CAP Reforms and Total Factor Productivity Growth in Belgian Agriculture: A Malmquist Index Approach

by

Tim Coelli

School of Economics, University of Queensland, Brisbane, Australia

Sergio Perelman

CREPP, University of Liège, Liège, Belgium

and

Dirk Van Lierde

Institute for Agriculture and Fisheries Research, Merelbeke, Belgium

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Abstract

Have the 1992 and 2000 CAP reforms had any discernable effect upon agricultural productivity? In this study we derive detailed information on the total factor productivity (TFP) growth of arable farms in Belgium over a 16-year period from 1987 to 2002. Calculations are based on a carefully constructed high-quality detailed farm-level data set containing 1728 observations, involving over 100 farms in most years. Three output variables (cereals, other crops, other outputs) and four input variables (land, labour, capital and other inputs) are constructed, using multilateral Fisher index numbers where crop aggregation is required.

The TFP measures are calculated using a Malmquist TFP index relative to a series of data envelopment analysis (DEA) frontiers. Annual average TFP change of 1.0% per year is estimated for this industry. This rate does not compare well with rates of over 2% that are commonly reported in studies involving other developed countries. The pattern of TFP growth over the period indicates that the two CAP reforms (in 1992 and 2000) have had no discernable effect upon TFP trends.

An inspection of shadow shares (derived from the DEA frontiers) indicates that substantial distortions remain in this industry, especially with regards to the excess use of labour and constrained use of land, relative to other inputs. Finally, tabulation of results by region and farm size shows fairly uniform TFP change across regions, but poor performance in small farms, where TFP actually levels actually fell over this period.

Keywords: CAP reforms, Belgian agriculture, total factor productivity, Malmquist index, shadow shares

JEL codes: C6, D2, O4, Q1

1. Introduction

In this paper we obtain measures of total factor productivity (TFP) growth for arable farms in Belgium over a 16-year period from 1987 to 2002. We have constructed a high quality detailed farm-level data set containing 1728 observations, involving over 100 farms in most years. This data is derived from the Farm Accounting Data Network (FADN) records of the Centre for Agricultural Economics (CAE) in Brussels. Three output variables (cereals, other crops, other outputs) and four input variables (land, labour, capital and other inputs) are constructed, using multilateral Fisher index numbers where aggregation is required. TFP is then calculated using a Malmquist TFP index, that is derived from a sequence of data envelopment analysis (DEA) frontiers that are fitted to the sample data in each of the 16 years.

This Malmquist TFP index method is chosen in preference to the more commonly used Tornqvist TFP index method, because the latter index involves the use of observed prices (to construct value share weights), and given the distortions introduced by the Common Agricultural Policy (CAP), these are unlikely to be representative of the true economic weights.

The 16-year period under study contains two major changes in CAP policy. The first occurring in 1992, when crop price subsidies were reduced and replaced with direct payments per hectare, and the second being in 2000, when crop price subsidies were further reduced and direct payments were increased. One would expect that these reforms would reduce market distortions and hence send better signals to farmers to encourage them to operate in a more efficient manner. In this study we divide the 16-year period into three sub-periods: 1988-1992, 1993-1999 and 2000-2002, in order to study the effects of these CAP reforms upon agricultural productivity. We also report results for four different regions by soil type and also by four different farm size classes.[1]

To our knowledge, this is the first attempt at TFP measurement using this rich farm-level Belgian FADN data. Also we believe it may be the first time that agricultural TFP growth has been measured using Belgian farm-level agricultural data. Some estimates of Belgian (aggregate) agricultural TFP growth have been reported in a few cross-country studies that have involved OECD countries, such as Bureau, Färe and Grosskopf (1985) and Coelli and Rao (2005). However, these latter studies produce fairly approximate country-level information, since they are based on data containing a substantial amount of aggregation, which relies upon the availability of comparable price information across countries, where data quality and definitions can vary substantially from one country to the next. Hence we would argue that our study will provide richer and more reliable information, relative to these cross-country studies.

In addition to providing information on TFP growth, this study also provides information on the degree of technical inefficiency of each farmer in each year (ie. the degree to which the farmer lies below the best practice production frontier), and the degree to which TFP growth is due to farmers catching up to the frontier over time, versus the degree to which the frontier itself shifts over time (ie. technical change). We also provide information on the contribution of scale changes on TFP, which we expect to be important, given the growth in average farm sizes over this period. Finally, we also present estimates of the shadow shares of outputs and inputs (derived from the shape of the DEA frontiers) and compare them to the observed share information. If the CAP reforms are reducing distortions in this industry, we expect that these two sets of shares should be converging.

The remainder of this paper is organised into sections. In section 2 we provide a brief description of arable farming in Belgium, including some discussion of CAP policies and reforms. In section 3 we describe the sample data and the large amount of work that went

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[1] This tabulation of results is feasible because the Malmquist TFP method provides measures of TFP growth for each individual farm between each pair of adjacent time periods.

into constructing the input and output variables that are used in the TFP analysis. Section 4 contains a description of the Malmquist TFP index and the DEA methods that we use to measure it. In section 5 we present our empirical results and discussion, followed by some concluding comments in Section 6.

