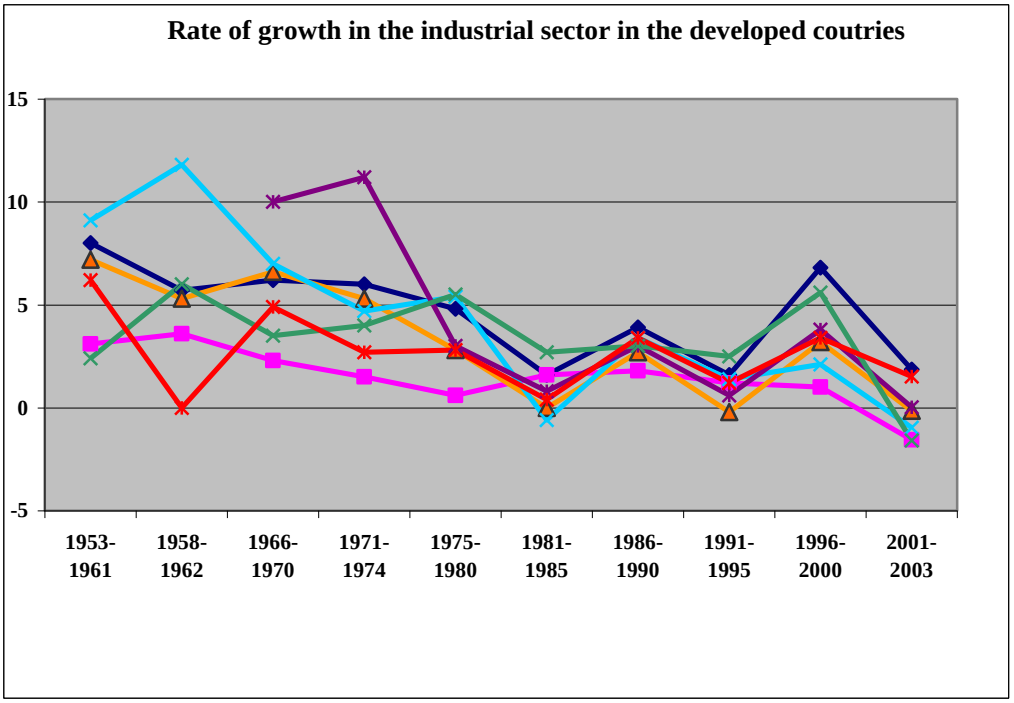
## Appendices

*Figure 1.*




*Source: Own calculation based on Agricultural Statictical database*

*Figure 2.*




*Source: Own calculation based on Agricultural Statictical database*

