The supply response and structural breaks in Slovene agriculture

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in

Mergos G. (ed.).
Agricultural price reform under transition in Bulgaria, Romania, and Slovenia

Chania : CIHEAM
Options Méditerranéennes : Série B. Etudes et Recherches; n. 22

1998
pages 132-146

SUPPLY RESPONSE AND STRUCTURAL BREAKS IN SLOVENE AGRICULTURE

Emil ERJAVEC, Danilo GAMBELLI and Jernej TURK

ABSTRACT

Supply response and structural breaks during a 30-year period (1966-95) were evaluated. The Kalman filter procedure was applied in order to establish supply elasticities for six (6) agricultural products. The results obtained concerning the agricultural supply response to changes in prices are interesting. High supply elasticities were obtained for beef and maize, while low elasticities were obtained for pork and potato, and very low supply elasticities were obtained for wheat and milk, perhaps indicating a high degree of State intervention (regulations) in the latter two individual agricultural markets in the past. The values of cross-price elasticities point at different complement and substitute relationships between various farm commodities.

Keywords:

SLOVENIA, AGRICULTURAL SUPPLY, KALMAN FILTER, TRANSITION ECONOMIES

1. Introduction

The production and economic characteristics of Slovene agriculture differ markedly from those prevailing in other Central and Eastern European countries (CEECs). The importance of agricultural production within the national economy is low; Slovenia is a net food importer with a dual farm structure. Small-scale, part-time farming dominates the farm structure, but an important market share of agricultural production (about a quarter) is provided by the former, State-run farms; after transition during the 1990s they were transformed into different types of businesses. Farm product prices approach the corresponding price levels in the EU; the PSE coefficient amounts to 40% (KIS, 1996), which probably constitutes the highest level of protectionism in all the CEECs. Non-stimulating agricultural policies of the past, which favoured the shaping and development of larger State-owned farms and discriminated against traditional peasant farms, are now mostly reflected through the low productivity levels attained by individual agricultural producers on family farms.

Slovenia is one of the potential candidates for accession to the EU. The impact of gradual integration of the domestic economy into the EU on the performance of agriculture can only be assessed by setting an appropriate empirical framework. Hence quantitative tools must be used to estimate supply elasticities, which are one of the prerequisites for the production of reliable agricultural policy recommendations. It should be stressed here that over the last eight years, no empirical supply analysis has been carried out in Slovenia with the aim of establishing agricultural supply elasticity coefficients. Given the great importance of elasticities in applied research, our decision to estimate the Slovene farm producers' response is further vindicated.

The main objective of this paper is therefore to evaluate the farmers' response to producer price changes for several agricultural commodities. Differences between various agricultural products may well be expected and, on this basis, forecasts of future trends in the implementation of agricultural price policy mechanisms for different farm goods will be made. If empirical estimates prove to be

sufficiently accurate, a final stage in the analysis would be to identify feasible structural breaks (changes) during the long-term period (1961-1995) of agricultural development in Slovenia. We dare to speculate that in this way the effects on supply response of a radical change in agricultural policy, with the introduction of input subsidies for family farms, can be assessed for the 1970s. Furthermore, some consideration can also be given to the estimation of the impact of the transitional period - which in fact began in Slovenia in the middle of the 1980s - and on the impact of Slovene independence in 1991 and the related loss of the large Yugoslav market for agricultural commodities.

During the last four decades, Slovenia has had "a semi-open market type of economy" with relatively free markes of goods, labour and capital, but a limited financial market. An assumption was made that this is a suitable condition for the use of long time-series data available for empirical purposes.

The structure of the paper is as follows: firstly the supply profiles of some main agricultural products taken into account for the estimations of elasticities are discussed. Secondly, a Kalman filter procedure has been chosen to estimate agricultural supply response; this is briefly reviewed with the explanation of partial models for agricultural products. Thirdly, special emphasis has been placed on the representation and discussion of the own and cross-price elasticities computed in this empirical analysis. Finally, the results are used to derive some conclusions concerning supply response and structural changes in Slovene agriculture.