2. Arable farming in Belgium

According to the 1999 agricultural census of the National Institute of Statistics Belgium has a total agricultural area of 1.39 million hectares. Of this area, 576,697 hectares is arable land, while the remainder are devoted to prairies, fodder maize and other fodder crops. Of the arable land 308,311 hectares are planted to cereals, of which 191,216 ha is wheat, 52,723 is corn maize, 40,805 ha is barley, and the rest is spelt, triticale and rye grain. Other arable crops that are important are sugar beets (91,177 ha), potatoes (59,300 ha), chicory (15,797 ha), flax (20,232 ha), vegetables (39,969 ha) and fallow land (29,875 ha).

As Belgium is a member of the European Union, Belgian agricultural policy is dominated by the common agricultural policy of the European Union. Prior to 1992 the policy for cereals was to support the price on a level that was significantly higher than the world market price (for example in 1990 the Belgian wheat price was approximately 0.214 €/kg while the world price was approximately 0.057 €/kg). In 1992, a CAP reform introduced a change in the policies for cereals, protein and oil crops, where the subsidies within the support prices were significantly reduced, and compensated by the introduction of new subsidies in the form of direct payments per hectare for each of these crops. Furthermore, there was an obligation to keep a certain percentage of the land as follow land. For this fallow land a direct payment per hectare was also paid. The direct payments per hectare were slightly different for the different agricultural regions that exist in Belgium. The premiums depended on the historical yields for the different crops. In the Agenda 2000

CAP reform, prices were reduced further and farmers were compensated by higher direct payments, which became more uniform across the crop types.[2]

Overall, the main objective of the CAP 1992 and 2000 reforms was to limit the market distortions created by price subsidies, mainly overproduction and unaffordable (CAP) budgetary costs. But the risk of overproduction is still present if direct (per hectare) subsidies are paid for all the surfaces devoted to crop production. This is particularly the case if direct subsides compensate the losses due to lower (market) prices. In an attempt to deal with this issue, direct subsidies are also paid for productive areas not exploited and maintained as follow land, however it is not clear that this has had a substantive effect on production over this period (when the increase in the minimum fallow requirement is taken into account).

3. Description of Sample Data

This study deals with specialised arable farms in Belgium. An arable farm is defined as a farm that obtains at least two thirds of its standard gross margin from arable crops (fodder crops excluded). This is *type 1* in the European farm typology that includes 13 categories. The data are obtained from the Farm Accounting Data Network (FADN) records collected by the Centre for Agricultural Economics (CAE) in Brussels.

The sampling procedure used in the FADN survey is designed to ensure the representativeness of agricultural regions and farm sizes within Belgium. Once a farm is selected to participate in the survey, it is asked to stay in the survey in the following years. When a farm is unable or unwilling to participate in a subsequent year, it is replaced with a “similar” farm.

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[2] In the near future, these policies are going to change. As a result of the negotiations in the World Trade Organisation, the direct payments will be uncoupled from production and replaced by a payment per farm.

The original data sample involved a total of 1823 observations, over a period of 16 years, providing an average of approximately 114 observations per year. However, given the nature of the Malmquist DEA TFP methods used in this study, we were obliged to delete any observations that did not belong to a sequence of at least two-consecutive years. This involved the deletion of 95 observations, leaving us with a total of 1728 observations, or 108 observations per year, ranging from 117 observations in 1999 to 92 observations in 2002. Approximately two fifths of farms (38.3%) participated for less than 6 years in the FADN survey over the 16- year period, but more than one third (35.3%) stayed for over 10 years.

The Malmquist TFP methods used in this study can produce information on TFP growth (and its components) for each farm between each pair of adjacent periods. The amount of information produced runs to dozens of pages of tables. In order to provide policy-relevant summaries of this material, we have divided the sample into size groupings and regional/soil type groupings. We identify four size classes – less than 30 hectares, 30-50, 50-80 and greater than 80 – each of which contains roughly 25 percent of the sample. In terms of regions, 12 agricultural regions are usually distinguished according to their average soils productivity in Belgium (CAE, 1999). In the present study we identify four groups, the three regions that have the largest numbers of specialised arable farms ("Polders", "Silt-laden" and "Sandy-silt-laden") and then we aggregate the remaining sample farms in an "Other" regions category. Note that approximately 50.0% of sample farms belong to the Silt-laden region and near 30.0% to the Sandy-silt-laden region.

The output and input variables used in this study are detailed below.

- Outputs:
    - Cereal crops (winter wheat, spring wheat, spelt wheat, rye, winter barley, spring barley, corn, grain corn)
    - Other crops (green peas, green beans, early potatoes, late potatoes, sugar beet, flax, oil seed, chicory)
    - Other outputs (animal and wood products, work for others, etc.)

- Inputs:
    - Land: total utilized area
    - Labor (total annual hours worked)
    - Capital (replacement values of machinery and buildings weighted by their respective sample average depreciation rates)
    - Other inputs.

The FADN-CAE data contains detailed information on 16 crop types, including production data on quantities and values. As noted above, we convert these 16 crop types into two aggregate output variables: “cereal crops” and “other crops”, each of which contained eight primary crops. Aggregation is done using a multilateral EKS Fisher quantity index,[3] where the (implicit) prices of each crop type is calculated as the ratio of the output value divided by the output quantity on each farm in each year.