*Figure 3.*

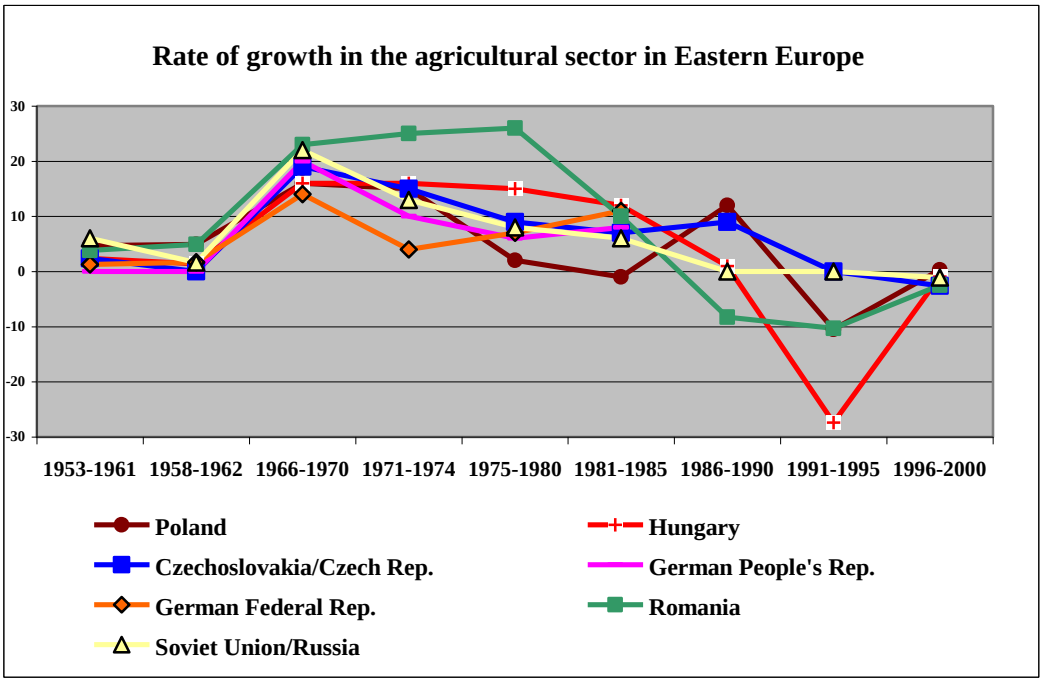



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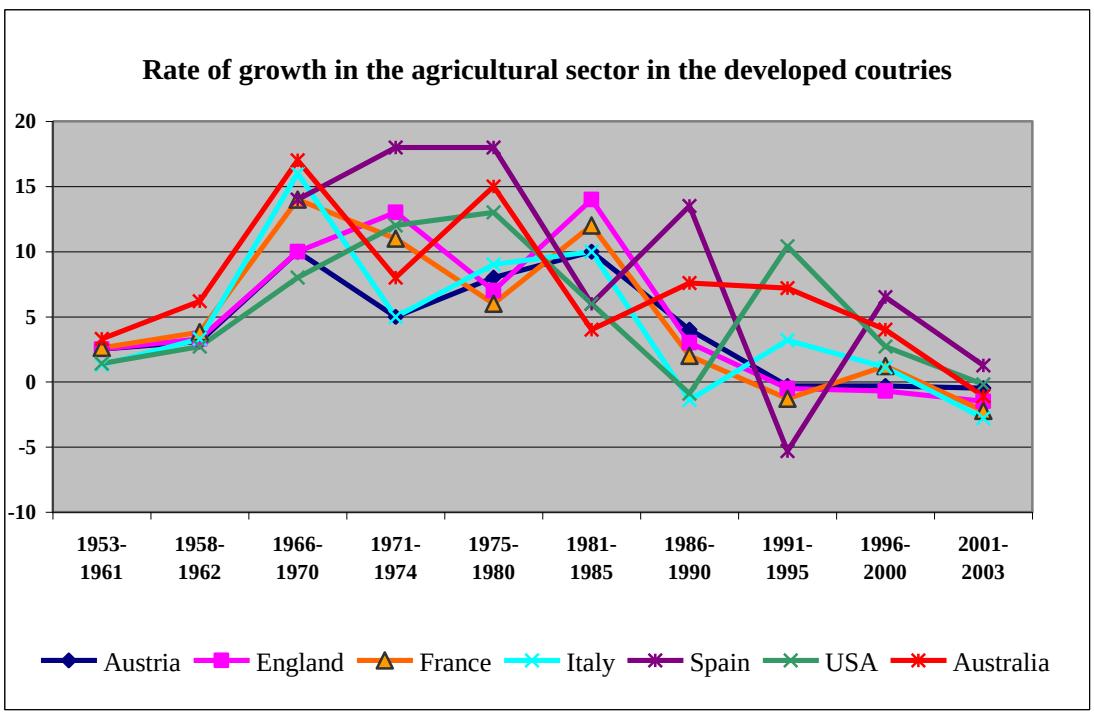
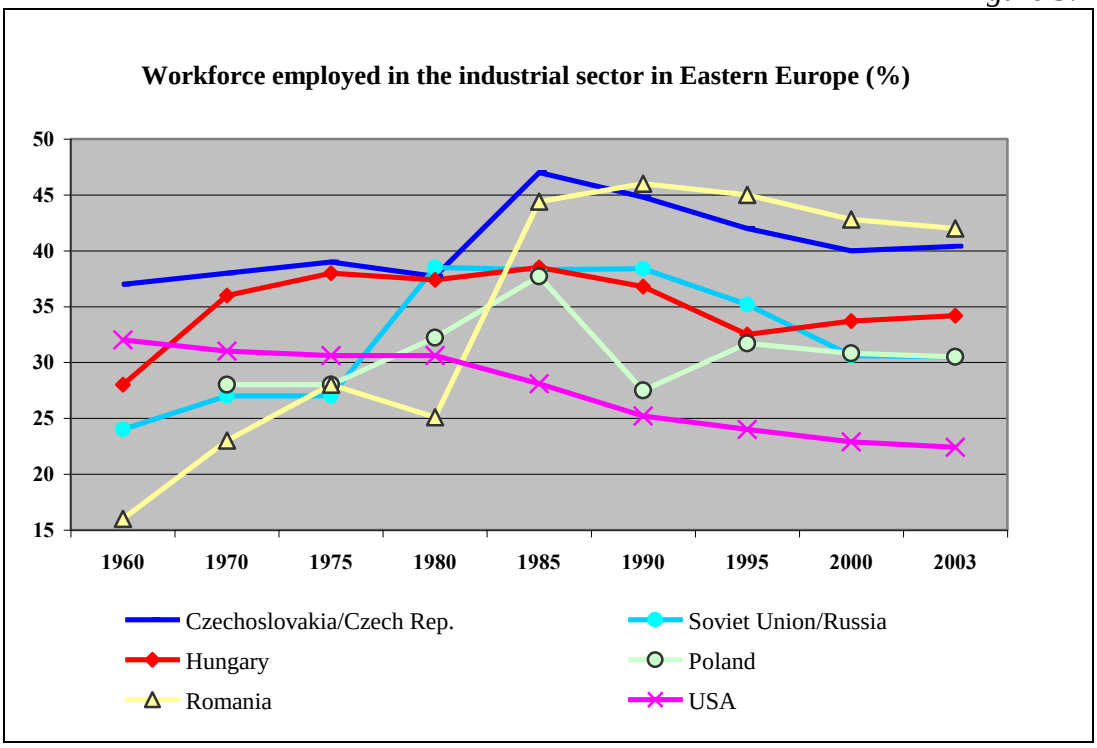
*Figure 4.*