2. Supply Profiles

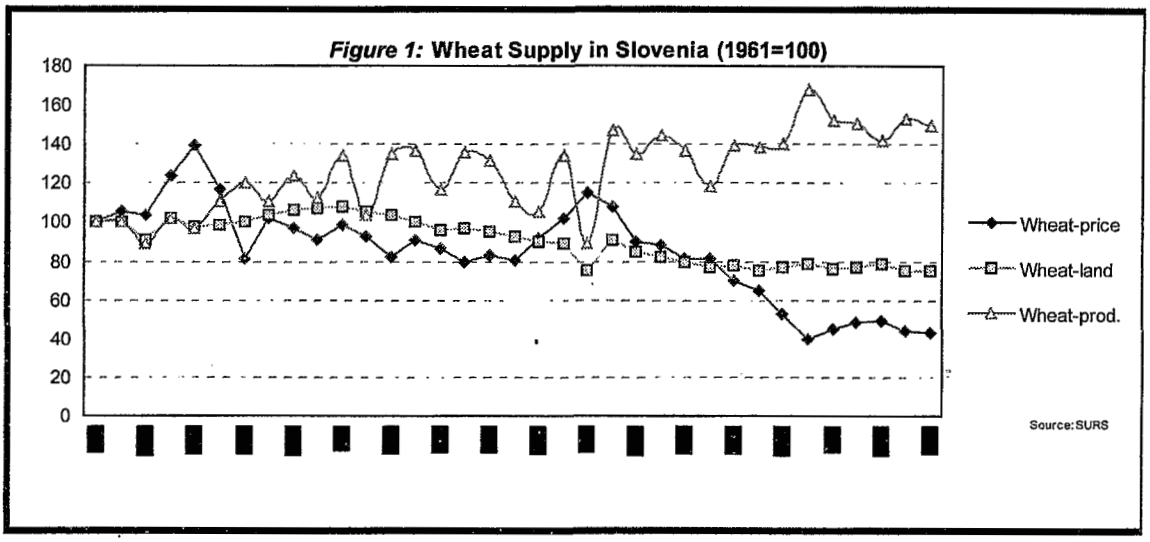
2.1. Data sources and explanations

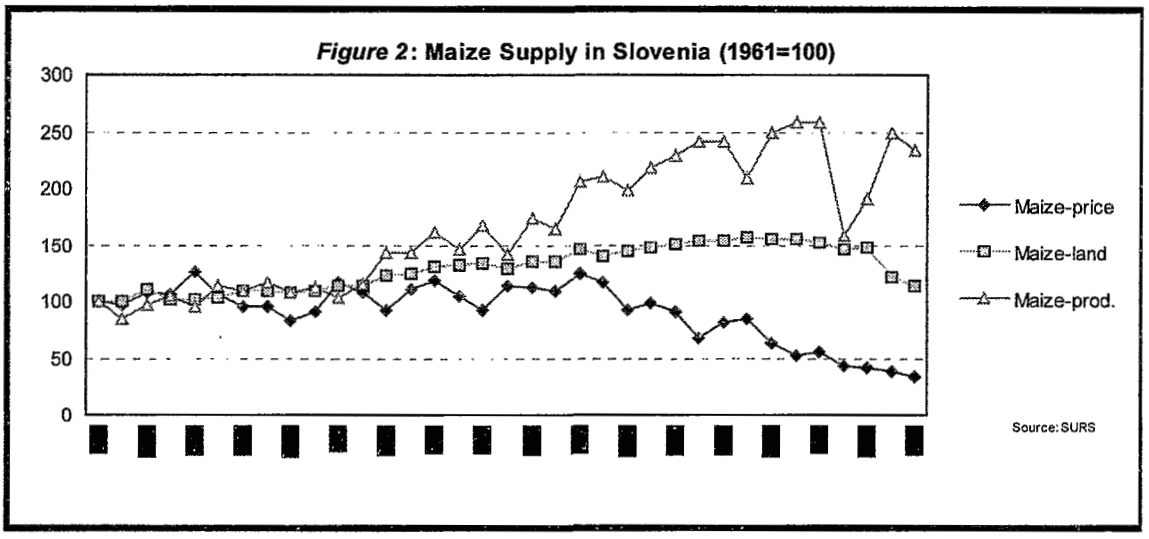
The process of data compilation was one of the key steps necessary to carry out this analysis of agricultural supply effectively. All quantities, factor and product prices, labour and land statistics were selected from two main data sources (SURS: Statistical Office of the Republic of Slovenia and KIS: Agricultural Institute of Slovenia). In the first stage, all the data available were reviewed and statistical information for all the staple agricultural commodities (12) was gathered for the period between 1961 and 1995. However, after statistical tests had first been carried out 6 major farm products were finally chosen for the Slovene supply analysis. These agricultural commodities are: wheat, maize, potato, milk, beef and pork, representing almost two-thirds of the total Slovene gross agricultural output. During the period studied (1961-1995), the accuracy of price data for all 6 products did not diminish significantly and even the rapid establishment of certain price patterns was possible.

2.2. Prices, production and policy in the crop sector

Slovenia is not self-sufficient in grain. The factors contributing to this situation are unfavourable conditions for production, small and fragmented farm structure and an agricultural policy designed in the past which mostly favoured livestock production. In the private farm sector the final result was the "supplementary nature" of grain production. Certain former State-run farms in the flat regions of Slovenia, however, remained important grain-producing enterprises.

During the period under discussion, the level of wheat production has exhibited certain oscillations (Figure 1). Yields and total production increased, but the area of land cultivated by wheat producers decreased. Therefore, despite yields per hectare about two times higher, the total volume of wheat production increased by 50%. Production was mainly supported by the implementation of input subsidies (e.g. seed and loan subsidies). Until 1970 the support was given only to the former State-run farms; later however it was also given to the private farm sector. The price of wheat was fixed by the State and guaranteed prices were set throughout the whole period. However, the price of wheat over the last 35 years has practically halved, with two price increases registered (one in the mid - 1960s and the other at the beginning of the 1980s).

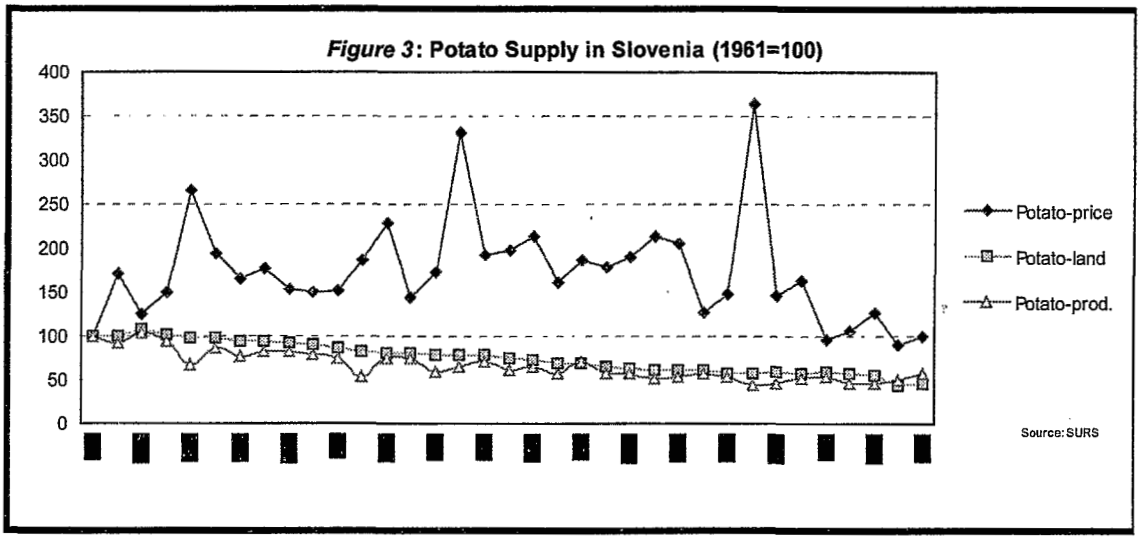




Maize production in Slovenia is seen, first and foremost, as an important source for feed where animal husbandry on the same farm is concerned. Maize was marketed only when higher prices emerged and when total grain production was abundant. With the increases in livestock production, maize output also rose. Despite only a slight increase in the amount of land used for growing maize, it is estimated that 2.5 times more maize is produced now than it was 35 years ago (Figure 2). It must be emphasised that maize yields per hectare have increased markedly over the first years of transition (up to 1992). During the last decade significant price reductions have taken place (i.e. the price of maize in 1995 was one third of the price in 1984). This was the result of domestic agricultural policy.

