FACEPA

Farm Accountancy Cost Estimation and
Policy Analysis of European Agriculture

Comparative ex-post analysis of past CAP reforms across selected Member States and regions with FADN data

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Edited by S. Bahta, F. Offermann and B. Henry de Frahan

with contributions by

S. Bahta and F. Offermann (vTI)

R. De Blander and B. Henry de Frahan (UCL)

L. Cesaro, S. Marongiu, A. Zanoli (INEA),

F. Arfini, M. Donati, S.Cernicchiaro (University of Parma)

N. Delame and J-Pierre Butault (INRA)

R. Soboh (LEI)

R.Popov, B. Ivanov, M. Anastasova and D. Nikolov, Institute of Agricultural Economics, Sofia

E. Matveev, M. Sepp (EMU)

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Executive Summary

Work package 9 of the FACEPA project is devoted to the evaluation of public policies based on EU FADN data. It includes the design, development and testing of FADN-based economic models that are appropriate for ex-post as well as ex-ante policy analyses across selected Member States. The outcome is published in four connected reports: two reports dealing the methodology for ex-post and ex-ante analysis, respectively, and two reports portraying the corresponding results of a comparative analysis of ex-post and ex-ante evaluations across selected EU members.

This report presents the results of implementing and testing the methodology and models developed by De Blander and Henry de Frahan (2011) for an ex-post evaluation of EU policy reforms on the basis of the EU FADN. The analyses were carried out separately for dairy, cattle and crop farms in Austria, Belgium, France, Germany, Italy and the Netherlands. For each of these farm types, a brief comparative description of model specification and performance is followed by an illustration and discussion of key results, e.g. estimated costs, technological change and policy impacts.

For **dairy** farms, regions of Basse-Normandie, Brittany and Pays de la Loire were selected for France, regions of Bavaria and Lower Saxony for Germany, and regions of Veneto, Lombardy and Piedmont for Italy. The selected form of the cost function is quadratic for dairy farms in Austria, France (Pays de la Loire and Basse-Normandie), Germany (Bavaria and Lower Saxony) and the Netherlands, and cubic for dairy farms in Belgium, France (Brittany) and northern Italy. Marginal costs of milk over its price range from 26 % in the Netherlands to 90 % in Bavaria. Estimated results point to the presence of economies of size in Austria, Belgium, France (Pays de la Loire and Basse-Normandie), Germany (Bavaria and Lower Saxony) and the Netherlands, and economies of scale among the dairy farms of Belgium, France (Brittany) and the Netherlands. Moreover, there are economies of scope among dairy farms of Austria, Germany (Bavaria and Lower Saxony), France (Pays de la Loire and Basse-Normandie) and the Netherlands. The analysis further shows that dairy farms in all countries or regions under consideration, with the exception of farms in France (Brittany) and northern Italy, seem to undergo an average (marginal) cost increasing and technologically regressive evolution with an increase in the use of almost all inputs in Austria, Belgium and Germany (Bavaria and Lower Saxony) and decrease or saving of most of inputs in France (Pays de la Loire and Basse-Normandie), northern Italy and the Netherlands.

The model results on the impact of the 2003 Fischler reform or Mid-Term Review are quite diverse across the analysed countries. The reform has a cost decreasing and rate of technology change increasing effect in dairy farms in France (Pays de la Loire and Basse-Normandie), northern Italy and the Netherlands, while it increases costs and slows down technological change in Belgium, Germany (Lower Saxony) and France (Brittany). Cost functions of dairy farms in Austria and Germany (Bavaria) show no impact of the reform. In the majority of the analysed countries, the reform increases the use of purchased feed, while it is input-saving with respect to the use of cow inputs.

In Germany, the introduction of a milk quota auction system in 2000 causes an increase in the rate of marginal cost diminution, the rate of cost diminution, and the rate of technical change, especially in dairy farms in Lower Saxony. At the same time it increases the use of crop inputs and decreases the use of cow inputs in Bavaria and decreases the use of all inputs in Lower Saxony.

