Productivity Change in Slovenian Agriculture During the Transition: A Comparison of Production Branches[1]

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Abstract

In this paper we investigate how Total Factor Productivity (TFP) has developed in Slovenian agriculture during the ten years of the transition for the period 1994 – 2003, and which agricultural production specializations recorded the highest TFP growth. Empirical results indicate that TFP, on average, progressed only slightly, by 1.8 percent, over the ten-year period. The decomposition of the TFP change indicates that it is mostly due to technological progress of 2.7 percent. Technical efficiency has remained rather stable on average, suggesting that farmers were able to implement the new technologies on time. Crop farms have performed the best, with a TFP progress on average by 9.5 percent solely due to technological progress. As we used a common frontier, our result indicates that crop specialization is leading the country's agricultural technology.

Keywords: *total factor productivity, farms, Slovenia, production branches*

JEL Classification: D24, Q12

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Introduction

The transition process from the previous socialist system to a market economy has brought significant changes in the economies and in the agricultural and food sectors of Central and Eastern European Countries (CEECs) (e.g. Barlow and Radulescu, 2005), most of them being now members of the enlarged European Union (EU). While the performance of agriculture in CEECs has received substantial consideration from researchers (see Gorton and Davidova, 2004, for a review), the productivity and efficiency performance of the Slovenian agricultural sector has rarely been investigated (Bojnec and Latruffe, 2008, 2009). The only available study is Brümmer (2001), who calculates technical efficiency of Slovenian farms, for the years 1995 – 1996. Gocht and Balcombe (2006) also used a Slovenian farm sample for the year 1996, but in a methodological view only, advocating the usefulness of bootstrapping and thus without discussing the implications for Slovenia.

Slovenia has attracted less research about productivity and efficiency performance in agriculture potentially because of its relatively small size (compared to Hungary, Poland or the Czech Republic, which have received considerable research interest), and because of its strong and quick economic development during the transition. However, there is still a substantial gap between the high level of overall economic development and the low productivity in agriculture, suggesting possible agricultural and farm restructuring problems. In terms of economic development measured by gross domestic product (GDP) per capita, Slovenia has exceeded the EU-27 average (Eurostat, 2007). Most of the Slovenian territory is classified as rural (European Commission, 2004) with a significant role of agriculture in employment. The noteworthy gap between the proportion of agricultural workers in total employment (10 percent) and the agricultural contribution to GDP (2 percent) indicates a lower productivity in agriculture vis-à-vis the other sectors in the economy. Therefore, investigating structures and patterns of the performance change in Slovenian agriculture in the past years is essential for understanding Slovenia's agricultural development within the overall economic development, and is also crucial in the lights of Slovenian competitiveness in the enlarged EU markets, which Slovenia joined on 1st May 2004.

This paper focuses on the development of a quantitative component of performance, namely Total Factor Productivity (TFP), of Slovenian agriculture during the transition. It provides three contributions to the existing literature. Firstly, it contributes to the research on agricultural performance in Central and South-Eastern Europe. Secondly, it covers the long period 1994 – 2003, when the Slovenian economy and agriculture were adjusting to market conditions and finally were preparing for EU membership. Thirdly, it uses an original Farm Accountancy Data Network (FADN) dataset that includes representative farms by agricultural production branches (13 in total). This enables to discuss which type of farming has had the strongest TFP growth, and, in the light of EU agricultural policies and subsidies now granted to Slovenian farmers, if this performance is likely to remain after the EU accession.

The rest of the paper is organized in the following way. We start with a brief literature review on agricultural productivity and dynamics focusing in pre- and post-reform Slovenia. Then, we present the methodology, the data used and the empirical results on technical efficiency change, technological change, pure technical efficiency change, scale efficiency change and TFP change. The final section concludes.

1. Brief Literature Review

The first studies on agriculture in CEECs focused on comparisons of performance of different production systems pre-transition. Brada and King (1993, 1994) analyzed and compared efficiency and performance of private and state farming in Poland. Boyd (1987) investigated the performance of private and state organization in post-war (1956 – 1979) Yugoslav agriculture.[2] Slovenia at that time was a constituent part of the former Yugoslav economy and agricultural system. The author found that state enterprises in Yugoslav agriculture experienced higher levels of productivity growth than private small-scale producers. State enterprises were found to exhibit technology adoption behaviour similar to enterprises in non-socialist agriculture elsewhere, whereas technological change for private agriculture reflected the different institutional and organizational constraints they faced during the communist system. Piesse et al. (1996) and Thirtle et al. (1996) focused on the last years of communist regime (1974 – 1990) for productivity of private and state farms in Slovenia in particular when it was still part of Yugoslavia. The authors studied a sample of Slovenian dairying enterprises, pooling together four state (called "social") enterprises and 12 large private, family producers in dairy farming. Their findings highlight that despite

[2] Similar as in Poland, the most of agricultural land during the communism in Slovenia was in the private sector. The process of communist collectivization failed. After then the state enterprises and agricultural service cooperatives were important within the non-private agriculture. However, agricultural service cooperatives were mostly without ownership and operation of own land, and they mostly provided selling and purchasing service activities for the private agricultural sector. To avoid confusion, we use consistently the state enterprises, which in the former Yugoslavia were called "social enterprises" (in Slovenian "družbena podjetja" and in Serbo-Croatian "društvena poduzeća").

a technology policy discrimination in disfavour of the private farms, the latter experienced more or less the same technological change but three times greater TFP growth, than state farms. Scale inefficiency explained the poorer absolute performance of the private farms, indicating the need for land reform as well as technological change.