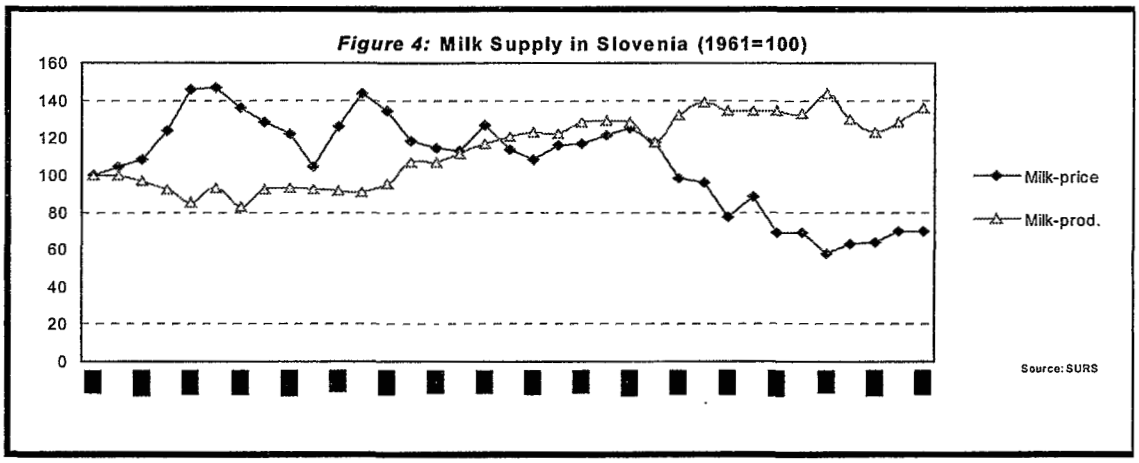
Traditionally, Slovenes are potato producers and consumers; this has resulted in the high own-production and consumption levels of potatoes of the past. The majority of farms, as well as a significant number of rural households and some urban households, did not produce potatoes for the market. After 1970, the total of potato production decreased and today it is only half that of 1961 (Figure 3). Potato production has also become increasingly market-orientated; Slovenia has supplied several ex-Yugoslav markets with potatoes. The reduction in supply, as a consequence of increasing demand and the absence of any special framework for market policy, has resulted in relatively high price levels. It is interesting that the productivity level is relatively low and that yields did not change

significantly in the period in question.



2.3. Prices, production and policy in the livestock sector

Due to the discriminatory policy against the private farm sector, milk output did not increase during the 1960s. The farm policy changes at the beginning of the 1970s, which recognised the genuine role of private farming in Slovenia, have brought about significant improvements in milk production on family farms. With strong State investment supports, farm infrastructure was first established between 1972 and 1982. The building-up of infrastructure was concerned with breeding services, milking equipment and housing. As a result, milk production has been enhanced by one half during the period between 1975 and 1985 (Figure 4). Total milk production has remained at the same level after this growth in output, despite the increase in the average milk yield per cow, since the number of cows has declined. This was mainly the result of an unfavourable price situation in the milk market after the first years of transition. After 1991, milk prices became relatively stable, at a level equal to 50-60% of the milk prices at the beginning of the 1960s. During the whole period under discussion, the milk price was set and controlled by the Slovene Government, and also during certain periods by some of the dairy industry associations (this was the typical Yugoslav self-government "style" of political system) .



Slovene beef production exhibits dual characteristics. On the one hand, it is a by-product of cattle production on private farms; on the other, a beef industry has developed which was based mostly on

the former State farms. In the past, farms bought calves for fattening from other former Yugoslav republics. Most of these animals were later exported as carcasses to Italy. It should be stressed here that in the beef sector, the daily gains and the carcass weights also significantly increased in the period in question. Thus total beef output increased to reach figures up to 2.5 times more than those from the beginning of the period (1960s). As Figure 5 shows, there is a noticeable decline in beef production in the first years of transition (i.e. through the loss of the Yugoslav calf market). Price movements are similar to milk price shifts, i.e. there are relatively high price levels until 1984, with a subsequent price reduction during the last 10 years of the period. It should be noted that beef prices were increasingly market-determined. In addition, relatively strict border controls (for protection) were introduced and remained more or less in place after transition.

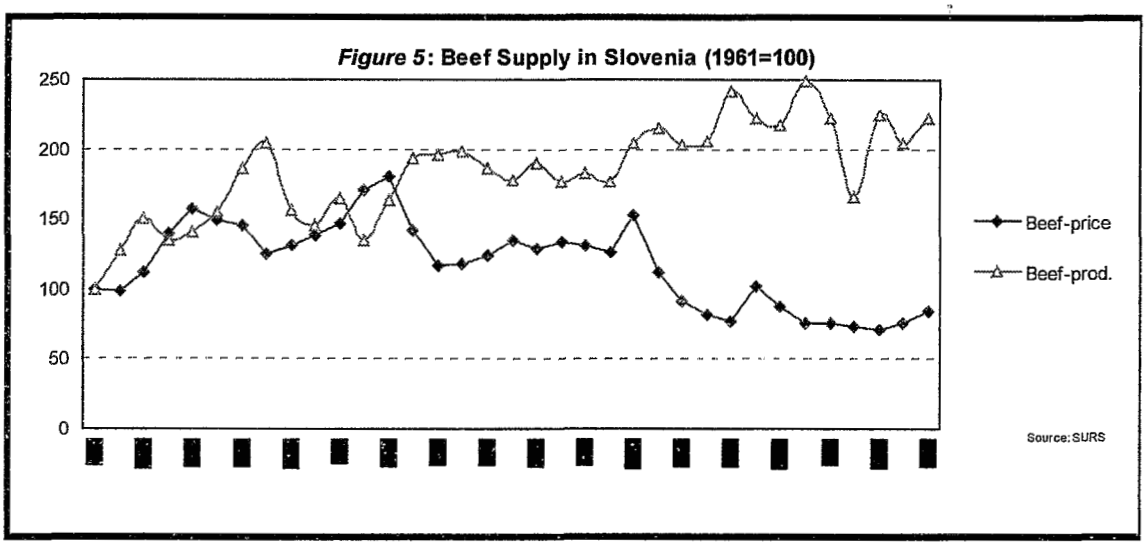


***Figure 5*: Beef Supply in Slovenia (1961=100)**

Pig production in Slovenia is shared proportionately between production on State farms and production on family farms. This is the agricultural sector with one of the highest growth rates in the last 35 years (Figure 6), which is generally the result of the establishment of industrial pig production on the State-run farms. From the 1960s onwards, the Government supported the development of eight different State farms (all of them huge - the two largest of these produce around 90,000 slaughter hogs per year) which at the end of the period account for half of the Slovene pork market. Private pig production is small- scale, mostly for own consumption, and directly sales-orientated. It is not surprising that the monopolistic position of State farms led to relatively stable price movements for pork until 1990. There were some remarkable pig cycles, but their impact on prices was not dramatic. The stable price trend was curtailed in the first transitional years when certain price reductions were observed. As in the case of the beef sector, border controls were already established in the former Yugoslavia; now Slovenia became an independent state.