These specialized farms produce other marketable goods and services, among them animals and wood products and work for others, that on average represents about 25 percent of their total revenue. However, detailed quantity and value information was not available for these items, so we constructed an implicit quantity index for this third output variable, defined as non-crop revenue deflated by the CEA *Global price index of agricultural and horticultural production*.

Four input variables are distinguished: land, capital, labor and others. Land is represented by the total surface devoted to commercial crops and follow land. Capital is represented by the replacement value of machinery and buildings weighted by sample average depreciation rates (5.5% for machinery and 1.3% for buildings), and deflated by the CEA *Total investment price index*. Labour is represented by the total number of annual hours worked, including unpaid work realized by the farmer and family members. Finally, the

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[3] For the details on this method see, for instance, Coelli et al (2005).

“other inputs” variable (including energy, fertilizers, and so on) was constructed using an implicit quantity index, defined as non-labour operating costs deflated by the CEA *Intermediate consumption price index*.

Indices of average per farm output and input quantities are plotted in Figure 1. We observe that outputs have all increased: by 35 percent, 58 percent and 26 percent, for cereals, other crops and other outputs, respectively. Input growth is less strong, with land, capital and other inputs increasing by 34 percent, 18 percent and 10 percent, respectively, and labour falling marginally by 2 percent. The 34 percent growth in average farm size, from 48.7 hectares to 65.2 hectares, is of particular interest, suggesting that subsidy reductions may be encouraging this move.

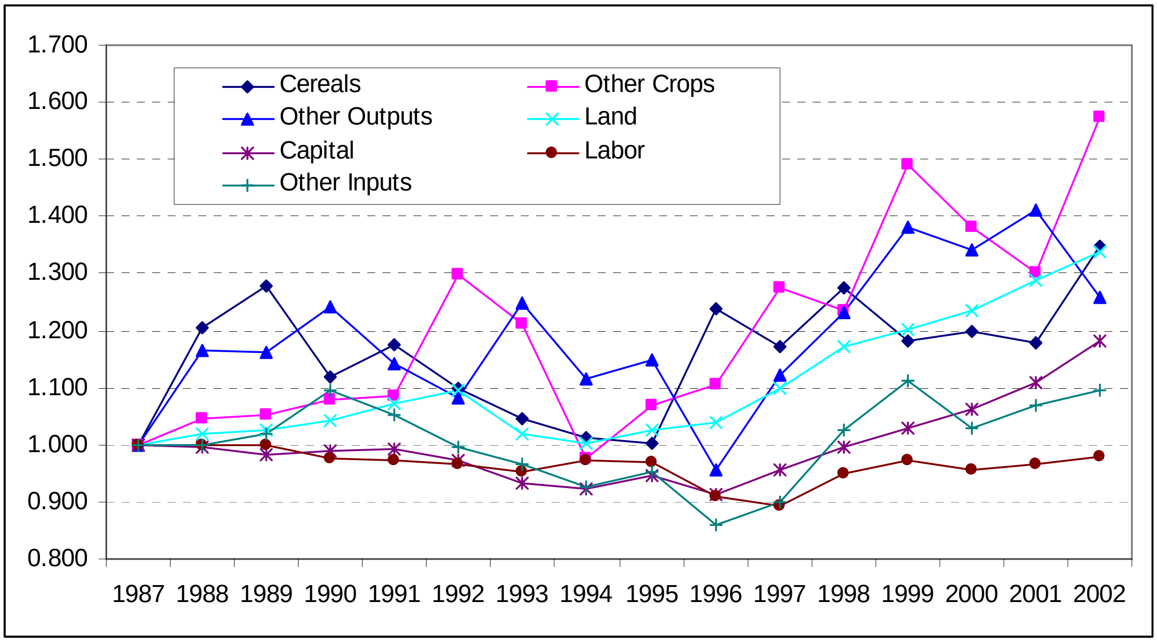

Figure 1: Indices of input and output quantities

4. Methodology

In this section we briefly outline the Malmquist TFP index, and then describe how it can be calculated using linear programming methods, known as data envelopment analysis (DEA).

The Malmquist TFP index

Following Färe *et al.* (1994), the Malmquist TFP index measures the TFP change between two data points by calculating the ratio of the distances of each data point relative to a common production technology. We consider the case of a firm that produces M outputs using K inputs. If the period t technology is used as the reference technology, the Malmquist (output-orientated) TFP change index (for a particular firm) between period s (the base period) and period t can be written as

$$m_o^t(\mathbf{q}_s, \mathbf{x}_s, \mathbf{q}_t, \mathbf{x}_t) = \frac{d_o^t(\mathbf{q}_t, \mathbf{x}_t)}{d_o^t(\mathbf{q}_s, \mathbf{x}_s)}. \tag{1}$$

where o denotes the output orientation, $\mathbf{q}_t$ is the (M×1) output vector of the firm (in period t), $\mathbf{x}_t$ is the (K×1) input vector of the firm (in period t); and $d_o^t(\mathbf{q}_s, \mathbf{x}_s)$ represents the distance from the period s observation to the period t technology.[4]

Alternatively, if the period s reference technology is used the TFP index is defined as

$$m_o^s(\mathbf{q}_s, \mathbf{x}_s, \mathbf{q}_t, \mathbf{x}_t) = \frac{d_o^s(\mathbf{q}_t, \mathbf{x}_t)}{d_o^s(\mathbf{q}_s, \mathbf{x}_s)}. \tag{2}$$

A value of m_o greater than one indicates positive TFP growth from period s to period t while a value less than one indicates a TFP decline.