After the collapse of the former Yugoslavia in 1991, during the transition to a market economy, Slovenia adopted a policy of land restitution to the former owners, which has strengthened the role of the private agriculture (Bojnec and Swinnen, 1997). Institutional and organizational constraints on the size and behaviour of private farms have been abolished, giving opportunities for market selection and concentration processes, which have been encouraged by the increased domestic and foreign competition arising from trade liberalization processes and the EU membership. Slovenian agriculture has remained dominated by private, on average small-scale, family farms, and performs well in comparison to other CEECs. According to Pouliquen (2001), in 1999 farm yields in Slovenia were on average up to 69 percent of the EU-15 average, while they were only up to 38.5 percent in the other CEECs. However, there is still some potential for productivity improvement in this country. This was for example underlined for the transition period by Brümmer (2001), whose analysis revealed significant inefficiency for Slovenian farms in 1995 and 1996. The author calculated technical efficiency for 185 farms. The more optimistic results (with the stochastic frontier) showed that farmers could have expanded their output by 25 percent without using additional inputs. As for differences between farms, the results indicated that part-time farmers and cattle farmers were the least efficient, while diversified farmers were the most efficient.

2. Methodology and Data Used

2.1. Methodology

In our paper TFP change was assessed with Malmquist indices calculated with the non-parametric Data Envelopment Analysis (DEA), a widely used approach in agriculture (e.g. Mathijs and Swinnen, 2001; Latruffe et al., 2004, 2005). Based on the concept of distance functions from Farell (1957), the DEA method, developed by Charnes et al. (1978), uses linear programming to construct the efficient frontier, with the best performing observations of the sample. This avoids errors from misspecification of the functional form or of the distributions. Färe et al. (1992) adjusted the DEA method to the calculation of productivity change with Malmquist indices, given by equation (1).

$$M_{t,t+1} = \left[\frac{d^t\left(X_{t+1},Y_{t+1}\right)}{d^t\left(X_t,Y_t\right)} \frac{d^{t+1}\left(X_{t+1},Y_{t+1}\right)}{d^{t+1}\left(X_t,Y_t\right)} \right]^{\frac{1}{2}} \tag{1}$$

with $M_{t,t+1}$ the Malmquist index of productivity change between periods t and $t+1$; $d^t\left(X_{t+1},Y_{t+1}\right)$ the distance from observations in the $t+1$ period to the frontier of the t-th period; $\left(X_t,Y_t\right)$ the input-output vector in the t-th period. The first ratio in the brackets is the productivity change index when considering the farm in period $t+1$ relative to the period t, while the second term is the productivity change index when considering the farm in period t relative to the period $t+1$. While both indices represent the same productivity change, they are not necessarily equal. As the choice of the benchmark is arbitrary, it is conventional to take the geometric mean of both indices as the final Malmquist productivity index (equation (1)) (Coelli et al., 2005).

Malmquist TFP indices can further be decomposed into technological change and technical efficiency change,[3] as shown by equation (2).

$$M_{t,t+1} = \left[\frac{d^{t+1}\left(X_{t+1},Y_{t+1}\right)}{d^t\left(X_t,Y_t\right)} \right] \times \left[\frac{d^t\left(X_{t+1},Y_{t+1}\right)}{d^{t+1}\left(X_{t+1},Y_{t+1}\right)} \frac{d^t\left(X_t,Y_t\right)}{d^{t+1}\left(X_t,Y_t\right)} \right]^{\frac{1}{2}} \tag{2}$$

where the left bracket gives the change in technical efficiency and the right bracket measures technological change. The left bracket measures the change in technical efficiency of a farm between the period t and the period $t+1$ as it is the ratio of the distance of a farm observed in $t+1$ to the frontier of the same period (i.e. efficiency of the farm at the period $t+1$) and the distance of the same farm observed in t to the frontier of the same period (i.e. efficiency of the farm at the period t). As for the right bracket, it gives the technological change: it represents the move of the frontier between period t and period $t+1$, as a geometric mean of two ratios that differ in the benchmark, similarly to the Malmquist TFP index in equation (1).

Finally, the method enables to break down technical efficiency change into scale efficiency change (focusing on optimal or sub-optimal farm size) and pure efficiency change (focusing on the management practices only, disregarding of the operation scale). The decomposition is given in equation (3).