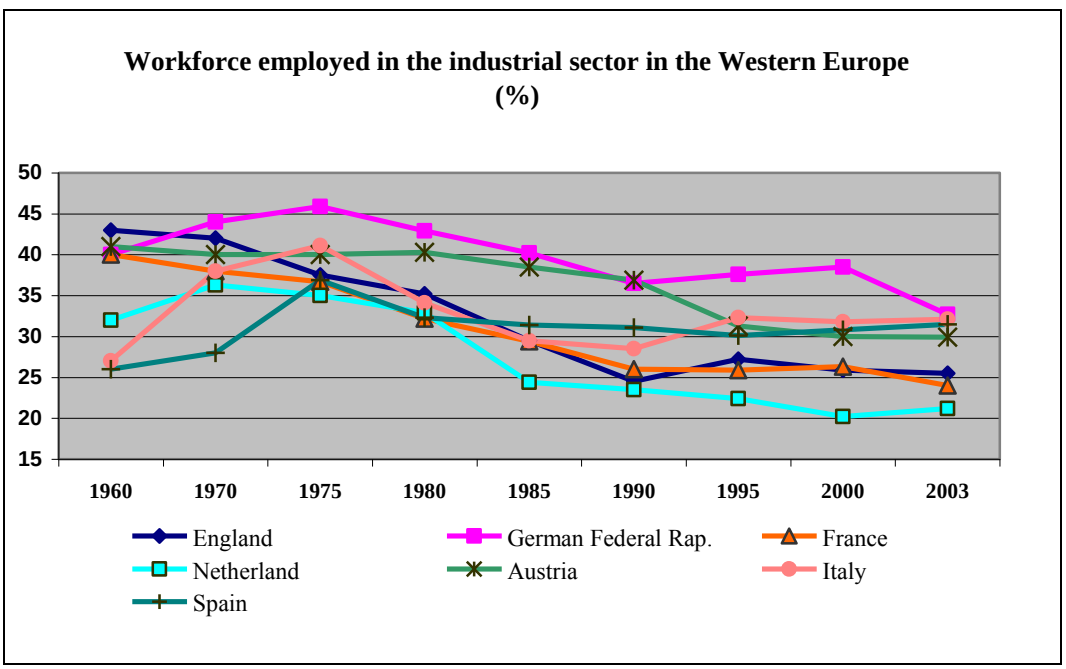

*Source: Own calculation based on Agricultural Statictical database*

*Figure 5.*



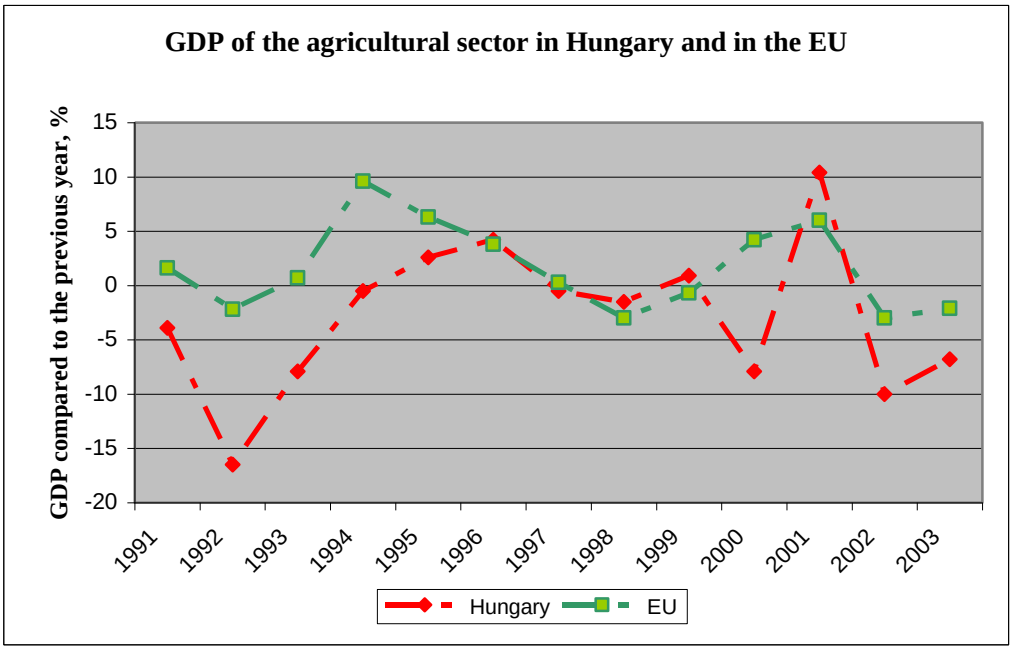

*Source: Own calculation based on Agricultural Statictical database*

*Figure 6.*



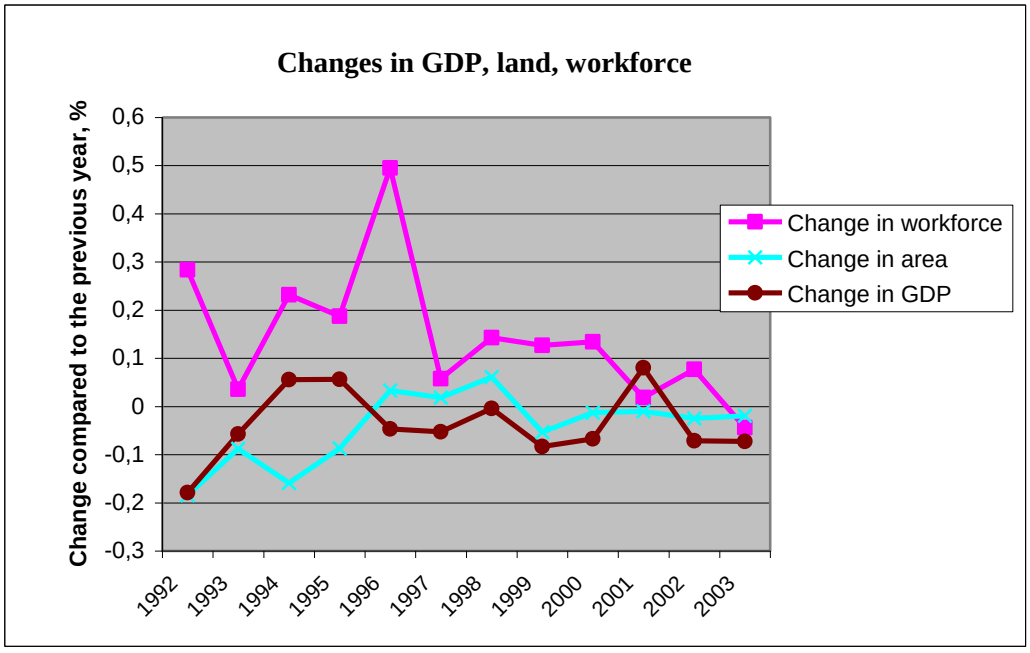

*Source: Own calculation based on Agricultural Statictical database*

*Figure 7.*




*Source: Own calculation*

*Figure 8.*




*Source: Own calculation*

*Figure 9.*

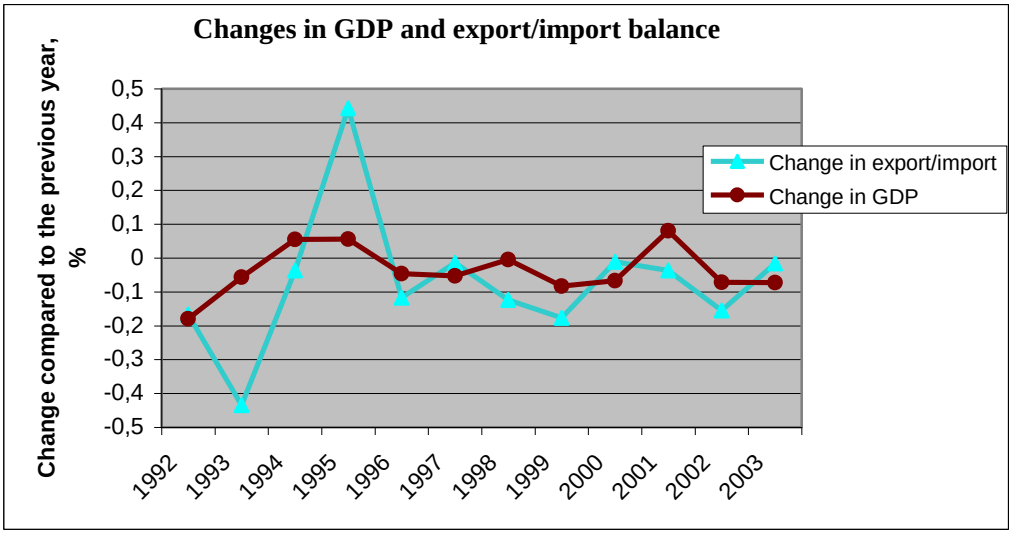



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*Figure 10.*

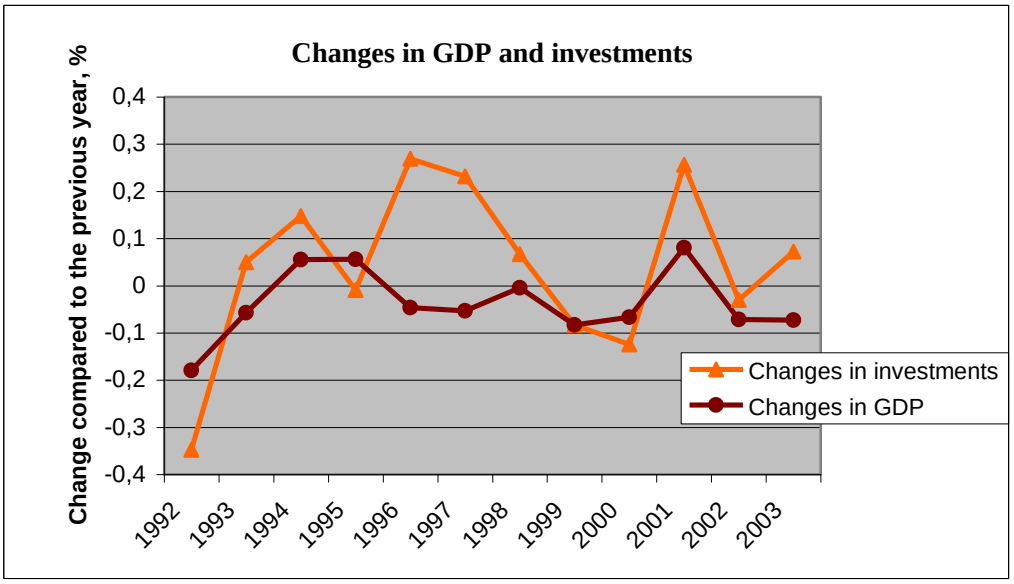


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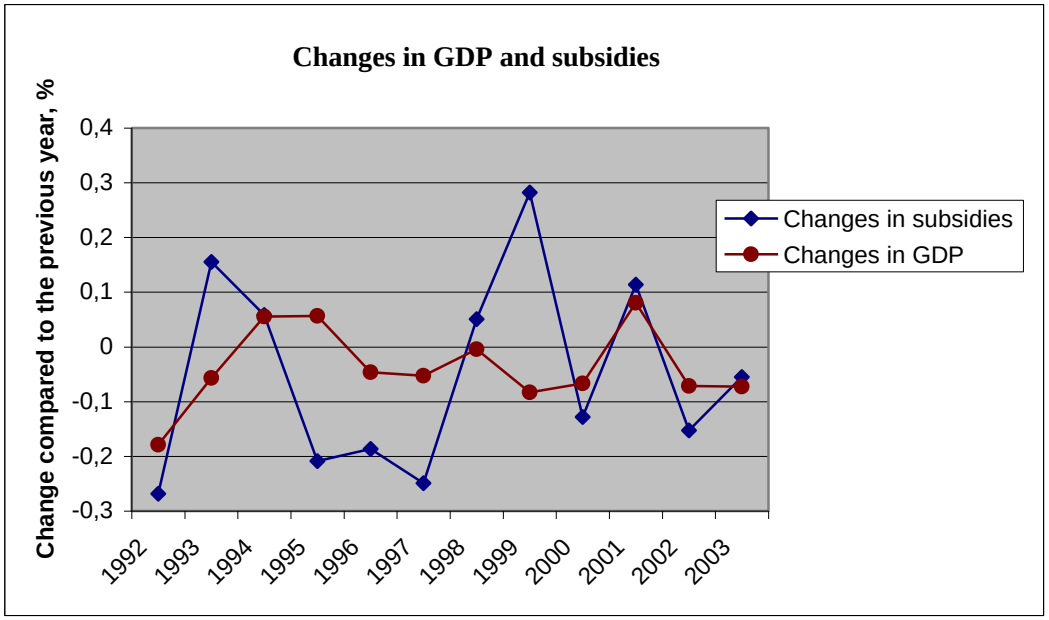
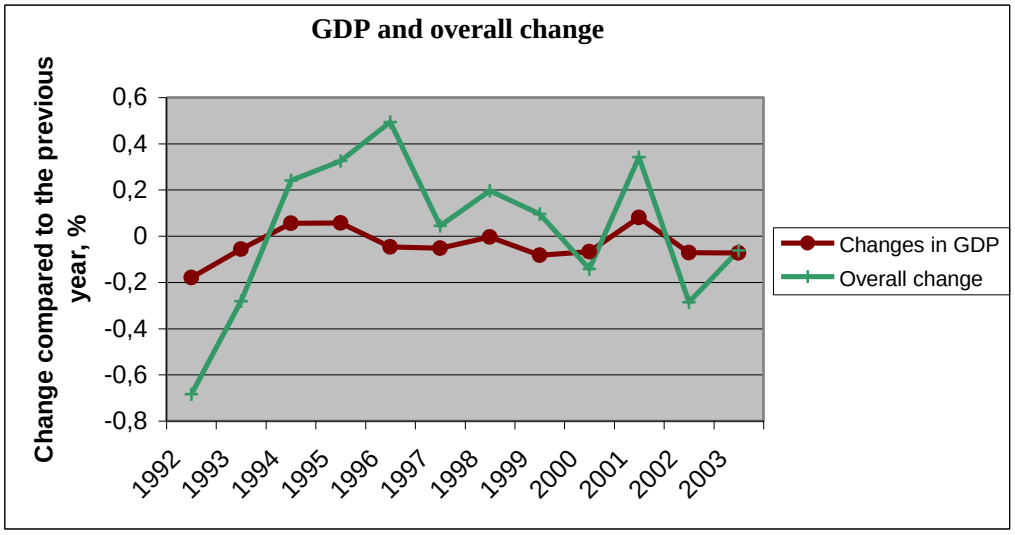
*Figure 11.*