As noted by Färe, Grosskopf and Roos (1998), these two (period s and period t) indices are only equivalent if the technology is Hicks output neutral. To avoid the necessity to either

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[4] For a discussion of the properties of these distance functions see Färe et al (1994) or Coelli et al (2005).

impose this restriction or to arbitrarily choose one of the two technologies, the Malmquist TFP index is often defined as the geometric mean of these two indices:

$$m_o(\mathbf{q}_s,\mathbf{x}_s,\mathbf{q}_t,\mathbf{x}_t)=\left[\frac{d_o^s(\mathbf{q}_t,\mathbf{x}_t)}{d_o^s(\mathbf{q}_s,\mathbf{x}_s)}\times\frac{d_o^t(\mathbf{q}_t,\mathbf{x}_t)}{d_o^t(\mathbf{q}_s,\mathbf{x}_s)}\right]^{1/2}. \tag{3}$$

The distance functions in this productivity index can be rearranged to show that it is equivalent to the product of a technical efficiency change index and an index of technical change:

$$m_o(\mathbf{q}_s,\mathbf{x}_s,\mathbf{q}_t,\mathbf{x}_t)=\frac{d_o^t(\mathbf{q}_t,\mathbf{x}_t)}{d_o^s(\mathbf{q}_s,\mathbf{x}_s)}\left[\frac{d_o^s(\mathbf{q}_t,\mathbf{x}_t)}{d_o^t(\mathbf{q}_t,\mathbf{x}_t)}\times\frac{d_o^s(\mathbf{q}_s,\mathbf{x}_s)}{d_o^t(\mathbf{q}_s,\mathbf{x}_s)}\right]^{1/2}, \tag{4}$$

where the ratio outside the square brackets in the above equation measures the change in the output-oriented measure of Farrell technical efficiency between periods *s* and *t*, and the remaining part is a measure of technical change (i.e., the geometric mean of the shift in technology between the two periods, evaluated at $\mathbf{x}_t$ and also at $\mathbf{x}_s$.)

The above technical efficiency change measure can also be decomposed into scale efficiency and "pure" technical efficiency components, when the distance functions in the above equations are estimated relative to a constant returns to scale (CRS) technology.[5]

$$\frac{d_o^t(\mathbf{q}_t,\mathbf{x}_t)}{d_o^s(\mathbf{q}_s,\mathbf{x}_s)}=\frac{d_{ov}^t(\mathbf{q}_t,\mathbf{x}_t)}{d_{ov}^s(\mathbf{q}_s,\mathbf{x}_s)}\times\left[\frac{d_{ov}^t(\mathbf{q}_t,\mathbf{x}_t)/d_o^t(\mathbf{q}_t,\mathbf{x}_t)}{d_{ov}^t(\mathbf{q}_s,\mathbf{x}_s)/d_o^t(\mathbf{q}_s,\mathbf{x}_s)}\times\frac{d_{ov}^s(\mathbf{q}_t,\mathbf{x}_t)/d_o^s(\mathbf{q}_t,\mathbf{x}_t)}{d_{ov}^s(\mathbf{q}_s,\mathbf{x}_s)/d_o^s(\mathbf{q}_s,\mathbf{x}_s)}\right]^{1/2}$$

(5)

where the extra subscript, *v*, indicates that a variable returns to scale (VRS) technology is used (as opposed to a CRS technology).

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[5] Grifell-Tatjé and Lovell (1995) argue that the Malmquist TFP index defined in equation 3 may not correctly measure TFP changes when variable returns to scale (VRS) is assumed for the technology. Hence CRS is usually imposed upon the technology that is used to estimate distance functions for the calculation of this Malmquist TFP index.

The first ratio term on the RHS of equation 5 is a measure of *pure efficiency change* (i.e., relative to the VRS technologies), while the second term is a measure of *scale efficiency change* (which is actually the geometric mean of two scale efficiency change measures, the first is relative to the period *t* technology and the second is relative to the period *s* technology).

Calculation using DEA Methods

In this study we follow Färe *et al* (1994) and calculate the four distance measures in equation 3 using the following four DEA-like linear programs.