3. The Estimation Procedure: Kalman Filter

Consider the usual GLM framework.

1) $\mathbf{y=Xb+e}$

with the standard assumptions about the covariance matrix:

2) $\mathbf{e} \approx N(\mathbf{0}, \mathbf{V})$

and the ortogonality condition $E(\mathbf{X'e})= \mathbf{0}$.

y is a nx1 vector of the depending variable through time, X is the nxk regressors matrix and **b** is a kx1 vector of (fixed) coefficients.

Then the OLS estimator $\hat{\beta}_0$ is BLUE, with covariance matrix and deviation respectively defined as:

3) $\text{Cov}(\hat{\beta}_0) = \mathbf{P}_0 = \sigma^2(\mathbf{X}'\mathbf{X})^{-1}$

4) $\hat{\beta}_0 - \beta = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\,\mathbf{e}$

We can now define the one-step-ahead forecast errors as

5) $\tilde{\mathbf{v}}_1 = \mathbf{y}_1 - \tilde{\mathbf{y}}_1$

where $\mathbf{y}_1$ is a qx1 vector of q new observation of variable **y** and $\tilde{\mathbf{y}}_1$ is the prediction of such a vector obtained by assuming an unchanged structure of model 1) and considering a qxk matrix $\mathbf{X}_1$ of q new observations of regressors.

The $\tilde{\mathbf{y}}_1$ is an unbiased prediction of the values $\mathbf{y}_1$; it only considers information available up to the forecast period, assuming no structural change in the model (i.e. time-invarying coefficients).

The Kalman procedure differs form the standard GLM as the coefficients are now treated as stochastic, so that they are allowed to vary over time. The stochastic generating process of the dependent variable **y** defined in 1) must now be associated with a stochastic generating process for the vector of coefficients **b**, supposing that some initial information $\mathbf{b}_0$ about the coefficients vector is available. A recursive procedure can be implemented, so that once the "new" observations for t>0 are available, the coefficients' vector $\mathbf{b}_0$ can be updated according to the new sample information.

To exploit the time variation specification of the coefficients, model 1) has to be redefined in a state-space formulation:

6) $y_t = \mathbf{x}_t'\beta_t + \varepsilon_t \qquad (t = 1,\ldots,n)$

7) $\beta_t = \mathbf{T}\beta_{t-1} + \mathbf{R}\eta_0$

8) $\mathbf{b}_0 = \beta_0 + \psi_o$

where $\varepsilon_t \approx N(0,\sigma^2)$, $\eta_t \approx N(0,\mathbf{Q})$, $\psi_t \approx N(0,\Psi_0)$. Equations 6), 7), 8) are respectively the measurement equation, the transition equation and the prior estimate of the coefficients; **x** is (kx1), **b**'s are (kx1) and **T**, **Q**, **R** are (kxk), and we consider $\mathbf{V} = (\sigma^2\mathbf{I})$. In what follows, these matrixes are treated as fixed and known, although in a more general definition of the Kalman Filter, they can be regarded as depending on a set of unknown parameters, and vary over time.

In order to apply the usual least squares estimates to model 6) - 8), we have to express it in a matrix notation. For the first period (t = 1) we have:

9) $$\begin{pmatrix} y_1 \\ \hat{\beta}_{1/0} \end{pmatrix} = \begin{pmatrix} \mathbf{x}_1' \\ \mathbf{I} \end{pmatrix} \beta_1 + \begin{pmatrix} \varepsilon_1 \\ \omega_1 \end{pmatrix}$$

where

10) $\hat{\beta}_{1/0} = \mathbf{T}\hat{\beta}_0$

is the unbiased predictor of β_1, i.e. the prediction of β_1 given the information available at time 0. ω_1 can be considered as the prediction error in forecasting β_1, and is defined as

11) $\omega_1 = \left(\hat{\beta}_{1/0} - \beta_1\right)$

As $\beta_1 = \mathbf{T}(\hat{\beta}_0 - \psi_0) + \mathbf{R}\eta_1$, from 10) results

12) $\omega_1 = \mathbf{T}\psi_0 - \mathbf{R}\eta_0$

which clearly shows that the prediction error can be regarded as a weighted average of the uncertainty in the prior estimate, ψ_0 and the uncertainty in the updating equation of **b**, η_1.

The covariance of $\hat{\beta}_{1/0}$ is defined as

13) $\mathbf{P}_{1/0} = \text{Cov}(\hat{\beta}_{1/0}) = \text{E}(\omega_1\ \omega_1\text{'}) = (\mathbf{T}\,\mathbf{P}_0\,\mathbf{T}\text{'} + \mathbf{RQR}\text{'})$

Equations 10) and 13) are the predicition equation at t+1 for the coefficients vector (i.e. state vector) β_t and its covariance matrix. Note that they can be calculated without any reference to the observation **y**.

We are now in the position to define the Kalman Gain, which is used to update the coefficients' vector, according to the stochastic variability of the measurement and state equation and to the one-step-ahead errors occurring at each step of the recursive estimation procedure.

For t = 1 we can define the so-called Kalman gain as the (kx1) vector:

14) $\mathbf{K}_1 = \mathbf{P}_{1/0}\mathbf{x}_1 f_1^{-1}$

where f_1^{-1} is a scalar defined as

15) $\text{f}_1^{-1} = (\mathbf{x}_1^{'}\mathbf{P}_{1/0}\mathbf{x}_1 + \sigma^2)$

The optimal updating equations for $\hat{\beta}_1$ and $\mathbf{P}_1$ are respectively

16) $\hat{\beta}_1 = \hat{\beta}_{1/0} + \mathbf{K}_1\tilde{\mathbf{v}}_{1/0}$

17) $\mathbf{P}_1 = (\mathbf{I} - \mathbf{K}_1\mathbf{x}_1^{'})\mathbf{P}_{1/0}$

where $\tilde{\mathbf{v}}_{1/0}$ is the one-step-ahead error defined as $y_1 - \mathbf{x}_1^{'}\hat{\beta}_{1/0}$

The updated values $\hat{\beta}_1$, $\mathbf{P}_1$ are then used in equations 10) and 13), so that the recursive estimation sequence can operate once the "new" information on y_t and $\mathbf{x}_t$ is considered.