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[3] A firm's technical efficiency refers to a its ability to maximize outputs for a given set of inputs, or to minimize the use of inputs given a set of outputs; in other words, it measures whether a firm is able to use at best the existing technology, without considering the relative prices of inputs and outputs.

$$M_{t,t+1} = \left[\frac{d_{VRS}^{t+1}\left(X_{t+1},Y_{t+1}\right)}{d_{VRS}^{t}\left(X_{t},Y_{t}\right)}\right]$$

$$\times\left[\frac{d_{VRS}^{t+1}\left(X_{t+1},Y_{t+1}\right)/d_{CRS}^{t+1}\left(X_{t+1},Y_{t+1}\right)}{d_{VRS}^{t+1}\left(X_{t},Y_{t}\right)/d_{CRS}^{t+1}\left(X_{t},Y_{t}\right)}\frac{d_{VRS}^{t}\left(X_{t+1},Y_{t+1}\right)/d_{CRS}^{t}\left(X_{t+1},Y_{t+1}\right)}{d_{VRS}^{t}\left(X_{t},Y_{t}\right)/d_{CRS}^{t}\left(X_{t},Y_{t}\right)}\right]^{\frac{1}{2}} \quad (3)$$

$$\times\left[\frac{d^{t}\left(X_{t+1},Y_{t+1}\right)}{d^{t+1}\left(X_{t+1},Y_{t+1}\right)}\frac{d^{t}\left(X_{t},Y_{t}\right)}{d^{t+1}\left(X_{t},Y_{t}\right)}\right]^{\frac{1}{2}}$$

where VRS means under the assumption of variable returns to scale, CRS means under the assumption of constant returns to scale, the left bracket in equation (3) gives the change in pure technical efficiency, and the middle bracket represents the change in scale efficiency, and the right bracket measures technological change.

The method computes indices (Malmquist productivity, technical efficiency, pure technical efficiency, scale efficiency, and technological change) that are compared to 1. If an index is equal to 1, it means that there is no change. An index greater than 1 indicates a progress, with the difference with 1 giving the percentage progress; for example, an index of 1.02 indicates a +2 percent change. An index less than 1 indicates a deterioration, with the difference with 1 giving the percentage deterioration; for example, an index of 0.98 indicates a –2 percent change.

We used an output-oriented model that includes three different outputs (crop, livestock, and other outputs) in value, and four inputs: land as the agricultural utilized area (UAA) in hectares (ha), labour use in Annual Working Units (AWU),[2] capital as the value of depreciated assets, and the value of intermediate consumption).

2.2. Data

The data used in the empirical analysis were obtained from the Slovenian Farm Accountancy Data Network (FADN) that was provided by the Ministry of Agriculture, Forestry and Food (MAFF) of Slovenia.

The data set contains individual family farms only, which represent the great majority of the Slovenian farming structures. The number of farms included in the FADN data varies by individual years between 226 farms in 2003 and 328 farms in 1996 with the average mean value of 271.4 farms per year in the FADN sample in the analyzed period 1994 – 2003. The farms have their own identification code and are classified according to socio-economic type into four groups (pure agricultural, mixed, supplementary, and farm with elderly members), by different types of areas according to factors of agricultural

[2] All labour (family/hired, full-time/seasonal, and male/female) is aggregated under the basis that 1 AWU corresponds to 2,200 hours per year.

production into six groups (lowland areas, hilly areas, less favoured areas with steeper terrain, mountainous areas, karsts areas, and non classified) and by production types into fifteen branches (crop; dairy using own feed; cattle using own feed; pigs using own feed; sheep using own feed; poultry using own feed; other livestock using own feed; livestock using purchased feed; fruit; grape and wine; mixed; vegetables; forestry; combined; and non classified) according to the shares of revenue. The share of a specific production in the total farm revenue is greater than fifty percent for the first ten branches of farms (from crop to grape and wine). The revenue structure of the mixed farms consists of a combination of revenues from crop revenues, own feed, livestock, fruit, grapes and wine and hops, where a single product contribution in total revenue is less than 50 percent. In the case of vegetables and forestry, the single revenue criteria are set as greater than 75 percent of total farm revenue. The combined farm in its revenue structure has incomes from crop and livestock using own feed, where the single production contribution in total revenue is less than 75 percent (Pajntar, 1997).

The consequence of the small number of farms in Slovenian FADN data is that there are only a few farms per production type in the country. Therefore, for confidentiality reasons, only data averages per production types can be provided by the MAFF. Due to missing data for some years, we have omitted poultry farms using own feed and non classified farms. The data used in the empirical analysis were thus the averages for 13 production branches, for the 10-year period 1994 – 2003. The nominal output data were deflated by the agricultural producer price index and the nominal input data were deflated by the agricultural input price index, which were provided by the Statistical Office of the Republic of Slovenia (SORS).

T a b l e 1

Summary Statistics of Real Output and Input Data per Year

	Total Revenue (mio SIT 1994 prices)	Land (UAA in ha)	Labour (AWU)	Capital (mio SIT 1994 prices)	Intermediate Consumption (mio SIT 1994 prices)
1994	2.49	12.39	2.02	12.9	1.43
1995	2.99	12.59	2.05	15.2	1.65
1996	3.17	12.14	2.29	12.4	1.78
1997	3.32	11.14	2.08	12.6	1.92
1998	3.99	10.98	2.26	12.3	2.35
1999	4.36	12.15	2.01	14.7	2.70
2000	7.39	15.89	2.31	21.1	4.35
2001	7.72	16.40	2.09	22.4	5.29
2002	7.51	21.50	5.57	30.4	3.64
2003	7.27	18.49	5.39	29.4	3.52

Note: The Slovenian tolars (SIT) was the Slovenian national currency between October 2001 and 31 December 2006, when the Euro was introduced.

Source: Own calculations based on Slovenian FADN database.

Table 1 presents the summary statistics of the total output and of the four inputs for all branches in each analyzed year in real terms (in 1994 prices). Slovenian farms are small on average, usually less than 20 ha. The sample's real value of production has been tripled over the analyzed period, while the input uses have been only doubled at most, therefore suggesting an increase in the farm productivity over the years.