For **cattle** farms, the region of Limousin was selected for France and regions of Veneto, Lombardy and Piedmont for Italy. The selected form of the cost function is quadratic for cattle farms in Austria, France (Limousin), Germany and the Netherlands, and cubic for cattle farms in Belgium and northern Italy. The estimation of cost functions for cattle farms proved to be challenging. Monotonicity restrictions on input prices are not respected with the selected long-run quadratic and cubic specifications in all countries under consideration. Furthermore the estimation provided unrealistic low marginal and average costs for the other animal outputs and, thus, results should be used with great caution. Estimated marginal costs of other animal outputs over their price range from 3 % in Austria to 28 % in the Netherlands. Estimated results indicate the presence of economies of size and scope among cattle farms of Belgium and the Netherlands and the presence of economies of scope among cattle farms of Austria, Germany and the Netherlands. Cattle farms in Austria, Belgium, Germany and the Netherlands exhibit (marginal) cost increases at a rate that diminishes over time, and a regressive technological change with an increase in the use of most of the inputs.

For cattle farms, the impacts of the implementation of the 1992 MacSharry reform and the Agenda 2000 were analysed. According to the model estimates, the impact of the MacSharry reform on cost functions for cattle differs among countries. While no significant impacts are detected for cattle farms in northern Italy and the Netherlands, the reform increases costs and slows down the rate of technical change for cattle farms in Belgium and Germany. In contrast, in France (Limousin) the reform increases the rate of cost diminution, with input-saving technological change for all inputs.

The Agenda 2000 continued the MacSharry reform with further price cuts and premium increases. Surprisingly, the model results imply that the Agenda 2000 has the exact reverse effects than the MacSharry reform in Belgium, France (Limousin) and Germany. In the Netherlands, costs increase and the rate of technical change increases, while in northern Italy, the picture of the direction of Agenda 2000 impacts is ambiguous. For Austria, clear negative effects of the reform are identified. As a general note of caution it has, however, be taken in into account that during this period, the beef market was significantly affected by the BSE crises, which may prevent the proper identification of the Agenda 2000 impacts.

For **crop** farms, the region of Centre was selected for France, regions of Bavaria and Lower Saxony for Germany, and regions of Veneto, Lombardy and Piedmont for Italy. In all countries, the selected form of the cost function is quadratic for crop farms, and the estimated costs functions do not respect the monotonicity restrictions imposed on the model. In addition, the respective specification used for each country provides unrealistically low marginal and average costs and, thus, results should be used with caution. Marginal costs of sugar beet over its price range from 24 % in Belgium to 55 % in Lower Saxony to. Over time, marginal costs tend to decrease in Lower Saxony but increase in Belgium, France (Centre) and northern Italy, while stagnating in the Netherlands. Estimated results show that crop farms in France (Centre) and northern Italy do not have economies of size, scale and scope. There is a (marginal) cost diminution among some crops and more specifically for wheat in Austria, Belgium, France (Centre), northern Italy and the Netherlands, and pulses, oilseeds and non-wheat cereals in Belgium.

With the exception of the Netherlands, the MacSharry reform decreases costs of crop farms in all the countries analyzed, and increases the rate of technical change. In many cases, technical change is input-saving with respect to seeds and plant protection.

The impact of the Agenda 2000 reform is similar in many cases, decreasing costs also for the Netherlands, and input-saving for most inputs. Only in Austria and Germany (Lower Saxony), costs of crop farms increase slightly.

Contents

Abbreviations and Acronyms

AVC	Average variable cost
EU	European Union
ESCP	Economies of scope
FACEPA	Farm Accountancy Cost Estimation and Policy Analysis of European Agriculture
FADN	Farm Accountancy Data Network
FbTC	Factor biased technical change
MC	Marginal cost
MTR	Mid Term Review
ORTS	Overall rate of return to scale
PSRT	Product specific return to scale
RCD	Rate of cost diminution
RMCD	Rate of marginal cost diminution
RTC	Rate of technical change
TF	Type of farm