$$
\begin{aligned}
&[d_o^t(\mathbf{q}_t, \mathbf{x}_t)]^{-1} = \max_{\phi,\lambda} \phi, \\
&\text{st} \quad -\phi\mathbf{q}_{it} + \mathbf{Q}_t\boldsymbol{\lambda} \geq \mathbf{0}, \\
&\qquad \mathbf{x}_{it} - \mathbf{X}_t\boldsymbol{\lambda} \geq \mathbf{0}, \\
&\qquad \boldsymbol{\lambda} \geq \mathbf{0},
\end{aligned} \tag{6}
$$

$$
\begin{aligned}
&[d_o^s(\mathbf{q}_s, \mathbf{x}_s)]^{-1} = \max_{\phi,\lambda} \phi, \\
&\text{st} \quad -\phi\mathbf{q}_{is} + \mathbf{Q}_s\boldsymbol{\lambda} \geq \mathbf{0}, \\
&\qquad \mathbf{x}_{is} - \mathbf{X}_s\boldsymbol{\lambda} \geq \mathbf{0}, \\
&\qquad \boldsymbol{\lambda} \geq \mathbf{0},
\end{aligned} \tag{7}
$$

$$
\begin{aligned}
&[d_o^t(\mathbf{q}_s, \mathbf{x}_t)]^{-1} = \max_{\phi,\lambda} \phi, \\
&\text{st} \quad -\phi\mathbf{q}_{is} + \mathbf{Q}_t\boldsymbol{\lambda} \geq \mathbf{0}, \\
&\qquad \mathbf{x}_{is} - \mathbf{X}_t\boldsymbol{\lambda} \geq \mathbf{0}, \\
&\qquad \boldsymbol{\lambda} \geq \mathbf{0},
\end{aligned} \tag{8}
$$

and

$$
\begin{aligned}
&[d_o^s(\mathbf{q}_t, \mathbf{x}_t)]^{-1} = \max_{\phi,\lambda} \phi, \\
&\text{st} \quad -\phi\mathbf{q}_{it} + \mathbf{Q}_s\boldsymbol{\lambda} \geq \mathbf{0}, \\
&\qquad \mathbf{x}_{it} - \mathbf{X}_s\boldsymbol{\lambda} \geq \mathbf{0}, \\
&\qquad \boldsymbol{\lambda} \geq \mathbf{0},
\end{aligned} \tag{9}
$$

where i denotes the i-th firm in a sample of N firms; $\mathbf{Q}_t$ is a ($M \times N$) matrix containing the output vectors for all firms in period t; $\mathbf{X}_t$ is a ($K \times N$) matrix containing the input vectors for all firms in period t; λ is a ($N \times 1$) vector of weights (one for each firm in the sample); and ϕ is a scalar. These four linear programs (LPs) must be solved for each firm in each pair of adjacent periods.

The decomposition of the technical efficiency change measure into a scale efficiency measure and a "pure" technical efficiency measure (see equation 5) requires the solution of two additional LPs (when comparing two production points). This involves repeating LPs 6 and 7 with a convexity restriction (i.e., the weights in the λ-vector must add up to one) added to each LP. This provides estimates of distance functions relative to a VRS technology.[6]

5. Results and Discussion

In this section we present and discuss the empirical results of our TFP calculations. We provide information on TFP change (TFPC), technical change (TC), technical efficiency change (TEC), and scale efficiency change (SEC). Average annual cumulative indices are plotted in Figure 2. Here we observe that TFP has increased by a 17% over this 16-year period, corresponding to at an average annual rate of 1.0% per year.

When we divide this 16-year period into the three sub-periods, corresponding to the period prior to the 1992 reforms, the 1992-2000 period, and the period following the 2000 reforms, we see no clear evidence of the reforms enhancing TFP growth. In fact, if anything one could conclude that TFP growth was fastest prior to these reforms.[7] This

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[6] For more on VRS and CRS DEA models see Coelli et al (2005).

[7] From Figures 1 and 2 one could conclude that the year-to-year volatility in the TFP index is primarily due to output variability, which is most likely a consequence of variations in climate conditions. We are currently attempting to adjust these indices using climate data (on rainfall, temperature and sunlight), with limited success.

result is disappointing, but perhaps not so surprising, given that the aggregate level of subsidy payments have not changed significantly over this period, even though the allocation mechanism has altered.

The results in Figure 2 show that the main contributor to TFP growth has been technical change (or frontier shift) of 23%. In addition to this we have a 4% reduction from scale efficiency change (SEC) and a 2% decrease due to technical efficiency change (i.e., VRS TEC). At first glance the negative SEC may seem strange, given that the average farm size has increased over this period. However, we suspect that the main reason for this fall in average SEC is the fact that the larger farms have been improving productivity at a faster rate than the smaller farms, meaning that the performance gap between small and large farms has been widening, and hence giving the smaller farms increasingly lower scale efficiency scores as time passes.