3. Results

3.1. Summary Statistics per Years and per Branches

Table 2 presents summary statistics of technical efficiency change, pure technical efficiency change, scale efficiency change, technological change, and total factor productivity change by year, as percentage changes. The first row shows the averages over the whole period. Between 1994 and 2003, the sample has experienced a TFP progress of 1.8 percent, due to technological progress (of +2.7 percent). Efficiency has approximately remained the same (–0.9 percent), with a slight worsening of the management practices (–1.1 percent of pure technical efficiency). Over the period studied, TFP change has fluctuated between –11.6 percent in 2001 – 2002 and +14.3 percent in 1997 – 1998. Those fluctuations are partly due to variations in technological change that are likely to be determined also by some influences of external factors such as weather conditions. It can however be noted that, except in the initial years, in most of the other analyzed years there has been technological progress (positive percentages). Efficiency oscillations between –8.7 percent in 2000 – 2001 and +8.5 percent in 1999 – 2000 explain the other part of the fluctuations in TFP. In general, technical efficiency change and technological change have varied in opposite direction patterns, confirming other studies on TFP change (Brümmer et al., 2002; Balcombe et al., 2008). The explanation is that it is easier for farmers to catch up with the technology (and thus improve their efficiency) when there is technological regress, while when there is technological progress a large part of farmers cannot adopt the new technique quickly (which means lower efficiency).

Productivity results of Table 2 are illustrated by Figure 1. This figure clearly shows the cyclical developments in TFP changes as well as oscillations in other change indices by the individual analyzed years. The peaks in TFP changes is found in 1998, and then in 2000 and 2003, whereas the deepest negative points in the TFP are found for the initial analyzed year 1995, and then in 1999 and particularly in 2002. This indicates around three year long cycles in the TFP change developments. There are some similarities between the patterns in development of the TFP and technological change, the outlier being particularly technological change in 2001. The other three analyzed productivity change indices (technical efficiency change, pure technical efficiency change, scale efficiency change) have experienced lower degree of variations over time. Except in 1997, their development patterns over time are in similar directions as they pattern in development of TFP, indicating an additional role they have played in the TFP changes of Slovenian farms. However, as stressed above, their development is usually in opposite direction of technological change.

T a b l e 2

Productivity Changes by Years (percentage changes, %)

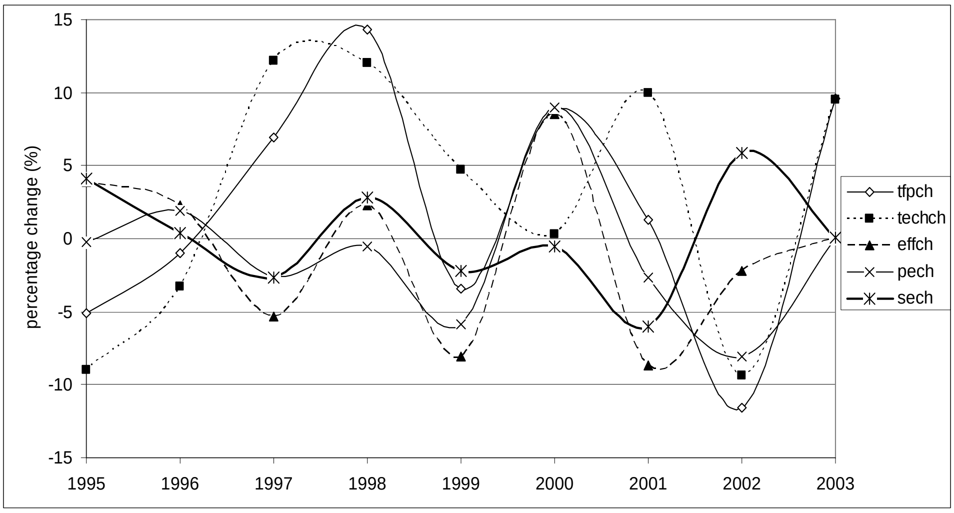
	tfpch	=	techch	+	effch	effch =		
						pech	+	sech
All years	+1.8		+2.7		–0.9	–1.1		+0.2
1994 – 1995	–5.1		–9.0		+3.9	–0.2		+4.1
1995 – 1996	–1.0		–3.3		+2.3	+1.9		+0.4
1996 – 1997	+6.9		+12.2		–5.3	–2.6		–2.7
1997 – 1998	+14.3		+12.0		+2.3	–0.5		+2.8
1998 – 1999	–3.4		+4.7		–8.1	–5.9		–2.2
1999 – 2000	+8.8		+0.3		+8.5	+9.0		–0.5
2000 – 2001	+1.3		+10.0		–8.7	–2.7		–6.0
2001 – 2002	–11.6		–9.4		–2.2	–8.1		+5.9
2002 – 2003	+9.6		+9.5		+0.1	0.0		+0.1

Note: effch – technical efficiency change, pech – pure technical efficiency change, sech – scale efficiency change, techch – technological change, and tfpch – Malmquist TFP change.

Source: Own calculations based on Slovenian FADN database.

F i g u r e 1

Productivity Changes by Years (percentage changes)



Note: effch – technical efficiency change, pech – pure technical efficiency change, sech – scale efficiency change, techch – technological change, and tfpch – Malmquist TFP change.
tfpch = techch + effch; effch = sech + pech.

