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A MALMQUIST INDEX BASED DECOMPOSITION OF EFFICIENCY AND PRODUCTIVITY CHANGE IN BELGIUM

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Abstract

The paper is an empirical estimation of the Total factor productivity change and its decomposition of four categories of farms producing field crops in Belgium during the period of 1989-2009 with the help of Malmquist index using the tool of Data Envelopment Analysis. The result suggests that throughout the entire period there is negative factor productivity both in farm wise and year wise. The positive technical efficiency chage is outweighed by the huge negative total factor productivity change. The study suggests government subsidy to the farms of small size and agricultural extension services should be provided to overcome inefficiency in production of field crops. Specialization in particular crop production may help in improving efficiency and productivity in the long run and the common agricultural policy on food self-sufficiency for the European Union can be met.

Keywords: Total factor Productivity Change, Technical Efficiency Change, Technological Change, Pure Technical Efficiency change, Scale Efficiency change

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1-INTRODUCTION

Belgium is a country of North-Western Europe. It is one of the smallest and most densely populated European countries and it has been since its independence in 1830, a representative democracy headed by a hereditary constitutional monarch. However in 1980's and 90's steps were taken to turn Belgium into federal state with powers shared among regions of Flanders, wallonia and Brussels.[1] The European economic Commission (EEC) common agricultural policy, foreseen in the Treaty of Rome was enacted in 1962-2012 marked the 50th anniversary of this key element of European integration. The initial objectives of the Common Agricultural Policy (**Eurostat yearbook, 2012**) were to improve the agricultural productivity in order to provide affordable food to all European citizens and a fair standard of living for farmers by means of guaranteed price. As per the 2012 Eurostat yearbook report, in 2009 agriculture in EU-27 generated around EUR 13600 million of value added around 1.2% of the added value for the whole economy, the contribution of agriculture fell from 1.4% a year earlier (2008) from 1.8% 5 years earlier (2004) and from 1.9% at the turn of the decade. Since the economic importance of agriculture in value added terms was generally much greater in east and south Europe than west and North. Since the agricultural holdings in Belgium is showing a declining trend from 2000 onwards (declined from 54.9 000holdings in 2003 to 48000 holdings in 2007, Eurostat Yearbook-2009, pp-335-37) and around 4.5% of the total agricultural holdings are irrigated, the importance of increasing farm productivity and efficiency is very much essential for the food security in the country as well as in the entire European Union. Secondly, the gross value added of agriculture, hunting and fishing has been steadily declined from 2.8% of the total gross value in 1997 to 0.9% in 2007, where as the share of trade, transport and communication, Business

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[1] It is bounded by Netherland to the North, Germany to the East, Luxemburg to the Southeast and France to the South. The open countryside of North central Belgium includes pastureland as well as intensive diversified cultivation of such crops as wheat, sugar beats and oats; local variation includes orchards. Farms range in size from 30 hectares to 100 hectares. Intensified cultivation is confined to gardens of small farms. Only a small percentage of country's active population engaged in agricultural activities and agricultural activity has continued to shrink both in employment and in its contribution to GDP. One fourth of the total land is under permanent cultivation. Major crops are sugar beats, chicory, flax cereal grains and potatoes. However, agricultural activity in Belgium constitute more than 2/3rd of the total farm value. Belgium's Economic freedom score is 69 making its economy 38th freest in the 2012 index. Its overall index has declined 1.2 points from the last year primarily reflecting a significant deterioration in government finance. Belgium is ranked 18th freest among 43 countries in the Europe region and its overall score. In respect of property right and freedom from corruption the sore and world ranks are respectively 80 (20) and 71(22). The fiscal freedom and government spending has increased from 54.1 per cent of the total domestic output leading to higher budget deficits averaging 4 percent and growing public debt has reached 96.7 per cent of the GDP. In terms of regulatory efficiency (Business freedom, labour freeodom, monetary freedom) the score and rank is 92.3 (11), 71.3 (55), 81.2 (36). As far as market freedom is concerned, trade freedom, investment freedom and financial freedom the score and the ranks respectively are 87.1 (12), 80 (14) and 70 (17) (Index of economic Freedom, 2012).