*Source: Own calculation*

*Figure 12.*




*Source: Own calculation*

*Table 1.*

**Additional statistical data for linear functions**

| | $R^2$ | *Sign.* | *Functions with two variables* |
|---|---|---|---|
| ***For subsidies*** | | | |
| Linear | 0,078 | ,379 | $\Delta Y = - 0{,}0313 + 0{,}1144\ \Delta S$ |
| **Inverse** | **0,235** | **,110** | $\mathbf{\Delta Y = - 0{,}0384 + 0{,}0032 / \Delta S}$ |
| *Square* | *0,297* | *,204* | $\Delta Y = 0{,}0071 + 0{,}0789\ \Delta S - 1{,}2755\ \Delta S^2$ |
| Exponential | 0,309 | ,372 | $\Delta Y = 0{,}0061 + 0{,}1796\ \Delta S - 1{,}2262\ \Delta S^2 - 1{,}8575\ \Delta S^3$ |
| ***For workforce*** | | | |
| Linear | 0,011 | ,743 | $\Delta Y = -0{,}0291 - 0{,}0539\ \Delta L$ |
| **Inverse** | **0,165** | **,190** | $\Delta Y = \mathbf{-0{,}0543 + 0{,}0016 / \Delta L}$ |
| Square | 0,014 | ,938 | $\Delta Y = -0{,}0328 + 0{,}0132\ \Delta L - 0{,}1509\ \Delta L^2$ |
| Exponential | 0,053 | ,928 | $\Delta Y = -0{,}0353 + 0{,}4093\ \Delta L - 3{,}1156\ \Delta L^2 + 4{,}4785\ \Delta L^3$ |
| ***For investment*** | | | |
| **Linear** | **0,425** | **,022** | $\Delta Y = \mathbf{- 0{,}0480 + 0{,}2667\ \Delta I}$ |
| Inverse | 0,067 | ,417 | $\Delta Y = - 0{,}0413 - 0{,}0005 / \Delta I$ |
| *Square* | *0,493* | *,047* | $\Delta Y = - 0{,}0323 + 0{,}22564\ \Delta I - 0{,}4941\ \Delta I^2$ |
| Exponential | 0,495 | ,124 | $\Delta Y = - 0{,}0321 + 0{,}3028\ \Delta I - 0{,}5513\ \Delta I^2 - 0{,}6030\ \Delta I^3$ |
| ***For land area*** | | | |