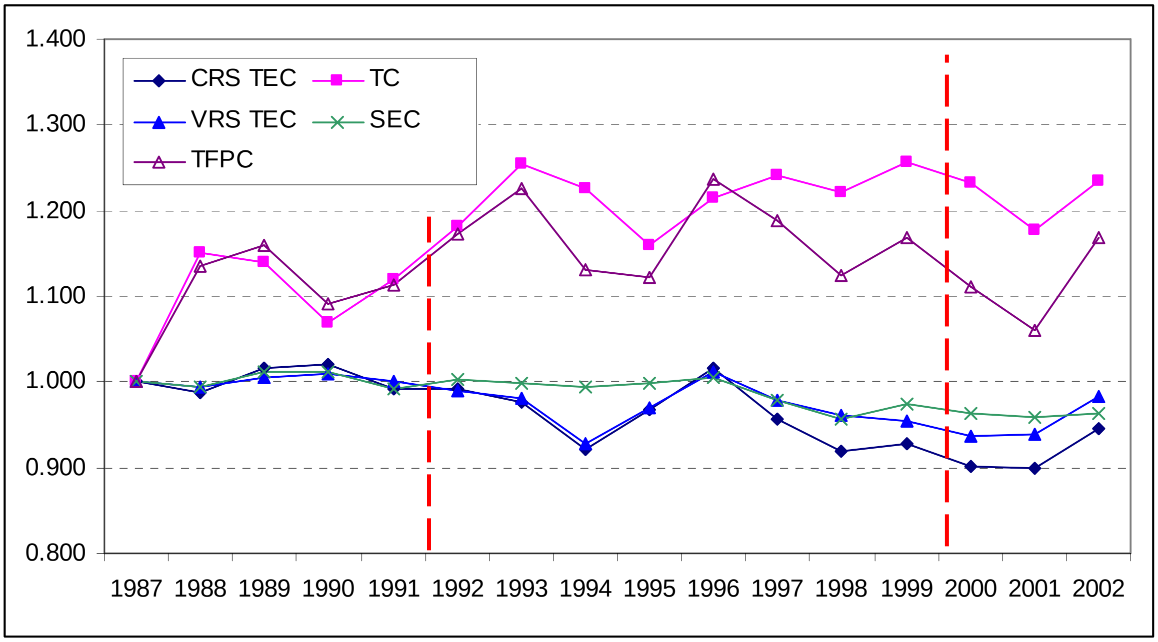

Figure 2: Indices of TFP change and its components

The degree to which the small farms are being left behind is illustrated in Figure 3, where we have plotted TFP change indices for the four size groupings. The TFP indices vary markedly by farm size, with the larger two categories achieving above average TFP growth of 26 to 28%, while the smallest farms have gone backwards by a disappointing 3%. This stagnation in the performance of small farms must be a concern for those responsible for Belgian agricultural policy, given that these farms must sell their products in a world where rates of agricultural TFP growth are often over 2% per year.[8] This suggests that a number of these small farms will either become bankrupt or demand even higher subsidies.

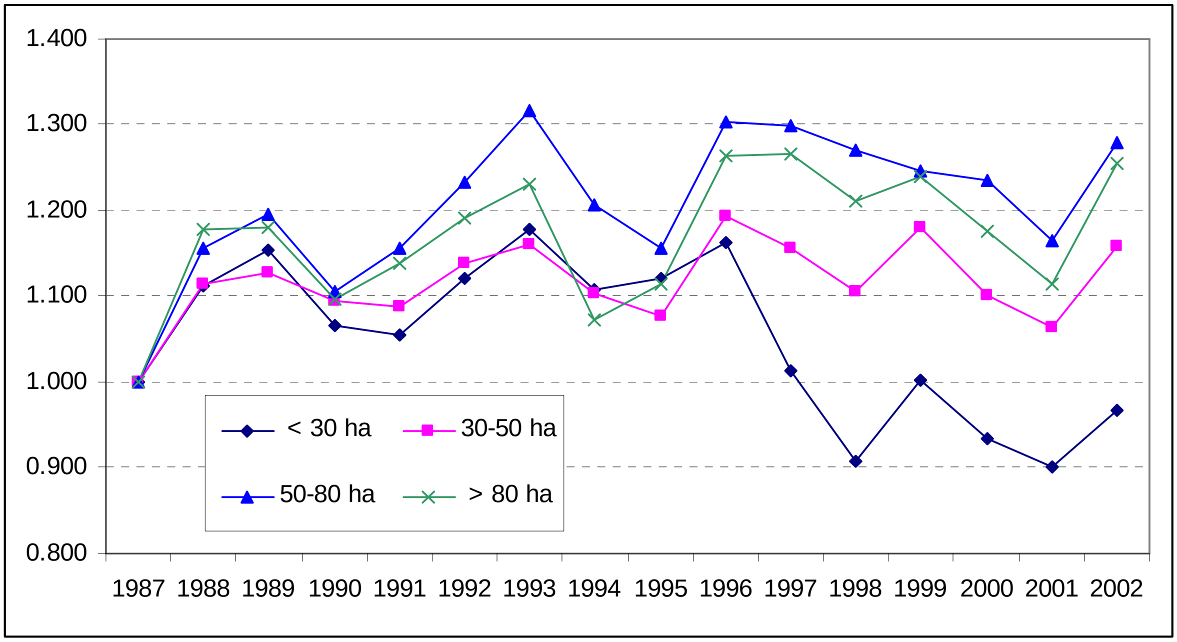

Figure 3: Indices of TFP change by farm size

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[8] For example, Leetmaa, Arnade and Kelch (2004) report annual average agricultural TFP growth rates over the 1973-1993 period of 2.41% for EU countries and 3.14% for the USA, based on the results reported in Ball et al (2001). Furthermore, Coelli and Rao (2005) report weighted annual average agricultural TFP growth rates of 2.1% for a sample of 97 countries over the period from 1980 to 2000.

Indices of TFP change for four different regions are plotted in Figure 4, where we observe that there is little difference in the patterns of TFP change across these four regions, other than some evidence of less volatility in TFP in the two regions with the most arable farms, namely the Silt-laden and Sandy-silt-laden regions. This is as one would expect given that these regions have conditions that are most favourable for arable farming and hence are less likely to be influenced by climatic variations.