activities and farm services, industry and other services are increasing sharply. Therefore, to meet the future excess demand for agricultural products, the efficiency and productivity of the household farms must increase. In this context, the paper aims at estimating whether there is any change in the total factor productivity of the total output during the period wise (1889-2009) and farm wise (Four categories). The paper empirically studies the decomposition of the total factor productivity change (TFPC) into technical efficiency change (TEC) and technological change (TCC). Further TEC is decomposed into pure technical efficiency change (PTEC) and scale efficiency change (SEC). Malmquist Index (MI) has been utilized to estimate all such components. MI based on Data Envelopment Analysis (DEA) is one of the prominent indexes for measuring the relative productivity change of the producing units in multiple time periods

The original idea of Malmquist Index (MI) was proposed by Malmquist (1953) who, advocated comparing the input of a given firm at two different point of time in terms of the maximum factor by which the input in one period could be decreased such that the firm could still produce same output level of the other time period.

Finally Fare et al (1992) successfully shown that MI can be calculated using non parametric DEA on assuming constant returns to scale and estimated technological change and productivity change over a period of time. This approach has been extended by Fare et al. (1994) through the use of variable returns to scale. And hence scale efficiency could be estimated. Fulginity and Perrin (1998) use a parametric meta production function and a non- parametric MI to examine the performance of the agricultural sectors in a set of 18 less developing countries and find productivity regress in many of them. Trueblood (1996) uses non-parametric MI and finds negative productivity growth in a significant number of developing countries. Arnade (1998) estimates agricultural productivity indices using non-parametric MI for 70 countries during the year 1961-93. Nin et al (2003) estimates TFPC for 20 countries during 1961-1994 using non-parametric MI and found most of developing countries experience productivity growth. Coelli et al (2003) estimate TFPC for Bangladesh crop and finds a decline in TFPC over the period Alene (2009) estimates TFPC in African agriculture for the period 1970-2004 using both contemporaneous and sequential MI and it was found that the sequential MI was found to be rising at 1.8% per annum. Kumar and Rosegrant (1994) found that TFPC has risen by 1.8% annually in southern region of India. Chand et al (2011) estimated crop level Total factor productivity change for the period 1986-2005 using Tornqvist index and found highest TFP growth for wheat crop. Mukharjee and Khuroda (2001) used Tornqvist-Theil methodology to construct the TFP index for Indian agriculture in fourteen states from 1973-1993 and found TFP index to be 1.73. Murgai (1999) uses Tornqvist-Theil approach to estimate TFP growth in Punjab at district level and found 1.9% TFP average growth from 1960-1993. Rao (2005) estimated TFP across different crops and found growth rate for all crops to be 0.23% in the pre 1990 and –0.7% in the post reform period. Other studies related to TFP are Bhusan (2005), Kumar and Mittal (2006).

2- MATERIALS AND METHODS

The discussion of efficiency measurement begins with Farrell (1957), who drew upon the work of Debreu (1951) and Koopmans (1951) to define a simple measure of farm efficiency that could account for multiple inputs. Farrell (1957) proposed that efficiency of firm consists of two components: technical efficiency which shows the ability of a firm to obtain maximal output from a given set of inputs and allocative efficiency implies the ability of a firm to use inputs in optimal proportions, given their respective prices production technology. The Farrell input-output oriented technical efficiency measures are equivalent to the input-output functions distant functions of Shephard (1970) and Fare and Primont (1995). It is possible that a firm is both technically and allocatively efficient but the scale of operation of the firm may not be optimal. Hence, efficiency of the firms might be improved by changing their scale of operations i.e., to keep the same input mix but change the size of operation. If the production technology is globally constant returns to scale technology, then the firm is automatically scale efficient.