Source: Own calculations based on Slovenian FADN database.

Table 3 and Figure 2 present summary statistics of technical efficiency change, pure technical efficiency change, scale efficiency change, technological change, and TFP change for the 13 analyzed branches.

The branches with the higher TFP growth are the following: 1 – crop (+9.5 percent), 6 – other livestock on own feed (+8.9 percent), 5 – sheep (+7.8 percent), 8 – fruit (+6.4 percent), 10 – mixed (+5.7 percent), 9 – grape and wine (+5.6 percent), 11 – vegetables (+4.6 percent), and to a lesser extent 2 – dairy (+2.3 percent). The worst performer is branch 7 – other livestock on purchased feed (–15.7 percent) followed by 12 – forestry (–7.0 percent). For branches 3 – cattle, 4 – pigs and 13 – combined, TFP has rather stagnated. For most of the branches, the productivity change is solely due to technological change (progress or regress), as the efficiency change is around 0. Three branches only have seen their efficiency evolved. Branch 7 – other livestock on purchased feed recorded a technical efficiency decrease (–13.2 percent) and branch 3 – cattle a pure technical efficiency decrease (–4.7 percent), while branch 5 – sheep experienced a scale efficiency increase (+5.8 percent).

It is interesting to notice that productivity changes are not necessarily related to government policies. Branches 2 – dairy and 3 – cattle have received major attention by policy makers in terms of the absolute size of government support (OECD, 2001). Whereas in the case of dairy improvements in TFP has been achieved, this is not the case of cattle where pure technical efficiency has deteriorated, and thus TFP has declined.

T a b l e 3

Productivity Changes by Branches (percentage change, %)

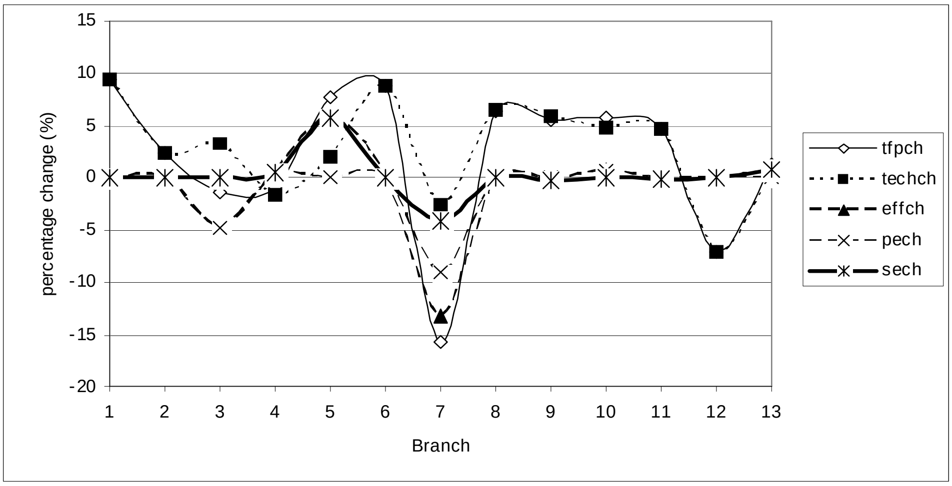
	tfpch	=	techch	+	effch	effch =		
						pech	+	sech
All branches	+1.8		+2.7		–0.9	–1.1		+0.2
1 – crop	+9.5		+9.5		0.0	0.0		0.0
2 – dairy	+2.3		+2.3		0.0	0.0		0.0
3 – cattle	–1.4		+3.3		–4.7	–4.7		0.0
4 – pigs	–0.9		–1.6		+0.7	+0.2		+0.5
5 – sheep	+7.8		+2.0		+5.8	0.0		+5.8
6 – other livestock using own feed	+8.9		+8.9		0.0	0.0		0.0
7 – livestock using purchased feed	–15.7		–2.5		–13.2	–9.1		–4.1
8 – fruit	+6.4		+6.5		–0.1	–0.1		0.0
9 – grape and wine	+5.6		+5.9		–0.3	0.0		–0.3
10 – mixed	+5.7		+4.9		+0.8	+0.7		+0.1
11 – vegetables	+4.6		+4.7		–0.1	0.0		–0.1
12 – forestry	–7.0		–7.0		0.0	0.0		0.0
13 – combined	+1.3		+0.5		+0.8	0.0		+0.8

Note: effch – technical efficiency change, pech – pure technical efficiency change, sech – scale efficiency change, techch – technological change, and tfpch – Malmquist TFP change.

Source: Own calculations based on Slovenian FADN database.

F i g u r e 2

Productivity Changes by Branches (percentage change)



Note: effch – technical efficiency change, pech – pure technical efficiency change, sech – scale efficiency change, techch – technological change, and tfpch – Malmquist TFP change.