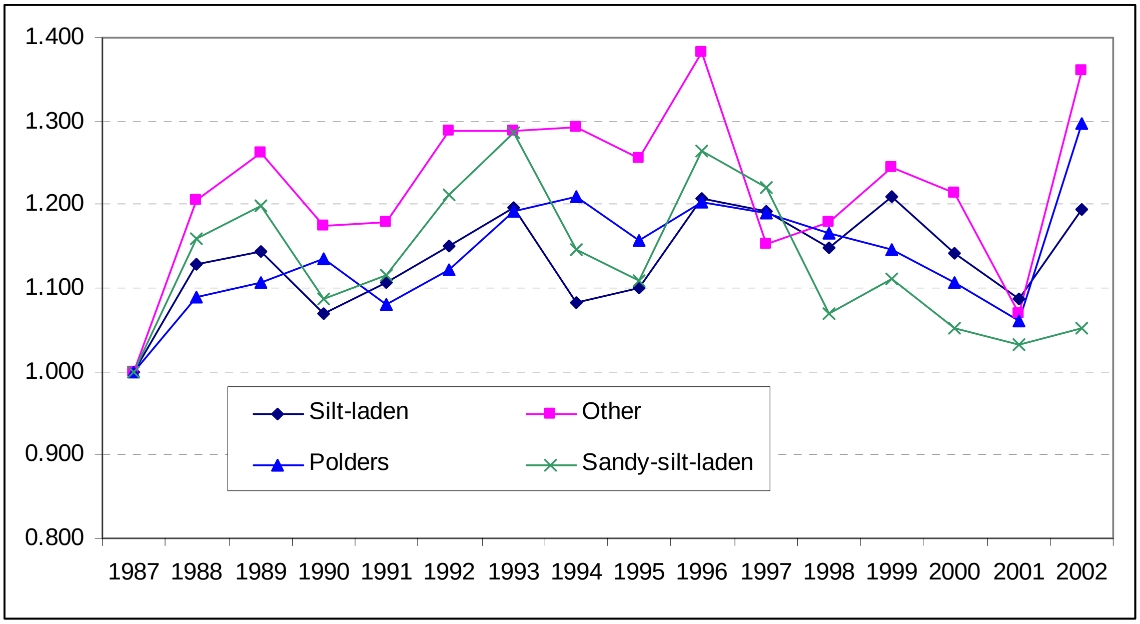
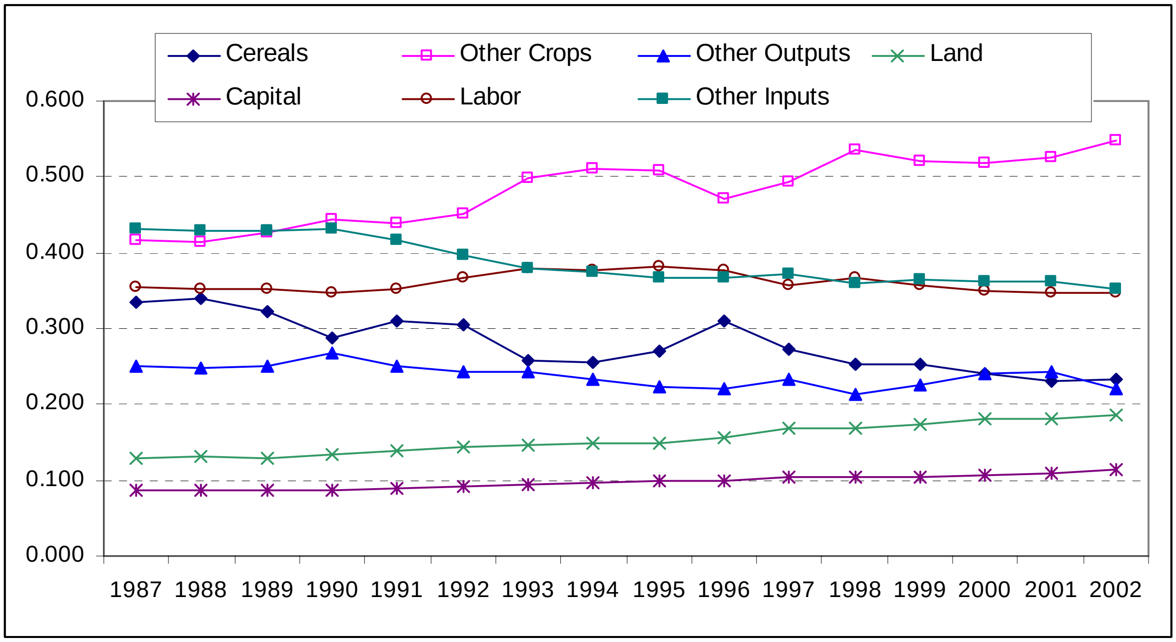