There have been several attempts to measure scale efficiency and its influence on productivity change over time. Some of the earlier measures of scale efficiency are Banker and Thrall (1992), Fare et al (1994). Fare et al (1998) presented a definition of scale efficiency and use it in deriving a decomposition of productivity change over time. Balk (2001) provides a formal framework to define scale efficiency and to study the role of scale efficiency in productivity change.

2.1 MEASURING CHANGE IN PRODUCTIVITY

Productivity is essentially a level concept and measures of productivity can be used in comparing performance of firms at a given point of time. Productivity change refers to the movements in productivity performance of a firm or an industry over time. In the presence of multiple output and inputs, TFP may be defined as a ratio of aggregate output produced relative to aggregate input used. Aggregation of inputs and outputs gives rise to index number problem. The change of productivity by a Total Factor Productivity (TFP) or a multi -factor productivity Index, among several approaches to measure changes in TFP, the component-based approach to productivity change as advocated by Balk (2001) is used.

Caves et al. (1982a, 1982b) first introduced the Malmquist Index (MI). The index is constructed by measuring the radial distance of the observed output and input vectors in period t+1 and t relative to a reference technology. In case of panel data DEA-like linear programming and a MI can be used to measure productivity change and to decompose the productivity change into technical change and technical efficiency change. Fare et al (1994) specifies an output based Malmquist productivity change Index as

$$M_I (Y_{t+1}, X_{t+1}, Y_t, X_t) = \left[\frac{D_0^{\,t}(Y_{t+1}, X_{t+1})}{D_0^{\,t}(Y_t, X_t)} \; x \; \frac{D_0^{\,t+1}(Y_{t+1}, X_{t+1})}{D_0^{\,t+1}(Y_t, X_t)} \right]^{½} \quad \ldots\ldots\ldots\ldots\ldots(1)$$

The index represents the productivity of production point (Y_{t+1}, X_{t+1}) relative to the production point (Y_t, X_t). A value greater than one indicates positive TFP growth from period t to period t+1. This index is the Geometric Mean (GM) of two output based Malmquist TFP index. Equation (1) can be formulized as

$$M_I (Y_{t+1}, X_{t+1}, Y_t, X_t) = \left(\frac{D_0^{\,t}(Y_{t+1}, X_{t+1})}{D_0^{\,t}(Y_t, X_t)} \right) x \left\{ \left(\frac{D_0^{\,t}(Y_{t+1}, X_{t+1})}{D_0^{\,t+1}(Y_{t+1}, X_{t+1})} \right) x \left(\frac{D_0^{\,t}(Y_t, X_t)}{D_0^{\,t+1}(Y_t, X_t)} \right) \right\}^{½}$$

--(2)

The first term in the right hand side of equation (2) measures change in input based technical efficiency between period t and t+1. The change in efficiency is represented by the ratio of efficiency in period (t+1) in proportion to efficiency in period t . The GM of two terms in the bracket represents the change in technology between two period. Hence changes in TFP and components are measured as GM of MI (Fare et al, 1994). TFP exceeding one indicates an increase in TFP during the period t and t+1 where as its being less than one means the contrary (Coelli 1996). Given the Constant returns to Scale (CRT) technology and input based approach the LP is used in building Malmquist TFP change index is as follows (Worthington, 2000)

$$\left[D_0^{t} (Y_t, X_t) \right]^{-1} = \text{Min}_{\theta, \lambda}\, \theta$$

Subject to

$$-y_{it} + Y_t\lambda \geq 0$$

$$\theta x_{it} - X_t\lambda \geq 0$$

$$\lambda \geq 0 \quad \text{--}(3)$$

$$\left[D_0^{t+1}(Y_{t+1}, X_{t+1})\right]^{-1} = \text{Min}_{\theta,\lambda}\ \theta$$