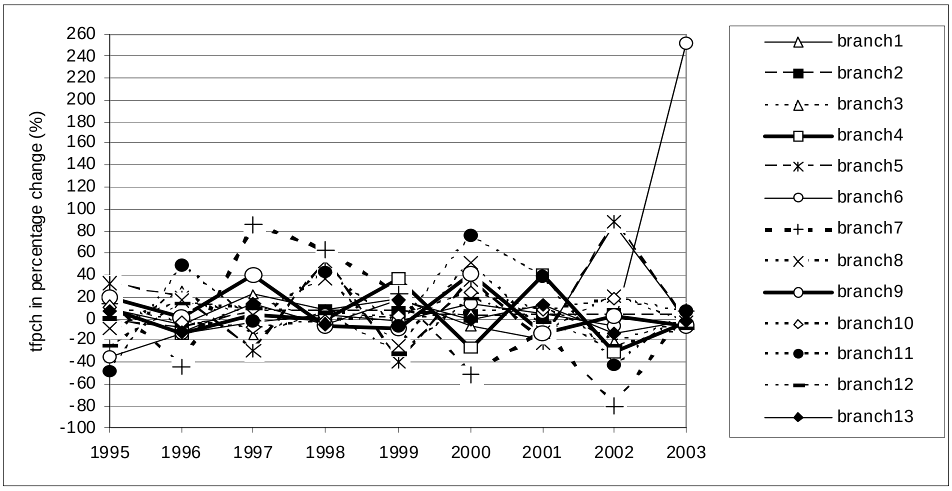
Source: Own calculations based on Slovenian FADN database.

3.2. Evolutions of the Branches over the Analyzed Period

Total Factor Productivity Change

F i g u r e 3

TFP Change by Branches and Years (percentage change)



Note: Numbers for branches mean: 1 – crop, 2 – dairy, 3 – cattle, 4 – pigs, 5 – sheep, 6 – other livestock using own feed, 7 – livestock using purchased feed, 8 – fruit, 9 – grape and wine, 10 – mixed, 11 – vegetables, 12 – forestry, and 13 – combined.

Source: Own calculations based on Slovenian FADN database.

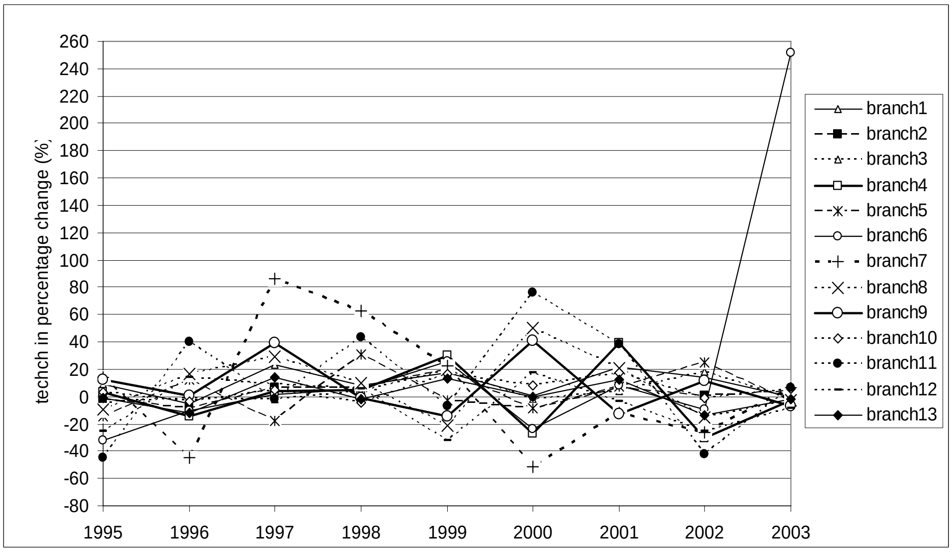
TFP change by individual production branches is shown for the period studied on Figure 3. The main outlier is a dramatic increase in TFP for branch 6 – other livestock on own feed in the last year. In the beginning of the period branches are relatively close to each other in terms of productivity change, while differences between them increase in the last years.

Technological Change

Figure 4 pictures the evolution of technological change for each branch. Branches experienced relatively similar technological changes, with two exceptions. The first one is the very high technological progress for branch 6 – other livestock on own feed in the last year, which explains the TFP outlier for this branch as well (see Figure 3). Such a sharp increase can be due to a significant improvement in external factors such as weather conditions that became favourable for crop feed. The second exception to smooth and similar evolutions of all branches is a high variation for branches 7 – other livestock on purchased feed and 11 – vegetables. This is not surprising for the latter production, as it is highly influenced by weather conditions. As for branch 7 – other livestock on purchased feed, the results suggests that this specialization's technology improvement might be constrained by the limited availability of high quality feed on the input market.

F i g u r e 4

Technological Change by Branches and Years (percentage change)



Note: Numbers for branches mean: 1 – crop, 2 – dairy, 3 – cattle, 4 – pigs, 5 – sheep, 6 – other livestock using own feed, 7 – livestock using purchased feed, 8 – fruit, 9 – grape and wine, 10 – mixed, 11 – vegetables, 12 – forestry, and 13 – combined.