Figure 4: Indices of TFP change by region

The CAP reforms were also designed to correct allocative distortions in European agriculture. We can obtain some insight into this issue by comparing the shadow revenue and cost shares derived from our DEA frontiers (see Coelli and Rao, 2001) with actual shares. These shares are reported in Figures 5 and 6. In terms of actual shares, we see a decrease in the revenue share of cereals from 33% to 23%, and a corresponding increase in the share of other crops from 42% to 55%, most likely reflecting the reduction in direct price subsidies on cereals, and the gradual equalisation of per-hectare subsidies across crop types. On the input side we see an increase in the land share from 13% to 19% and a reduction in the share of other inputs from 43% to 35%, perhaps being in part due to the reduction in direct price subsidies on cereals encouraging a reduction in the use of purchased inputs, such as fertiliser.[9]

The reduction in the share of purchased inputs is also reflected in the shadow shares, as is the increase in the shadow share for land. However, the size of the shadow share of land is (approximately 50%) is much greater than the actual share (approximately 15%), reflecting the degree to which the other inputs are overused relative to land. Furthermore, the shadow share of labour (approximately 8%) is substantially smaller than the actual share (approximately 36%), indicating that labour is overused relative to the other inputs. The sizes of these differences are rather surprising, and suggest that CAP policies remain particularly distorting, in terms of input allocation.



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[9] Another contributing factor could be the introduction of manure disposal regulations on intensive pig-finishing farms, which has led to many arable farmers in the North of Belgium using more organic fertiliser (obtained for free from the pig farmers) and less purchased chemical fertilisers.

Figure 5: Actual Revenue and cost shares

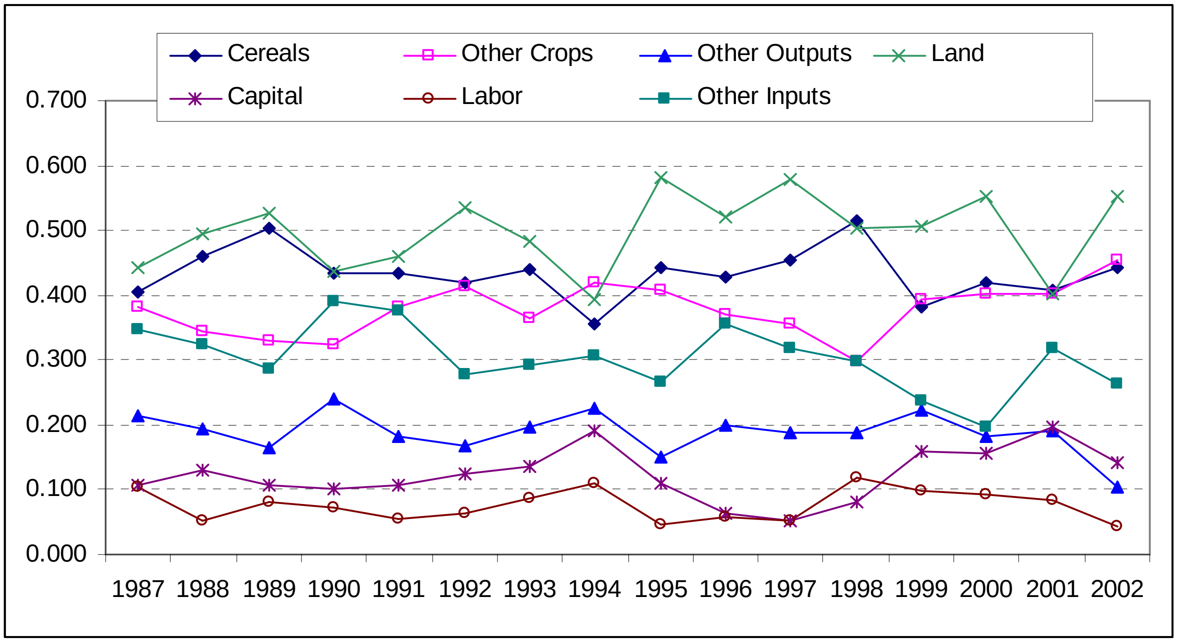

Figure 6: ShadowRevenue and cost shares

6. Conclusions

In this study we have obtained detailed information on the total factor productivity (TFP) growth of arable farms in Belgium over a 16-year period from 1987 to 2002. Calculations were based on a carefully constructed high-quality detailed farm-level data set containing 1728 observations, involving over 100 farms in most years. The TFP model involved three output variables (cereals, other crops, other outputs) and four input variables (land, labour, capital and other inputs).

The TFP measures were calculated using a Malmquist DEA TFP methodology, which provided detailed information on TFP change (TFPC), technical change (TC), technical efficiency change (TEC), and scale efficiency change (SEC) for each farm between each pair of adjacent periods. The results indicated an average annual rate of TFPC of 1.0% per year, with most of this being due to TC (or frontier shift). An inspection of the TFPC indices before and after the two CAP reforms (in 1992 and 2000) indicated that these reforms had had no discernable effect upon TFP trends. This was not surprising given that the aggregate amount of subsidies had changed little during this period – only the way in which they were allocated (by hectare as apposed to by kilogram) had changed.

A comparison of shadow shares (derived from the DEA frontiers) with market shares indicated that substantial distortions remain in this industry, especially with regards to the excess use of labour and constrained use of land, relative to other inputs. Furthermore, TFPC results were compared across four different regional areas and four different farm size categories, indicating that TFPC was fairly uniform across regions but differed across size categories, with larger farms achieving annual average TFPC close to 1.5% while the smaller farms actually went backwards in terms of TFPC over this period.

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