Subject to

$$-y_{i,t+1} + Y_{t+1}\lambda \geq 0$$

$$\theta x_{i,t+1} - X_{t+1}\lambda \geq 0$$

$$\lambda \geq 0 \text{---} (4)$$

$$\left[D_0^{t+1}(Y_t, X_t)\right]^{-1} = \text{Min}_{\theta,\lambda}\ \theta$$

Subject to

$$-y_{it} + Y_{t+1}\lambda \geq 0$$

$$\theta x_{it} - X_t\lambda \geq 0$$

$$\lambda \geq 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$\left[D_0^{t}(Y_{t+1}, X_{t+1})^{-1}\right] = \text{Min}_{\theta,\lambda}\ \theta$$

Subject to

$$-y_{i,t+1} + Y_t\lambda \geq 0$$

$$\theta x_{i,t+1} - X_t\lambda \geq 0$$

$$\lambda \geq 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

The equation (3) and (4) are evaluated by using the efficient limit of the given period as a base. Model (5) compares the data of period t with efficient limit of period (t+1) while model (6) compares the datum of period (t+1) with period t's efficient limit. For given number of period (T) and number of observation (N) N(3T-2) LP problems should be solved.

3-THEORY AND CALCULATION

On the basis of the equation 1-6, the total output data for Belgium, one of the members of the European Union, obtained for the year 1989-2009 form Farm Accounting Data Network (FADN) have been used to calculate the Total Factor Productivity Change (TFPC) and the components of TFPC by using the DEAP program developed by Coelli (1996a).

3.1- Type, Sources and Nature: The data used are extracted from the Farm Accounting Data Network (FADN) of European Commission. It is an instrument for evaluating the agricultural holdings and the impacts of Common Agricultural Policy. FADN information is aggregated into standard results database available for the following dimensions: Time (year), geographic (country, Region), Typology (type of farming TF8/TF14 and Economic Size ES6). All results are given in EUR/ECU). This enables the results for individual member states to be aggregated to the level of European Union and the results of two or more member states to be compared. The data are for field crops of TF8 groups for the four economic sizes of farms for 21 years i.e., from 1989-2009 for Belgium.

Out of different types of farming the TF8 of 2003/369(EC) version is classified as field crops, horticulture, wine, other permanent crops, milk, other grazing livestock, granivores, mixed.

Field crops include: specialist cereals, oilseeds and protein crops (COP), which include specialist COP other than rice, specialist rice, COP and rice combined.

General Field cropping includes specialist root crops, cereals and root crops, combined, specialist field vegetable various field crops (tobacco, cotton). Mixed cropping includes market gardening and permanent crops, field crops and market gardening, field crops and vineyards, field crops and permanent crops, mixed cropping mainly field crops, mixed cropping mainly market gardening or permanent crops.

Out of different economic size classes at the level of European Union and for each member states ES6 grouping consists of 0<4, 4<8, 8<16, 16<40, 40<100, >100 Economic Size Unit (ESU).

The Total output (SE131) is in EUR. It consists of total output of crops and crop products and of other output. The formula is SE135 + SE206 + SE256. The inputs used are

- SY502-farms represented: It is the sum of weighting coefficient of individual holdings in the sample.
- SE005-Economic Size of the holding (ESU) is expressed in European Size Unit (ESU). ESU= 1200.
- 021-Paid labour input- (Hours)
- SE016-Unpaid labour unit (Hours)
- SE025- Total Utilized agricultural area (Hectare (Ha))-Total utilized agricultural are of holding does not include areas used for mushrooms, land rented for less than one year on an occasional basis woodlands and other forms (road, ponds). It consists of land in sharecropping. It includes agricultural land temporarily not under cultivation for agricultural reasons or being withdrawn from production as part of agricultural policy measures.
- SE030-Rented UAA (Ha)-Unutilized agricultural areas rented by the holder under tenancy agreement for a period of at least one year (remuneration in cash or in kind)
- SE270- Total inputs (EURO)- Specific costs + overhead cost + depreciation + external factor (SE281 + SE336 + SE360 + SE 365)
- SE436-Total Assets (Euro)- Only assets in ownership are taken into account (Fixed assets + Current Assets)