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Introduction

This deliverable presents the results of implementing and testing the methodology and models developed by De Blander and Henry de Frahan (2011). Specifically, this deliverable aims at providing a comparative analysis of the impact of the MacSharry, the Agenda 2000 and the Mid-Term Review Reform in selected EU Member States. These policy reforms differ by farm type as well as the year implemented (De Blander and Henry de Frahan, 2011):

For dairy farms, the year 2005 corresponds to the year preceding the full implementation of the 2003 Fischler reform or Mid-Term Review under which, in the EU-15,

- intervention prices of butter and skimmed milk powder have been reduced by 25% and 15% respectively, and farm gate milk prices in EU-15 declined by 6% from 2004 to 2006 (though they rose again due to the international market developments in 2007),
- dairy quotas are expanded by 0.5% annually from 2006 to 2008, by 2% in 2009 and by 1% annually from 2009 to 2013,
- compensation payments calculated on the basis of 60% of the decline in intervention prices are included in direct payments tied to the quota and then in the Single Payment Scheme.

For dairy farms in Germany, an important policy change also was the introduction of milk quota auctions in the year 2000.

For cattle farms, the year 1995 corresponds to the year of full implementation of the 1992 Mac Sharry reform under which, in the EU-15,

- the basic price of beef has been reduced by 15% from 1993 to 1995
- premiums for steers and suckler cows are increased.

And the year 2001 for corresponds to the year of the implementation of Agenda 2000 under which, in the EU-15,

- the basic price of beef is further reduced by 20%, and farm gate prices in EU-15 declined by approx. 10% from 2000 to 2003 (though they rose again in the subsequent years),
- premiums for male bovines and suckler cows are again increased.

As a general note of caution it has however be taken in into account that during this period, the beef market was significantly effected by the BSE crises, which may prevent the proper identification of the Agenda 2000 impacts.

For crop farms, 1995 corresponds to the year of full implementation of the 1992 Mac Sharry reform under which, in the EU-15,

- intervention prices of cereals have been reduced by 30% from 1993 to 1995, and farm gate cereal prices declined strongly,
- compensation payments calculated on the basis of the full decline in intervention prices are included in direct payments tied to crop acreage,

- a set-aside from 15% in 1993 to 10% of the farm cropland in 1996 is imposed for farms claiming compensation payments and producing more that 92 tons equivalent of cereals.

And the year 2001 for crops corresponds to the year of the implementation of Agenda 2000 under which, in the EU-15,

- intervention prices of cereals are further reduced by 15%, and farm gate prices of most cereals declined, though often to a lesser extent than intervention prices,
- additional compensation payments calculated on the basis of the 50% decline in intervention prices are added to direct payments tied to crop acreage,
- the set-aside obligation is set at 10% of the farm cropland for farms claiming compensation payments and producing more that 92 tons equivalent of cereals.

It is anticipated that

- price declines would reduce average and marginal costs of production,
- quota expansion would increase average and marginal costs of production and reduce quota rents,
- set-aside would decrease average and marginal costs of production and increase profit margins, i.e. the differences between output prices and marginal costs.

To asses and evaluate the impacts of these policy reforms an unbalanced panel data analysis with either quadratic or cubic specification of the Seemingly Unrelated Regression (SUR) econometric model is used. It takes in to account the policy impacts on dairy, cattle and crop farms in Austria, Belgium, France, Germany, Italy and the Netherlands.

The paper is organised in such a way that the data preparation and results for dairy, cattle and crop farms are presented separately.

For each type of farms the first part deals with data preparation and sampling specifications followed by a second part on empirical specification that deals with the type of specification used to estimate the ex-post evaluation. The selection of the empirical specification could be a quadratic or cubic specification and depends on the outcome of the results produced by respective empirical specification.

The third part is econometric estimations. This part deals with the performance of the model and the specific empirical specification used, uncentered R^2, percentage of statistical significant variables and the statistical significance of parameter vectors or splines are some of the ways to look at the performance of the model used.

The fourth part deals with the input demand and marginal cost elasticities. This part explains to what extent the monotonicity restriction imposed on the model are respected. After the discussion on marginal and average costs in the fifth part, the sixth part deals on cost flexibility, scale and scope economies. This part explores the presence of economic of size, scope and scale in each respective type of farm and commodity. The seventh part discusses indicators of technical change.