Note that the usual recursive least squares can be defined as a special case of the Kalman Filter estimation procedure by setting $\eta_t = 0$; **Q** = **R** = 0; **T** = I.

The prediction equations are

18) $\hat{\beta}_{t/t-1} = \hat{\beta}_{t-1}$

19) $\mathbf{P}_{t/t-1} = \mathbf{P}_t = \sigma^2(\mathbf{X}'\,\mathbf{X})_{t-1}^{-1}$

and the updating equations become

20) $$\hat{\beta}_t = \hat{\beta}_{t/t-1} + \mathbf{K}_t(y_t - \mathbf{x}_t'\hat{\beta}_{t/t-1})$$

21) $$\mathbf{P}_t = (\mathbf{I} - \mathbf{K}_t\mathbf{x}_t')\mathbf{P}_{t/t-1}\,.$$

4. Estimation of Supply Elasticities

4.1. Descriptions of models and results

In view of the unavailability of data about labour and intermediate input costs for the whole period, it was not possible to use one of the dual approaches in supply response analysis proposed in the literature (see *inter al.* Thijssen, 1992 and 1995). We decided to carry out a detailed analysis of the way in which the quantities of each product supplied reacted to variations in both its own price and the prices of related products. In particular we were concerned with the following products: wheat, maize, potatoes, pork, beef, poultry and milk (Table 1).

The explanatory variables for wheat are lagged prices of wheat, lagged prices of maize and land used for wheat production. Maize production is regressed on lagged prices of maize, lagged prices of wheat, lagged prices of beef and pork, and land used in maize production. In fact, the maize is largely used for animal feed on private family farms; our expectation is thus that high prices for animal products can have consequences for animal production and hence for maize production.

The potato supply is explained only by the lagged prices of potatoes. In this case, we did not find a reasonable connection with the price of wheat, or with the land cultivated for potato. Our prior estimations led us to the conclusion that due to relatively higher yields, a real problem of land scarcity in the potato sector did not exist and that there is not a strong connection between the production of potatoes and that of the other two crops examined.

In the analysis of the meat supply, each product (i.e. beef, pork, poultry) has been explained with its own lagged prices and the lagged prices of maize, which is largely used for animal feed. Milk production has been regressed on its own lagged price and on the lagged prices of beef. This is because farmers who mostly breed dual-purpose cattle can decide to support more milk or beef production on the same farm. The opposite impact - the influence of the milk price on the beef supply - was not noted as statistically significant, a finding which we interpret to be a result of the organisation of beef production of which an important share was accounted for by specialised beef farms not engaged in milk production.

The functional form for each model is a Cobb-Douglas form, as the use of logs for the linearisation of the equations helps to reduce variability in the data and yields a straight interpretation of elasticities for the coefficient estimates.

A Kalman Filter is used in this estimations procedure. The Kalman Filter estimator allows for coefficient variations over the sample, so that it is possible to analyse whether some significant variation in the estimates of coefficients occurs. In particular, price responsiveness might be expected to exhibit some impulses during the years of the political and economic transition of Slovenia to market economy.[23]

Table 1 provides empirical estimates of the Kalman filter procedure. Elasticities are computed for each farm good. Own and cross-price elasticities are derived where applicable. Except in the case of milk, the signs and sizes of all other parameter estimates generally agree with economic reasoning. Statistical tests of significance show a relatively high degree of statistical consistency of models for

[23] See section 3 for a more detailed description of the Kalman Filter estimation.

maize, potato, pork and beef. High land coefficients for maize and wheat suggest land scarcity for these two field crops.

Table 1. Models Results

Variable wheat	Coefficient	Error	t-statistic	Variable pork	Coefficient	Error	t-statistic
C	3,974	0,964	2,024	C	4,011	0,562	7,137
pWHEAT(-1)	0,037	0,960	0,385	pPORK(-1)	0,451	0,179	2,519
pMAIZE(-1)/ WHEAT	-0,174	0,146	1,188	pMAIZE(-1)/ PORK	-0,265	0,129	-2,044
WHEAT-land	0,454	0,163	8,901				
maize				**beef**			
C	4,206	4,630	0,908	C	1,956	0,500	3,914
pMAIZE(-1)	0,984	0,239	4,117	pBEEF(-2)	1,038	0,498	2,083
pWHEAT(-1)/ MAIZE	-0,505	0,230	-2,192	pMAIZE(-1)/ BEEF	-0,430	0,113	-3,817
pBEEF(-1)/ MAIZE	0,630	0,566	1,113				
pPORK(-1)/ MAIZE	0,256	0,286	0,894				
MAIZE-land	1,016	0,360	2,823				
potato				**milk**			
C	13,476	0,257	52,436	C	13,256	0,466	28,442
pPOTATO(-1)	0,113	0,063	1,802	pMILK(-1)	-0,040	0,121	-0,333
				pBEEF(-1)/ MILK	-0,657	0,351	-1,870

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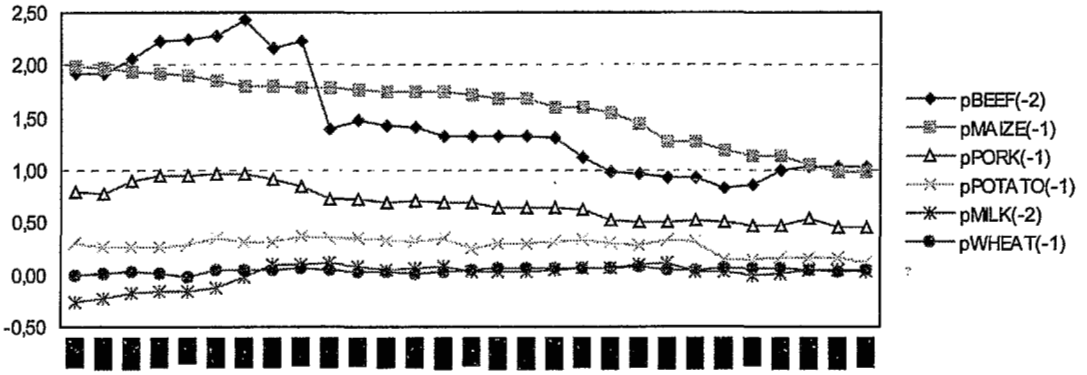
4.2. Own-price elasticities

The sizes and paths of supply own-price (lagged) elasticities over the period can clearly be seen from Figure 7. Three different groups of products can be distinguished. The first group is represented by maize and beef. These are two agricultural goods with high elasticity coefficients; whereas in the first decade the elasticity coefficient for both products approaches 2, and at the end of the period observed this value has decreased to 1. Reasons for high elasticity coefficients can be sought in the fact that these are mainly intermediate goods; as such they are not really market products (maize) or in the case of beef, price dependent products. If the price of maize went up, for instance, other foodstuffs would be used; if the beef price increased farmers would buy more calves. Rapid reduction

[24] See section 3 for a more detailed description of the Kalman Filter estimation.