- SE441 Total Fixed Assets (Euro)-Agricultural land and farm buildings and forest capital + buildings + machinery and equipment + breeding livestock.
- SE465-Total current Assets Euro)- Non-breeding livestock+ Circulating capital
- SE485-Total liabilities (Euro)-Value at closing valuation of total (long + medium + Short) loans still to be paid.
- SE605-Total subsidies excluding on investment (Euro)-SE610 + SE615 + SE699 + SE624 + SE625 + SE626 + SE630.

4-RESULTS AND DISCUSSION:

The results obtained through DEAP (Coelli, 1996a) for the 21 years and for four categories of the farm sizes are presented and discussed below. The mean values of all the inputs used in the analysis are presented in the Table-1. As far as the farm size (16-40) is concerned the inputs used to produce the output is comparatively larger than the other three categories. For example the output of the farm size (40-100) is about the double of the farm size (16-40). But the inputs used by the farms (16-40) are very much close to the later category. This means the small farms sizes are experiencing large expenditure in terms of fixed and variable costs which results in low profitability and leading to inefficiency. The trends of the output of different farm sizes for the entire 21 years are shown in the figure1. It shows that there is no significant increase in output in the specific time period for different farm sizes

Fig-1:Total output of different farm size from 1989 to 2009

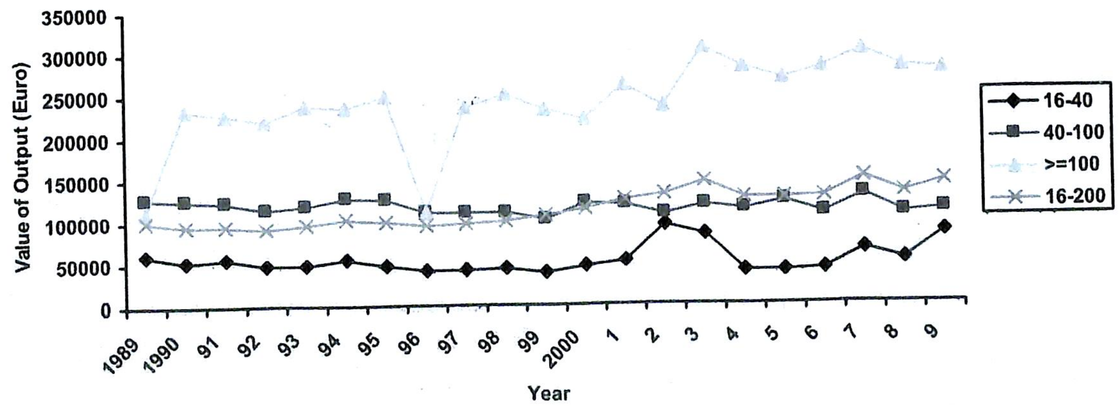

Table-1: Mean values of output and inputs used for different Economic Size of Holding in 1989-2009

Output/Input	16-40	40-100	>100	16-200
Output (Euro)	53615	116879.6	238145	114435.6
Farms represented (No)	2179.048	1919.048	1182.38	5499.524
Economic Size(ESU)	28.95714	30.45714	32.02381	33.54762
Paid labor input (Hours)	129.318	142.3238	163.5881	184.8167
Total UAA (Ha)	24.77952	25.97143	27.14905	28.34714
Rented UAA (Ha)	18.82238	19.79524	20.77143	21.8081
Unpaid labor (Hours)	2519.743	2557.565	2605.478	2648.861
Total Input (Euro)	40572.33	42729.9	45148.14	47653.9
Total Assets (Euro)	147875.4	154445.4	161386.3	167148.8
Total Fixed Assets (Euro)	128219.8	133306.8	138767.7	143293.3
Total Current Asset (Euro)	19655.52	21138.52	22618.52	23855.38
Total Liabilities (Euro)	29490	33260.1	37537.57	41731.43
Total Subsidies (Euro)	5898.571	6012.286	6122	6246.381