| *Linear* | 0,027 | ,609 | $\Delta Y = - 0{,}0298 + 0{,}1616\ \Delta F$ |
| Inverse | 0,035 | ,559 | $\Delta Y = - 0{,}0426 - 0{,}0003 / \Delta F$ |
| Square | 0,054 | ,779 | $\Delta Y = - 0{,}0270 - 0{,}1200\ \Delta F - 2{,}1764\ \Delta F^2$ |
| **Exponential** | **0,268** | **,450** | $\mathbf{\Delta Y = - 0{,}0575 - 0{,}1882\ \Delta F + 15{,}5869\ \Delta F^2 + 100{,}57\ \Delta F^3}$ |
| ***For exports*** | | | |
| **Linear** | **0,234** | **,111** | $\Delta Y = \mathbf{- 0{,}0245 + 0{,}1762\ \Delta X}$ |
| Inverse | 0,006 | ,815 | $\Delta Y = - 0{,}0323 + 0{,}002 / \Delta X$ |
| Square | 0,241 | ,288 | $\Delta Y = - 0{,}0285 + 0{,}1717\ \Delta X + 0{,}0896\ \Delta X^2$ |
| Exponential | 0,332 | ,330 | $\Delta Y = - 0{,}0005 + 0{,}5481\ \Delta X - 0{,}0012\ \Delta X^2 - 2{,}157\ \Delta X^3$ |