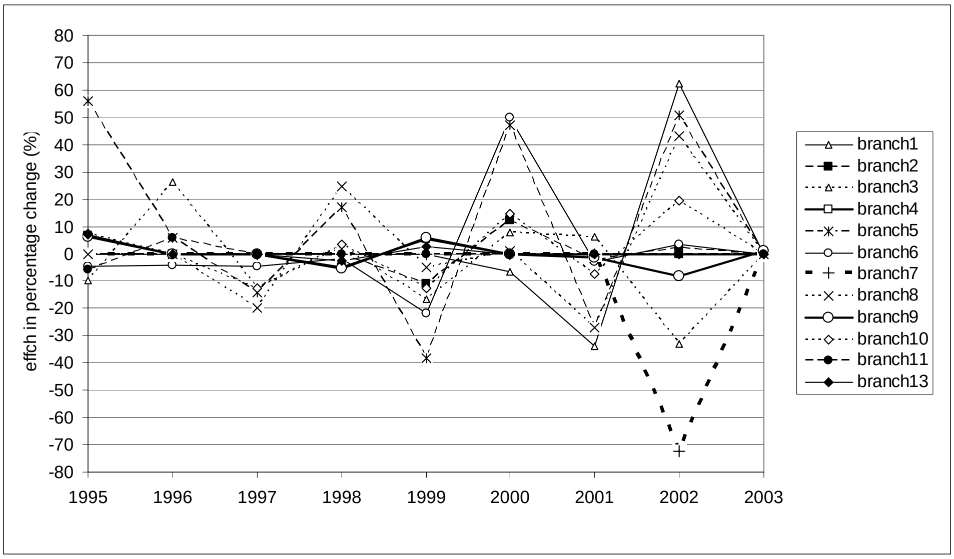
Source: Own calculations based on Slovenian FADN database.

Technical Efficiency Change

The evolution of technical efficiency change over the period for each branch is presented in Figure 5. Branch 12 – forestry had a perfect stagnation of average technical efficiency (index of technical efficiency change equal to 1 in each year), and other branches recorded also almost no change in their average technical efficiency (branch 2 – dairy, branch 4 – pigs, branch 6 – other livestock using own feed, 9 – grape and wine, 11 – vegetables, 13 – combined). By contrast, branch 5 – sheep has the most recurrent variations: the technical efficiency for the branch has on average increased or decreased each year. Other branches (1 – crop, 3 – cattle, and 8 – fruit) also recorded yearly fluctuations, with a period of efficiency decrease (respectively increase) being followed by a period of efficiency increase (respectively decrease). Only branch 7 – other livestock on purchased feed experienced a single drop (in 2001 – 2002), not followed back by an increase.

F i g u r e 5

Technical Efficiency Change by Branches and Years (percentage change)



Note: Branch 12 – forestry has technical efficiency change equal to 0 percent in each year. Numbers for branches in this figure mean: 1 – crop, 2 – dairy, 3 – cattle, 4 – pigs, 5 – sheep, 6 – other livestock using own feed, 7 – livestock using purchased feed, 8 – fruit, 9 – grape and wine, 10 – mixed, 11 – vegetables, and 13 – combined.

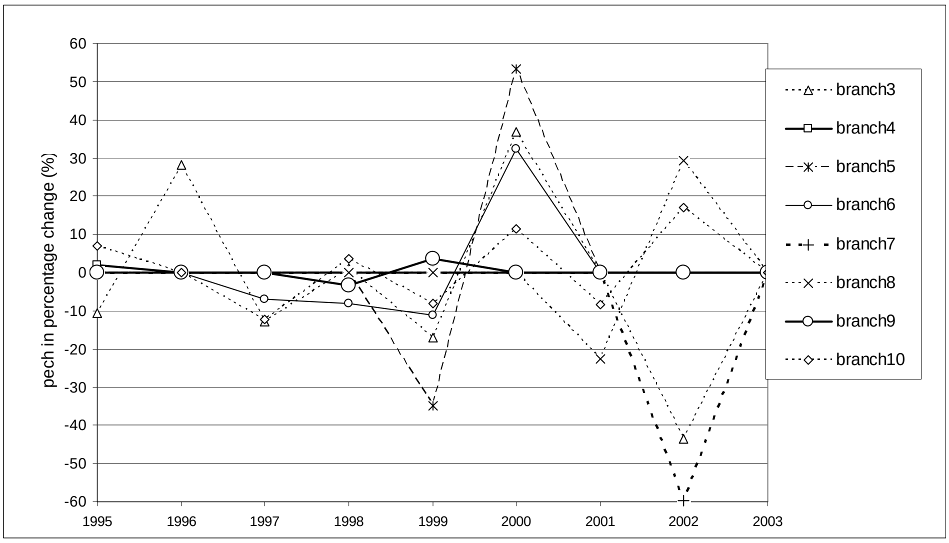
Source: Own calculations based on Slovenian FADN database.

Pure Technical Efficiency Change

Figure 6 shows the indices of pure technical efficiency change over the period per branch. Five out of thirteen production branches (1 – crop, 2 – dairy, 9 – grape and wine, 11 – vegetables, 12 – forestry, and 13 – combined) are found with constant pure technical efficiency (indices equal or almost equal to 1 in each year). This indicates that these branches have not modified (neither improved nor worsened) their farming practices over the period, and that any change in technical efficiency identified on Figure 5 would be solely due to a change scale in efficiency. Branches 3 – cattle and 7 – other livestock on purchased feed are the only branches that have recorded a deep decline in pure technical efficiency without recovery following the decline that occurred in the period 2001 – 2002, and in the next period the index was 1 meaning that there had been no change in pure technical efficiency between 2001 – 2002 and 2002 – 2003. This indicates that farming practices within these two branches have worsened at the end of the period studied, and suggests that those livestock farmers might not have been able to adapt their practices to the EU policy adoption.