Table-2: **Year-Wise Malmquist Index Summary of Annual Means**

Year	TEC	TCC	PTEC	SEC	TFPC
1990	1.037	0.417	1.000	1.037	0.432
1991	1.000	0.864	1.000	1.000	0.864
1992	0.992	1.502	0.998	0.994	1.489
1993	0.954	1.116	1.002	0.952	1.065
1994	1.054	1.013	1.000	1.054	1.068
1995	1.003	0.820	1.000	1.000	0.797
1996	1.000	0.714	1.000	1.000	0.714
1997	1.000	1.139	1.000	1.000	1.139
1998	1.000	1.457	1.000	1.000	1.457
1999	1.000	0.999	1.000	1.000	0.999
2000	1.000	0.823	1.000	1.000	0.823
2001	0.995	0.617	1.000	0.995	0.615
2002	1.005	0.891	1.000	1.005	0.895
2003	0.995	0.975	1.000	0.995	0.970
2004	1.005	1.118	1.000	1.005	1.124
2005	1.000	0.403	1.000	1.000	0.403
2006	0.988	0.569	1.000	0.988	0.562
2007	1.008	1.012	1.000	1.008	1.020
2008	1.004	1.008	1.000	1.004	1.092
2009	0.998	0.950	1.000	0.998	0.948
Mean	**1.002**	**0.876**	**1.000**	**1.002**	**0.877**

As per the results reported in the **Table-2,** the Geometric mean (GM) the Technical efficiency Change (TEC) is 1.002. This is the product of Pure Technical Efficiency Change (PTEC) and Scale Efficiency Change (SEC). The mean PTEC and SEC are repsectively1.000 and 1.002. The Total factor productivity Change (TFPC) is the product of TEC and Technological Change (TCC). The mean TFPC is 0.877, which is the product of (TEC and TCC i.e., 1.002 and 0.876). During the entire 21 years (from 1989-2009) the highest mean change occurs in the year 1991 (1.489) and the lowest men TFPC is in the year 2005 (0.403).

The decomposition of the TFPC for the corresponding years into TEC and TCC reveals that 48.9% increase in TFPC is due to largely 50.2% improvement in the technology used and 0.02% negative change in the PTEC and 0.04%nagative growth in SEC. But the low mean TFPC in the year 2005 is entirely due to huge negative growth in the technology of about 60%.

As far as the technical efficiency change (TEC0 is concerned, the positive change occurred only in six years i.e., 1990, 1994, 1995, 2002, 2004, 2007 and 2008 and highest positive TEC was in 1990 i.e., 3.7%. This positive change in TEC is entirely due to scale efficiency change. Ad per the farm structure survey in Belgium (2007) out of 48000 agricultural holdings, 46100 holdings had an economic size of at least one European Size Unit compared to 49600 holdings in 2005 (7% reduction). These farms made use of 1.37mha of utilized agricultural area (UAA) a decrease of nearly 1% compared to 2005 which makes the average size of holding in Belgium around 30 hectares implies that the farm people are using more of human labour (specially Family labour) without any improvement in the technology they use. Therefore, even if technically, there is positive improvement in efficiency but total factor productivity change is negative. Hence, the farms seems to be more traditional and if needs lot of improvement in front of application of modern technology. Even though the farms are considered to be commercial, lack of technological improvement in the farm holding reduces the gross profit of the farm. During the 21 years there is lot of opportunity for the farm to improve the total factor productivity on an average by 13% with a highest opportunity of 60%.