***Figure 7*: Supply Own-Price (Lagged) Elasticities for Agricultural Products in Slovenia**



in the values of supply elasticity coefficients for maize and beef over time may be explained by the growing economy and its side-effects on agriculture, where market structures became more developed.

A similar declining trend in the values of own-supply elasticities is noticeable with the second group of agricultural products (pork and potatoes). These are particularly own-consumption products for the non-specialised farms, or main farm products on the specialised farms, and as such represent a chief source of farm income. Alongside the significant technical progress achieved in the case of both types of farming activities, a capitalisation of production has gradually taken place which could be a reason for the declining tendency in the elasticities. Pig producers responded more to price changes than farmers involved in potato growing. Elasticity supply estimates comply with economic reasoning and are comparable with the estimates found in the literature. At the end of the period, the own-price elasticity for potato is 0.11, whereas the corresponding estimate for pork is 0.45. The own-price elasticities computed for these products indicate the unwillingness of Slovene farmers to radically adjust the quantity they produce in the light of farm price changes.

The third group of agricultural products is composed of wheat and milk. Because of the State monopoly in these two markets and guaranteed product prices, the supply elasticity coefficients are close to zero and insignificant. We speculate that the other reason for this may be found in a traditional type of production with a higher value of own consumption (milk and wheat), and in the importance of quasi-fixed factors (milk production). Slovene farmers are somehow used to producing either milk or wheat regardless of the level of economic efficiency or earnings.[25] Not surprisingly, no particular structural breaks (changes) have been noticed in either wheat or milk production.

Certain structural changes, however, can be seen in the case of four other farm products. The first period relates to 1972 and 1976, when the first steps were taken towards market-organised production on family farms. Elasticity estimates have particularly declined for beef and pork. The second wave of changes is actually related to the process of economic transition which began in Slovenia in the mid 1980s. Changes occurred mainly in maize, potato and beef production due to the loss of the input/output market of the former Yugoslavia. This did not affect the supply of pork meat, where changes on the market were not that dramatic.

[25] It should be noted that similar results were also obtained for horticulture products (hops, wine, apples) and poultry. Because of the unreasonable signs of coefficient the results were not represented here.

4.3. Cross-price elasticities and land coefficients

Various supplement and complement linkages between farm goods were included in this model (Figure 8). A clear complement (positive) effect of pork prices on the quantity of maize produced was established. The same sign of relationship between the beef price and the supply of maize was restored at the end of the period. At the end of the period the reverse relationship (maize-pork and maize-beef) became the case. It is interesting that at the beginning of the period a completely opposite relationship between the price of maize and the quantity of pork exists, but later this relationship gradually gained a different (theoretically right) momentum.

The strongest substitute relationship is traced between milk and beef. If the beef price increased, the supply of milk clearly decreased. During the whole period a slight substitute linkage was traced between wheat and maize. The price of wheat has a stronger impact on the quantity of maize than the price of maize on the quantity of wheat, which confirms our hypothesis concerning the intermediate nature of maize production.

There are two structural breaks to be observed here. Nevertheless, when cross-price elasticity amplitudes are analysed these effects are not as apparent as they were in the case of the own-price elasticity presentation (Figure 7). The most recent transitional period (1991-1995) has certainly not contributed any important event or occurrence to change this course.

The land scarcity represented by the land coefficients is particularly obvious in wheat and also in

Figure 8: **Supply Cross Elasticities for Agricultural Products in Slovenia**

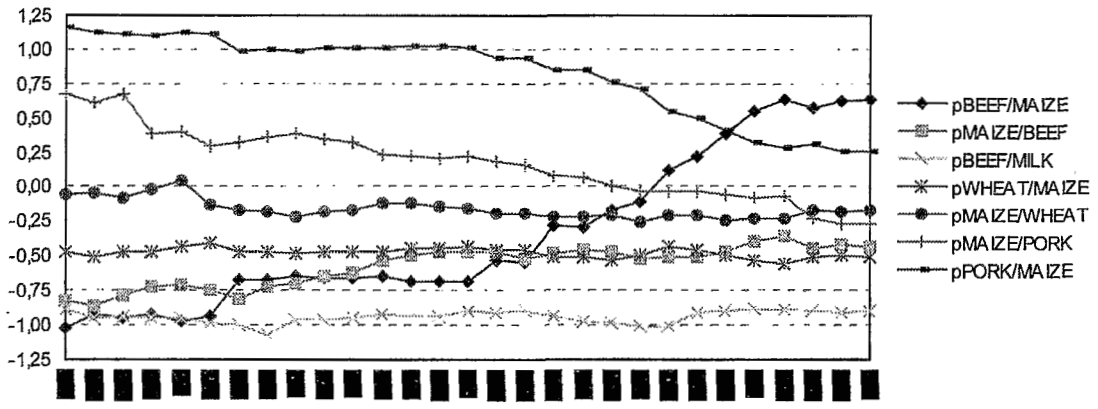
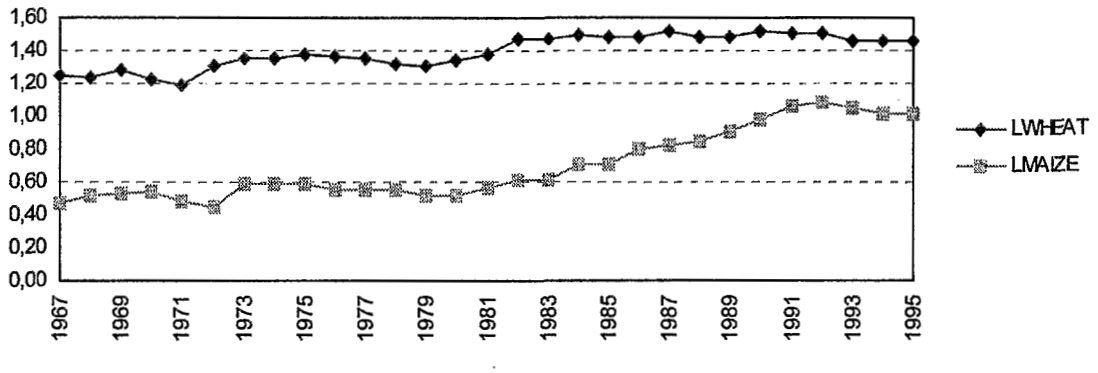


Figure 9: **Land Coefficients for Wheat and Maize in Slovenia**



maize farming, as can be seen from Figure 9. Since the mid-1960s there has been an increasing tendency in land coefficient growth, supporting the thesis concerned with the problem of land scarcity in crop production in Slovenia which is mentioned by several domestic authors (Rednak et al. 1995).