Figure 6

Pure Technical Efficiency Change by Branches and Years (percentage change)



Note: Branches 1 – crop, 2 – dairy, 11 – vegetables, 12 – forestry and 13 – mixed have pure technical efficiency change equal to 0 percent in each year. Numbers for branches in this figure mean: 3 – cattle, 4 – pigs, 5 – sheep, 6 – other livestock using own feed, 7 – livestock using purchased feed, 8 – fruit, 9 – grape and wine, and 10 – mixed.

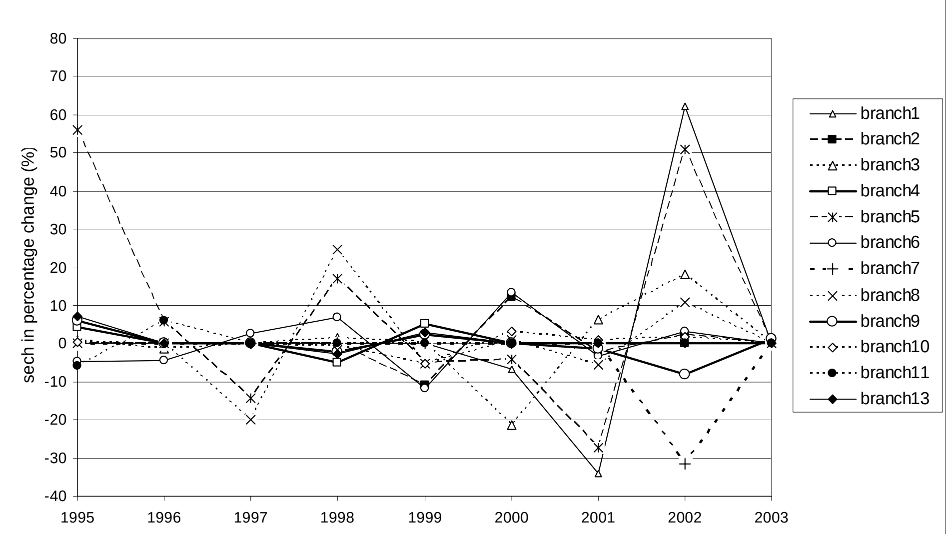
Source: Own calculations based on Slovenian FADN database.

Scale Efficiency Change

The evolution of scale efficiency per branch is illustrated on Figure 7. Scale efficiency seems to have fluctuated greatly for branches 1 – crop, 3 – cattle, 5 – sheep, 7 – other livestock on purchased feed, and 8 – fruit. Here again, branch 7 – other livestock on purchased feed has recorded a decrease in scale efficiency (i.e. farm size becoming sub-optimal) without any recovery following.

F i g u r e 7

Scale Efficiency Change by Branches and Years



Note: Branch 12 – forestry has scale efficiency change equal to 0 percent in each year. Numbers for branches in this figure mean: 1 – crop, 2 – dairy, 3 – cattle, 4 – pigs, 5 – sheep, 6 – other livestock using own feed, 7 – livestock using purchased feed, 8 – fruit, 9 – grape and wine, 10 – mixed, 11 – vegetables, and 13 – combined.

Source: Own calculations based on Slovenian FADN database.

Conclusions

Empirical results indicate that TFP, on average, progressed only slightly, by +1.8 percent, over the ten-year period. However, this relatively slow TFP growth hides a switchback evolution over the analyzed period, with for example a peak of +14.3 percent in the years 1997 – 1998 and a drop of –11.6 percent in the years 2001 – 2002. As in any productivity calculations, such fluctuations in TFP can be attributed partly to short-term factors such as animal health diseases or pests, climatic or weather conditions, which vary greatly from year to year. But changing economic conditions during the transition and adjustment periods to trade liberalization and membership of Slovenia in the EU with price and policy transfers' shifts are likely to have played a role as well. The decomposition of the TFP change indicates that the driving force behind it is mostly technological progress, of +2.7 percent. Technical efficiency has remained rather stable on average, suggesting that farmers were able to implement the new technologies on time and to efficiently use them.

Dissimilar developments in TFP are shown according to the production specialization. Crop farms have performed the best, with an average TFP progress of +9.5 percent solely due to technological progress. Forestry farms were, by contrast, very bad performers, with a technological regress of –7 percent on average, suggesting that new technologies are less common in forestry than in crop or livestock production. For all branches, technological change constitutes the sole part of TFP change, except for sheep farms, which recorded a high technical efficiency progress and livestock on purchased feed which experienced a dramatic technical efficiency reduction. The latter production recorded the worst development of all branches over time, with a particular sharp decrease in efficiency, both pure technical and scale.

The fact that crop farming has had the strongest TFP development compared to livestock farming was also given evidence for example in France by Guyomard et al. (2006) for the period 1995 – 2002, although the authors used separate frontiers for production specializations. As we used a common frontier, our result indicates that crop specialization is leading the country's agricultural technology. So far greater policy focus in Slovenia has been directed towards livestock, dairy and beef, but our results suggest that this has not resulted in successful TFP progress. By contrast, conditions for productivity increase in Slovenia seem to be favourable for farms specialized in crop production. Slovenia needs to emphasize productivity progress in crop production in order to increase synergies within agricultural production structures, rationalize and increase agricultural productivity to compete on the enlarged EU agricultural markets.

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