A last part provides a comparative summary of the outcomes of the econometric estimation of the cost functions, as well as the impact of the analyzed policy changes on level and characteristics of the production cost functions.

Part 1: Dairy Farms

1 Data preparation and statistics

1.1 Data preparation

The cost functions estimated for the ex-post evaluation of dairy farms includes dairy output (Ya) and aggregated animal outputs and crop outputs (Yb+Yc) while on the input side it includes animal specific inputs (X1), crop specific inputs and farm land (X2), cow inputs (X3), intermediate inputs (X4) and purchased feed (X5). The construction of the output and input variables is similar across the countries and regions under consideration.

1.2 Sample specifications

For all countries under consideration, samples of dairy farms (TF equal to 4110, 4120 and 4310) include farms for which at least two observations are present from 1990 to 2007. This leads to unbalanced panels of 11518 in Austria, 6456 observations in Belgium, 4134 in Brittany (France), 2915 observations in Pays de la Loire (France), 2516 in Basse-Normandie (France), 7460 observations in Bavaria (Germany), 5335 observations in Lower Saxony (Germany), 9547 observations in the regions of Veneto, Lombardy and Piedmont (northern Italy), and 7385 in the Netherlands.

In Austria the minimum and maximum observations are 831 in 2001 and 931 in 2006, respectively.

In Belgium, the lowest numbers of 296 observations are recorded in 1990 and 2007 and the highest number of 411 observations in 1999. Among these farms 42 are recorded each year during the whole period from 1990 to 2007.

In Bavaria, the lowest number of 245 observations is recorded in 1995 and the highest number of 625 observations in 2002, whereas in Lower Saxony the lowest number of 234 observations and the highest number of 386 observations are recorded in 2007 and 1994, respectively. None of the farms are recorded each year in Bavaria, while 16 farms are recorded each year in Lower Saxony.

In Italy, although results are aggregated, the analysis considers only the regions of Veneto, Lombardy and Piedmont where the lowest and highest numbers of observations are observed in 2004 with 407 farms and 1993 with 884 farms, respectively. None of the farms are recorded each year during the whole period.

In the Netherlands, the lowest number of 324 observations is recorded in both 2001 and 2007, and the highest number of 517 observations in 1991. One single Dutch farm shows up in each year from1990 to 2007.

2 Empirical specifications

The empirical specification of the model used is either a quadratic or a cubic long-term specification. For Belgium, Brittany (France) and northern Italy, the best fit is the cubic specification where as for Austria, France (Pays de la Loire and Basse-Normandie), Germany (Bavaria and Lower Saxony), and the Netherlands, the quadratic specification is found to be the best fit. The model specification further allows restriction on global positiveness of marginal costs and input demands which is applied in all countries except in northern Italy.

To account for the policy impact of the 2003 Mid-Term Review of the CAP, splines are added to the cost function specification in 2005 for all countries. In Germany an additional spline is specified in 2000 to take into consideration the policy effect of the introduction of milk quota auctions during 2000.

In Belgium, two out of four free cubic output parameters of the cost function are significant while none of the three free quadratic output parameters is significant. Whereas in northern Italy, one out of four free cubic output parameters of the cost function is significant. All the three free quadratic output parameters are significant.

All the quadratic output parameters for Austria, Bavaria (Germany) and two of the three for Lower Saxony (Germany) are statistically significant.

3 Econometric estimations

3.1 Estimation results

Table 1.1 shows the econometric specification used, the uncentered R^2 range and the percentage of significant coefficients. The R^2 in France is the lowest in all the regions while the results in northern Italy show both the highest R^2 range as well as percentage of significant coefficients. Although R^2 range of the estimates of Bavaria seems to be low, apparently it has the highest percentage of significant coefficients.