5. Conclusions and Policy Implications

This paper is concerned with the examination of production and price trends in Slovene agriculture over the period between 1961 and 1995. Own and cross-price elasticities for six main agricultural products are established (i.e. for wheat, maize, and potatoes in the crop sector, and milk, beef, and pork in the meat sector). During the whole period total production has more than doubled for meat and maize production; a somewhat lesser degree of output growth is registered for wheat and milk production, whereas potato production has decreased on the 50% of production level in 1961.

The agricultural policy framework differed significantly for different farm products. In the past the market conditions for potato, pork and beef production were already relatively developed, and a more or less absolute State control was exercised on the milk and wheat "markets" (i.e. there was a State monopoly in the purchase of wheat and milk, with a system of guaranteed prices for these two commodities). Maize is grown by livestock farmers and is, therefore, not for sale, unless there are abundant yields or very favourable producer prices for the crop.

The prices of all farm products exhibit a declining tendency which is the most profound in the case of maize, wheat and pork, and weakest in the case of potatoes. It is interesting to observe that farm price reductions are most significant during the process of economic transition which began in Slovenia in the mid-1980s.

The Kalman filter procedure has enabled the calculation of supply elasticity coefficients for each separate year. Where the magnitude of the elasticity coefficients is concerned, three groups of agricultural products can be distinguished:

i.) Those with high supply elasticities which at the end of the period approach the value of 1.00 (beef and maize). These are farm goods not regulated by the State, but depend largely upon various market trends. We also speculate that both these products are not that strongly affected by the effects of quasi-fixed factors of production.

ii.) Those with low supply elasticity coefficients with the values falling below 0.50 and lower at the end of the period (pork and potatoes). Slovene farmers involved in potato and pork production have encountered quasi-market conditions over the period in question, with a State intervening to a larger extent than in the previous case. Governmental intervention mainly comprises the implementation of foreign trade protectionism mechanisms and even of input subsidies. The presence of quasi-fixed factors of production is much higher than in group I.

iii.) A third group of farm products is represented by wheat and milk. Elasticity coefficients are close to zero. There is a high degree of State regulation in wheat and milk market organisations over the whole period. This regulation is manifested mostly through the implementation of guaranteed prices for wheat and milk and through the establishment of the system of input subsidies. From the perspective of agricultural policy, wheat and milk are undeniably the most important farm goods in Slovenia. Furthermore, small private farmers largely engaged in wheat and milk production do not generally respond to market changes (i.e. price shifts). Milk production also falls within an environment of quasi-fixed factors of production.

On the basis of the empirical estimates obtained, the conclusion is drawn that agricultural supply elasticities in Slovenia have constantly been diminishing along with:

– The growing importance to agricultural policy of a particular farm product and the related high degree of State intervention(s) in the market of that good

- The presence of quasi-fixed factors of production
- The habitual ability of private farmers to achieve a certain volume of production from "traditional" farming activities, without particular consideration of the economic implications.

A Cobb-Douglas type of supply model was used where price impacts of either substitutes or complements were applied in accordance with the statistical significance of the parameter estimates of the specific farm goods. As previously expected, important linkages appeared between maize and meat, maize and wheat and between beef and milk. As expected, complement relationships are valid for maize and meat (pork and beef), with substantial changes over the period. There are two substitute relationships: beef - milk and wheat - maize (the latter is not so strong).

By including land as an exogenous variable in the model, an attempt was made to expose the issue of land scarcity in the empirical study of Slovene agricultural supply. The issue of land scarcity especially emerges in the case of wheat production, and to a lesser extent in that of maize. No effect of the land factor was detected in the case of potato production.

Another objective of this paper was to examine the impact of structural changes on the magnitude of supply response. Two structural breaks are actually traced. The first of these occurred in the mid-1970s, with a sudden change in Slovene agricultural policy towards support for private farmers (i.e. structural policy measures). The second structural break took place in the mid-1980s when certain democratic and market reforms were gradually undertaken. These effects became even stronger with the process of Slovene independence in 1991. Both structural breaks can be observed (i.e. for beef and pork in the first stage, and for maize and potatoes in the second phase); they are not as clear as expected. Surprisingly enough, transitional effects cannot be identified as constituting a shock movement during any precise period. This leads to the conclusion that the extent of agricultural reforms has been defined gradually and that they started long before the process of political transition (the first democratic elections and the declaration of independence took place in 1990/91). The most important conclusion here is that the regime of agricultural policy has indeed not changed to a degree which would dramatically affect the price responsiveness of private farmers.

What policy implications can be derived from this empirical study? The values of elasticity coefficients for very important farm sectors (wheat and milk) do not allow us to conclude that a change in the course of domestic agricultural policy (for example: Slovene accession to the EU) would lead to significant changes in agricultural supply response. These would more likely be effected through growing farm productivity levels and constant technological progress. Although there was a stronger response in the case of potato production than in that of milk and wheat, the response of potato growers would not accompany the possible dramatic changes taking place in the socio-political and economic environment. Market changes would have more influence on pork production; however, the strongest response is expected in the production of beef and coarse grain (maize). Because the production of these two farm goods takes place in a virtually market-free environment, the adoption of more protectionist CAP mechanisms in both sectors would significantly (positively) affect the supply of these two Slovene agricultural products. This is clearly pure speculation, since it is almost impossible to envisage what the CAP framework will be at the time when Slovenia enters the EU.

REFERENCES

European Commission (1995): Agricultural situation and prospects in the Central and Eastern European Countries. Brussels, EU Commision

Hall, S. (1993). Modelling structural change using the Kalman Filter, *Economics of Planning*, 26.

Hall, S., and O'Sullivan, J. (1994). Forecasting economies in transition: The case of Romania, *Economics of Planning*, 27: 175-184.

Harvey, A. (1987). Applications of the Kalman Filter in Econometrics. In: Bewley, T. (ed) *Advances in Econometrics*, 5th World Congress, Cambridge University Press.