In case of technological change, the average change is negative i.e., 0.87. However, the specific years which shown positive technological changes are in 8 years out of the total 21 years. These years are 1992, 1993, 1994, 1997, 1998, 2004, 2007 and 2008. Among those years, highest technological change occurred in the year 1992 (50.2%)followed by 1998 (45.7%). In fact the positive technological change solely contributed to the positive growth in the total factor productivity in 1992 (highest 48.9%) followed by 1998 (45.7%). Another fact is that the positive growth in technological change leads to the positive change in total factor productivity. Since in many years there is deceleration in technological change, the average technological change shows deceleration. The most interesting fact is that, throughout the years there is neither improvement nor deceleration in the pure technical change. Hence, the farms are not adopting any modern managerial practice and just adopt same practice throughout the years.

Table-3: **Farm-Wise Malmquist Index of Farm Means**

Farm	TEC	TCC	PTEC	SEC	TFPC
1	1.000	0.712	1.000	1.000	0.712
2	1.003	0.832	1.000	1.003	0.835
3	1.000	0.868	1.000	1.000	0.867
4	1.004	1.144	1.000	1.004	1.149
Mean	**1.002**	**0.876**	**1.000**	**1.002**	**0.877**

Table-3 presents the farm-wise Malmquist Index of TFPC and TCC. The farms are classified on the basis of the Economic Size of 16-40, 40-100, 100 and more and 16 to 200. The farm-wise mean change pro vides the information that mean TFPC is 0.877, the product of mean TEC (1.002) and mean TCC (0.876). Out of all these four categories of farms the second category performs a positive change of about 0.3% and the 4th category of about 0.4% while the other two categories do not show any kind of positive TEC. The positive TEC is entirely due to the positive change in the scale. However, the fourth category shows a lot of improvement in the technological change.

However, the entire period of 21 years is divided into two phases: (from 1989-1999) and (from 2000-2009) to know any remarkable changes occurred in the change in efficiency and productivity year wise and farm wise. As per the table-4 the men Tec for the first 11 year is

Table-4: **MALMQUIST INDEX SUMMARY OF ANNUAL MEANS (1989-1999)**

Year	TEC	TCC	PTEC	SEC	TFPC
2	1.037	0.417	1.000	1.037	0.432
3	1.000	1.025	1.000	1.000	1.025
4	1.000	0.835	1.000	1.000	0.835
5	0.989	0.674	1.000	0.989	0.666
6	1.011	1.317	1.000	1.011	1.332
7	1.000	1.010	1.000	1.000	1.010
8	0.995	0.617	1.000	0.995	0.614
9	0.995	1.561	1.000	0.995	1.553
10	1.010	0.731	1.000	1.010	0.738
11	0.998	0.743	1.000	0.998	0.742
Mean	**1.004**	**0.836**	**1.000**	**1.004**	**0.839**

1.004 which is the product of Pure Technical Efficiency Change (PTEC) (1.000) and Scale Efficiency Change (SEC) (1.0004). However, the mean productivity change is 0.839 which, is the product of Technical Efficiency Change (TEC) and Technological Change (TCC) i.e., 1.004 and 0.836. It implies that the farms on an average experiencing improvement of 0.4% in the efficiency owing to the change in the scale of production. But the change in total factor Productivity Change (TFPC) is showing a deceleration owing to the deceleration in farm technology. The year wise comparison reveals that the acceleration in TFPC occurred in the year 1991, 1994, 1995, 1997, and the highest occurrence is in the year 1997 which is due to purely improvement in the technology by 56%. Positive efficiency change occurred in 1990, 1994, 1998 which are owing to the positive contribution of change in the scale in production. However, there is no change in the PTEC hence, there is no indication of improvement in the managerial efficiency of the farm activities. This may be due to the fact that the farms have huge amount of fixed assets whose maintenance yields no positive improvement on the output.