*Source: Own calculation*

*Table 2.*

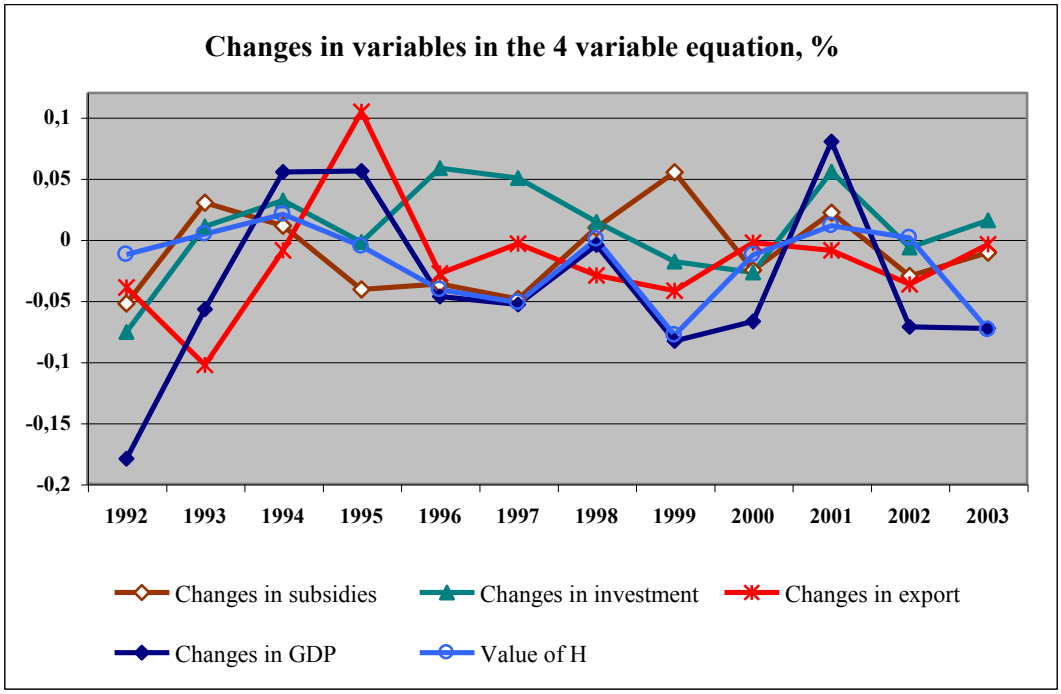
**Data for the variations of the model**