KIS, Agricultural Institute of Slovenia (1996). Poroθilo o stanju v kmetijstvu v letu 1995. (Slovene Agricultural Report - 1995) Ljubljana, KIS

Rednak, M., Turk, J., Erjavec, E., Volk, T. (1995). Scale efficiency of Slovene family farms. V: *Proceedings of the 41st EAAE Seminar on "Challenge and Strategies for Re-establishing East-Central European Agricultures"*, Goedoelloe, 1995-09-06/08. Goedoelloe, European Association of Agricultural Economists, 1995, s.197-205

SURS, Statistiθni urad Republike Slovenije (Statistical Office of the Republic of Slovenia: different sources

Thijssen, G. (1992). Supply response and input demand of Dutch dairy farms, *European Review of Agricultural Economics,* 19, 219-235

Thijssen, G. (1995). Supply response and dynamic factor demand of Dutch dairy farms, *European Review of Agricultural Economics,* 241-258.

Watson, M. and Engle, R. (1983) Alternative algorithms for the estimation of dynamic factor, mimic and varying coefficient regression models, *Journal of Econometrics*, 23: 385-400

APPENDIX

The results of the models for the years 1966-1995

	Own price elasticities						Cross-price elasticities							Land elasticities	
Year	pBeef (-2)	pMaize (-1)	pPork (-1)	pPots. (-1)	pMilk (-2)	pWheat (-1)	pBeef/ Maize	pMaize /Beef	pBeef /Milk	pWheat /Maize	pMaize Wheat	pMaize /Pork	pPork /Maize	LWheat	LMaize
1966	2.20	1.99	0.74	0.29	0.90	-0.01	-1.02	-0.93	-1.99	-0.47	-0.02	0.81	1.16	1.22	0.47
1967	1.93	1.99	0.80	0.30	-0.26	0.00	-1.02	-0.82	-0.88	-0.47	-0.05	0.68	1.16	1.25	0.47
1968	1.92	1.98	0.78	0.26	-0.22	0.01	-0.92	-0.86	-0.95	-0.51	-0.05	0.61	1.13	1.24	0.51
1969	2.06	1.94	0.89	0.26	-0.18	0.03	-0.95	-0.78	-0.94	-0.47	-0.09	0.67	1.11	1.28	0.53
1970	2.23	1.92	0.94	0.27	-0.17	0.01	-0.92	-0.72	-0.95	-0.47	-0.02	0.39	1.10	1.22	0.55
1971	2.24	1.90	0.95	0.28	-0.16	-0.02	-0.97	-0.71	-0.95	-0.43	0.04	0.40	1.12	1.18	0.48
1972	2.28	1.86	0.96	0.35	-0.12	0.04	-0.93	-0.75	-0.99	-0.41	-0.14	0.29	1.11	1.31	0.45
1973	2.44	1.80	0.97	0.32	-0.02	0.04	-0.68	-0.81	-1.00	-0.47	-0.18	0.32	0.99	1.35	0.59
1974	2.16	1.80	0.92	0.33	0.10	0.05	-0.68	-0.72	-1.08	-0.47	-0.19	0.35	0.99	1.36	0.59
1975	2.23	1.78	0.85	0.36	0.10	0.06	-0.64	-0.70	-0.97	-0.48	-0.22	0.39	0.99	1.38	0.59
1976	1.39	1.78	0.72	0.36	0.11	0.04	-0.66	-0.65	-0.96	-0.47	-0.18	0.35	1.01	1.36	0.55
1977	1.47	1.77	0.73	0.35	0.08	0.04	-0.66	-0.63	-0.94	-0.47	-0.17	0.33	1.01	1.35	0.56
1978	1.43	1.75	0.70	0.33	0.05	0.02	-0.65	-0.54	-0.92	-0.47	-0.12	0.24	1.01	1.31	0.56
1979	1.42	1.74	0.71	0.31	0.07	0.02	-0.68	-0.50	-0.93	-0.45	-0.12	0.22	1.03	1.31	0.52
1980	1.33	1.74	0.70	0.35	0.07	0.03	-0.69	-0.47	-0.93	-0.45	-0.15	0.20	1.03	1.35	0.52
1981	1.32	1.72	0.69	0.25	0.03	0.04	-0.68	-0.47	-0.90	-0.44	-0.16	0.22	1.01	1.38	0.56
1982	1.32	1.68	0.65	0.30	0.03	0.06	-0.54	-0.47	-0.91	-0.46	-0.19	0.18	0.94	1.47	0.61
1983	1.32	1.68	0.65	0.30	0.04	0.06	-0.54	-0.52	-0.90	-0.46	-0.19	0.16	0.94	1.47	0.61
1984	1.31	1.60	0.64	0.33	0.05	0.06	-0.29	-0.49	-0.94	-0.51	-0.22	0.08	0.85	1.49	0.70
1985	1.13	1.60	0.63	0.33	0.06	0.06	-0.29	-0.46	-0.98	-0.51	-0.22	0.07	0.85	1.49	0.70
1986	0.98	1.55	0.52	0.31	0.06	0.06	-0.17	-0.47	-0.98	-0.53	-0.21	0.00	0.75	1.48	0.80
1987	0.96	1.43	0.51	0.28	0.10	0.07	-0.10	-0.52	-1.01	-0.50	-0.25	-0.03	0.71	1.52	0.82
1988	0.93	1.28	0.51	0.33	0.11	0.05	0.12	-0.51	-1.01	-0.43	-0.21	-0.03	0.55	1.49	0.85
1989	0.93	1.26	0.52	0.31	0.03	0.05	0.22	-0.51	-0.91	-0.46	-0.21	-0.03	0.50	1.49	0.91
1990	0.84	1.18	0.50	0.15	0.03	0.05	0.39	-0.47	-0.89	-0.50	-0.25	-0.06	0.41	1.52	0.98
1991	0.87	1.14	0.47	0.15	-0.01	0.06	0.55	-0.40	-0.88	-0.54	-0.24	-0.08	0.32	1.51	1.06
1992	0.99	1.14	0.47	0.16	0.02	0.06	0.64	-0.36	-0.89	-0.56	-0.24	-0.07	0.28	1.51	1.08
1993	1.03	1.05	0.54	0.17	0.05	0.04	0.58	-0.44	-0.90	-0.50	-0.17	-0.23	0.31	1.45	1.04
1994	1.04	0.99	0.45	0.16	0.05	0.04	0.62	-0.42	-0.91	-0.50	-0.18	-0.27	0.26	1.46	1.02
1995	1.04	0.98	0.45	0.11	0.03	0.04	0.63	-0.43	-0.90	-0.51	-0.17	-0.26	0.26	1.45	1.02