Table 1.1: Specifications and econometric results for dairy farms

Country	**Region**	**Econometric Specification**	**Uncentered R^2 Range**		**% significant coefficients**
			Minimum	**Maximum**	
Austria		Quadratic	0.33	0.683	61
Belgium		Cubic	0.20	0.49	50
Germany	Bavaria	Quadratic	0.10	0.63	78
Germany	Lower Saxony	Quadratic	0.07	0.46	46
Italy	Veneto, Lombardy & Piedmont	Cubic	0.61	0.84	71
France	Brittany	Cubic	0.08	0.17	58
France	Pays de la Loire	Quadratic	0.03	0.21	29
France	Basse-Normandie	Quadratic	0.05	0.22	50
The Netherlands		Quadratic	0.2	0.50	44

3.2 Splines

All three parameter vectors (a, b and G) or splines for the break point of 2005 are statistically significant in Austria, Belgium, Basse-Normandie (France) and northern Italy, whereas in Brittany only the a parameters, in Pays de la Loire only the a and b parameters, in Bavaria only the b and G parameters and in Lower Saxony only the b parameter are statistically significant. None of 2005 spline parameters are statistically significant in the Netherlands. For the additional 2000 break point introduced in Germany to account for the policy effect of the introduction of milk quota auctions, all three parameter vectors (a, b and G) or splines are statistically significant.

4 Input demand and marginal cost elasticities

4.1 Input demands

All estimated input demands are non-negative without imposition of non negativity in Belgium. The number of observations that show negative input demand in Bavaria, Lower Saxony, northern Italy and France are very low, almost zero. Similarly, in Austria and the Netherlands, all except cow inputs have non negative input demands. The percentage of negative input demands for cow inputs in Austria is 53% which is quite high (Figure 1.2.).

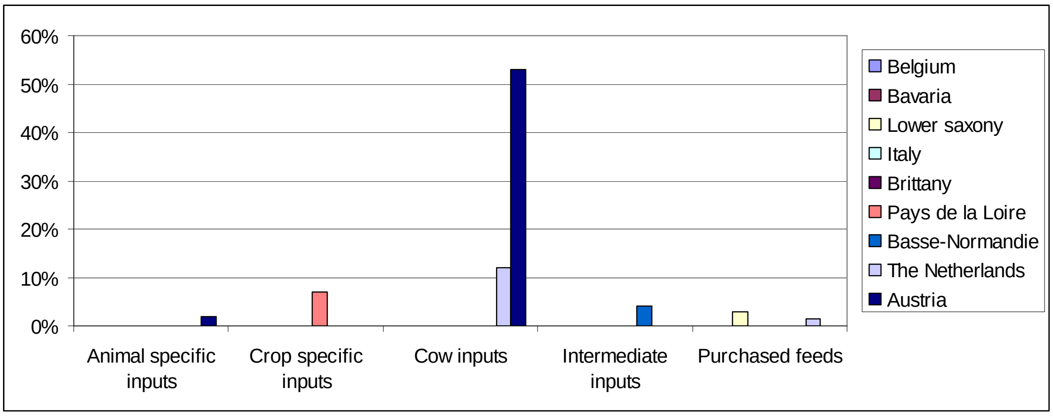


Figure 1.1: Percentage of negative input demands for dairy farms

4.2 Own input demand cost elasticities

Table 1.2 shows the medians of input demands. In particular in Belgium, input demands for X1 (animal-specific inputs), X2 (crop-specific inputs and farmland) and X4 (intermediate inputs) are inelastic. Whereas in Bavaria and Lower Saxony the medians of input demands for crop specific inputs and farm land (X2), cow inputs (X3) and intermediate inputs (X4) and crop specific inputs and farm land (X2) and intermediate inputs (X4) are inelastic. Similarly all the medians of input demands in Austria, France and the Netherlands and all the medians of input demands except for X1 (animal-specific inputs) in northern Italy are inelastic.