| | | | |
|---|---|---|---|
| ***Data related to the model*** | | | |
| **Regression equation for 4 variables:** $\Delta Y = -0{,}0197+0{,}195\Delta S+0{,}217\Delta I+0{,}236\ \Delta X$<br>**Regression equation for 6 variables:** $\Delta Y = -0{,}03088 + 0{,}187\ \Delta S + 0{,}261\ \Delta I + + 0{,}231\Delta X + 0{,}001865\ \Delta L - 0{,}188\ \Delta F$ | | | |
| | **Model with 4 variables*** | **Model with 6 variables ****** | **Better model** |
| **R** | ,89 | ,904 | 6 |
| **$R^2$** | ,792 | ,818 | 6 |
| **Standard error** | ,03569 | ,04212 | 4 |
| **Significance** | ,00300 | ,03200 | 4 |
| *Data related to the variables* | | | |
| ***Significance of variables*** | | | |
| **Miscellaneous (constant, H)** | ,194 | ,200 | 4 |
| **Subsidies(S)** | ,031 | ,077 | 4 |
| **Labour/Workforce (L)** | – | ,985 | Value too high, only 4 |
| **Investment (I)** | ,012 | ,025 | 4 |
| **Land area (F)** | – | ,402 | Value too high, only 4 |
| **Export (X)** | ,007 | ,018 | 4 |
| ***Standard error for each variable*** | | | |
| **Miscellaneous (constant, H)** | ,014 | ,021 | 4 |
| **Subsidies(S)** | ,075 | ,088 | 4 |
| **Labour/Workforce (L)** | – | ,097 | Value too high, only 4 |
| **Investment (I)** | ,068 | ,088 | 4 |
| **Land area (F)** | – | ,209 | Value too high, only 4 |
| **Export (X)** | ,066 | ,072 | 4 |

**1 dependent (GDP) and 3 independent (subsidies, investment, export) variables*
***1 dependent (GDP) and 5 independent (subsidies, investment, export, plus workforce, land area) variables*

*Source: Own calculation*

*Figure 13.*




*Source: Own calculation*

*Table 3.*

**Rates of substitutability**

| *Year* | Subsidies/ Investments | Proportion of Gradients | Nominal values after modification * | | New ratio of variables (Subsidies/ Investments) |
|---|---|---|---|---|---|
| | | | Subsidies | Investments | |
| **1992** | 1,91358 | 1,97 | 40228,45 | 10671,37 | *3,769753* |
| **1993** | 2,169405 | 2,96 | 72346,88 | 11266,46 | *6,421438* |
| **1994** | 2,314116 | 2,38 | 63971,31 | 11615,11 | *5,507596* |
| **1995** | 1,997771 | 3,75 | 22384,11 | 42017,05 | *0,532739* |
| **1996** | 1,598803 | Not possible | | | |
| **1997** | 0,925971 | Not possible | | | |
| **1998** | 0,898927 | 1,49 | 16573,87 | 27471,72 | *0,603306* |
| **1999** | 1,23302 | Not possible | | | |
| **2000** | 1,261533 | 1,45 | 29053,75 | 15883,11 | *1,829223* |
| **2001** | 1,288538 | 1,14 | 23150,96 | 20482,2 | *1,130297* |
| **2002** | 1,170856 | 4,33 | 20578,72 | 76103,22 | *0,270405* |
| **2003** | 1,075757 | Not possible | | | |

** Tousand HUF*

*Source: Own calculations*

*Table 4.*

**Changes in gradients**

| Year | "Investments era" 1992-1994; 1999-2000 | | |
|---|---|---|---|
| | **Gradient of investments** | **Gradient of subsidies** | **Ratio** |
| **1992** | 3,7459E-07 | 1,93637E-07 | 1,934491 |
| **1993** | -5,8119E-08 | -1,7232E-07 | 2,964914 |
| **1994** | -3,5932E-08 | -8,5864E-08 | 2,389619 |
| **1995** | | | |
| **1996** | | | |
| **1997** | | | |
| **1998** | | | |
| **1999** | 3,4205E-08 | -2,8738E-07 | Not possible but better |
| **2000** | 1,0795E-07 | 7,48574E-08 | 0,693431 |
| **2001** | | | |
| **2002** | | | |
| **2003** | | | |
| **Year** | **"Subsidies era" 1995-1998; 2001-2003** | | |
| | **Gradient of investments** | **Gradient of subsidies** | **Ratio** |
| **1992** | | | |
| **1993** | | | |
| **1994** | | | |
| **1995** | 3,8046E-08 | 1,42569E-07 | 3,747234 |
| **1996** | -8,4842E-08 | 1,25666E-07 | Not possible but better |
| **1997** | -3,4456E-07 | 1,82301E-07 | Not possible but even better |
| **1998** | -1,2177E-07 | -8,2213E-08 | 1,481215 |
| **1999** | | | |
| **2000** | | | |
| **2001** | -1,5410E-07 | -1,3613E-07 | 1,131963 |
| **2002** | 2,2165E-08 | 9,60929E-08 | 4,335223 |
| **2003** | -7,5435E-08 | 1,17272E-08 | Not possible but worser |

*Source: Own calculation*