Table-5: **MALMQUIST INDEX SUMMARY OF FIRM MEANS**

(1989-1999)

Firm	TEC	TCC	PTEC	SEC	TFPC
1	1.000	0.581	1.000	1.000	0.581
2	1.006	0.847	1.000	1.006	0.852
3	1.000	0.876	1.000	1.000	0.876
4	1.008	1.135	1.000	1.008	1.144
Mean	**1.004**	**0.836**	**1.000**	**1.004**	**0.839**

Table-5 shows the change in efficiency and productivity farm wise. The farms with economic size of 40-100 experience improvement of 0.6% in the TEC which is due to change in the SEC. Similarly, the farms (16-200) experience improvement in efficiency of 0.8%. The last category farm experiences improvement in the TFPC of 14.4%. This is purely due to TCC. Hence it is inferred that farms with large size reaps the benefit of improvement of technology. But on an average, t is deceleration in productivity change but positive improvement in the efficiency change.

Table-6: **MALMQUIST INDEX SUMMARY OF ANNUAL MEANS**

(2000-2009)

Year	TEC	TCC	PTEC	SEC	TFPC
2	0.957	1.548	0.998	0.959	1.482
3	1.053	0.642	1.002	1.052	0.677
4	0.999	1.011	1.000	0.999	1.011
5	0.941	0.822	1.000	0.941	0.773
6	1.064	0.995	1.000	1.064	1.058
7	0.995	0.967	1.000	0.995	0.962
8	1.005	0.921	1.000	1.005	0.926
9	1.000	0.653	1.000	1.000	0.653
10	0.998	0.950	1.000	0.998	0.948
Mean	**1.001**	**0.916**	**1.000**	**1.001**	**0.917**

In Table-6, as far as the time period (200-2009) is concerned the average change in the efficiency is 1.001 (1.000X1.001) and it is resulting from the improvement in efficiency due to change in the scale of production. However, the years having efficiency improvement are 2002, 2005 and 2007 and the improvements are due to improvement in the scale. Secondly, the improvement in the productivity change occurred in 2001, 2003 and 2005. But the improvement in the productivity in 2005 is due to change in scale only. The contribution of change in technology occurred in 2001 and 2003.

Table-7: MALMQUIST INDEX SUMMARY OF FIRM MEANS (2000-2009)

Farm	TEC	TCC	PTEC	SEC	TFPC
1	1.000	0.830	1.000	1.000	0.830
2	1.000	0.857	1.000	1.000	0.857
3	0.999	1.004	1.000	0.999	1.003
4	1.003	0.986	1.000	1.003	0.990
Mean	**1.001**	**0.916**	**1.000**	**1.001**	**0.917**

Farm wise change in efficiency and productivity are shown in the Table-7. The mean efficiency change in TEC is 0.1% which, is due to change in scale of production. However, the third category all other farms experience deceleration in productivity.

5. CONCLUSION:

The study is essentially related to the measurement of Total factor productivity change of the farms of different sizes of Belgium during 21 years from 1989-2009. The productivity change has been estimated by the Malmquist index using the DEA technique. Further, the total factor productivity change has been decomposed into Technical efficiency change and Technological change. Technical efficiency change has been further decomposed as pure technical efficiency change and scale efficiency change when production operated under variable returns to scale. The results suggest that during the entire 21 years the total factor productivity has been decelerated by 12.3%. This is due to increase in Technical efficiency by 0.2% and deceleration in technology by12.4%. On the other hand, in the two-phase period, the TFPC are 0.839 and 0.917. The same pattern is observed in farm wise. The farm s with size (16-40) must be provided more subsidies on supply of inputs and better extension services should be provided so that the production can increase. Secondly, more intensification of cultivation should be under taken. Instead of cultivating many crops some specialized crops may be grown so that the per unit cost will diminish and the fixed cost will gradually decline.

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