Table 1.2: Own input demand elasticities for dairy farms

Country	**Region**	Median own input demand elasticities				
		Elx1_px1	Elx2_px2	Elx3_px3	Elx4_px4	Elx5_px5
Austria		-0.055	-0.142	-0.879	-0.043	-0.456
Belgium		0.000	-0.022	-0.514	-0.007	-0.361
France	Brittany	-0.597	-0.002	-0.100	-0.094	-0.085
France	Pays de la Loire	0.000	-0.002	-0.054	-0.180	-0.494
France	Basse-Normandie	-0.343	-0.001	-0.004	-0.054	-0.342
Germany	Bavaria	-0.239	-0.004	-0.075	0.001	-0.233
Germany	Lower Saxony	-0.191	-0.055	-0.136	-0.002	-0.264
Italy	Veneto, Lombardy & Piedmont	-1.470	-0.359	-0.217	-0.028	-0.077
The Netherlands		0.000	-0.063	-0.024	-0.152	-0.496

4.3 Own marginal cost elasticities

The median marginal cost elasticities for both outputs in Belgium and Brittany (France) are negative: over 50% of dairy farms are on their downward sloping curve of marginal cost. However, these elasticities are on average close to zero.

The median marginal cost elasticities for dairy in Austria, Pays de la Loire (France), Basse-Normandie (France), both regions of Germany as well as in northern Italy, and the Netherlands, are positive (Table 1.3), indicating dairy farms are on their upwards sloping curve of marginal cost. However, similar to the marginal cost elasticities of Belgium and Brittany (France), these elasticities are also on average close to zero.

Table 1.3: Own marginal cost elasticities for dairy farms

Country	**Region**	Median own marginal cost elasticities	
		ElMCya_ya	ElMCyb_yb
Austria		1.50E-06	2.90E-03
Belgium		-2.20E-06	-9.10E-06
France	Brittany	-1.70E-05	1.56E-04
France	Pays de la Loire	3.58E-04	-1.20E-05
France	Basse-Normandie	1.50E-05	1.66E-04
Germany	Bavaria	2.50E-07	3.42E-03
Germany	Lower Saxony	4.86E-04	2.30E-07
Italy	Veneto, Lombardy & Piedmont	6.60E-10	7.10E-08
The Netherlands		1.40E-07	1.00E-05

5 Marginal and average costs

Table 1.4 reports the mean observed absolute marginal cost for milk output. It varies across countries.

Table 1.4: Marginal and average costs of milk output for dairy farms

Country	Region	Marginal cost (€/ton)	Marginal cost (% of farm gate price)	Average cost (€/ton)	Average cost (% of farm gate price)
Austria		188	63	187	62
Belgium		229	80	231	80
France	Brittany	249	83	265	88
France	Pays de la Loire	144	48	112	37
France	Basse-Normandie	255	81	252	81
Germany	Bavaria	283	90	282	90
Germany	Lower Saxony	106	35	102	34
Italy	Veneto, Lombardy & Piedmont	274	75	275	75
The Netherlands		84	26	84	26

In Austria, the mean observed absolute marginal cost for milk output amounts to 188 €/ton (62.5% of the observed farm gate price). Figure 1.2 shows that the marginal cost of milk output in Austria slightly increases in the years from 1995 to 2006. In 2006 it reaches the maximum (about 225 €/ton or 78% of the farm gate price) and then it slightly decreases.

In Belgium, the mean observed absolute marginal cost for milk output amounts to 229 €/ton (80% of the observed farm gate price). As shown in Figure 1.2, it increases steadily from 220 €/ton in 1991 to 241 €/ton in 2004, but then decreases down to 232 €/ton in 2007. The mean observed relative marginal cost for milk output is at 80% of the observed farm gate price which is realistic given the quota constraint. It fluctuates between 68% in 2007 and 85% in 1991.

In northern Italy, the mean observed absolute marginal cost of milk output is 275 €/ton (75% of the observed farm gate price). It increases from 1993 to 2005, but decreases in the last two years as shown in Figure 1.2.

In the Netherlands, the mean observed absolute marginal cost for milk output is 84 €/ton (26% of the observed farm gate price), which is the lowest of all the countries under consideration. It has an increasing linear pattern since 1990. In 2005 the marginal cost slightly decreases for that it increases again until it reaches its peak in 2007 as shown in Figure 1.2.

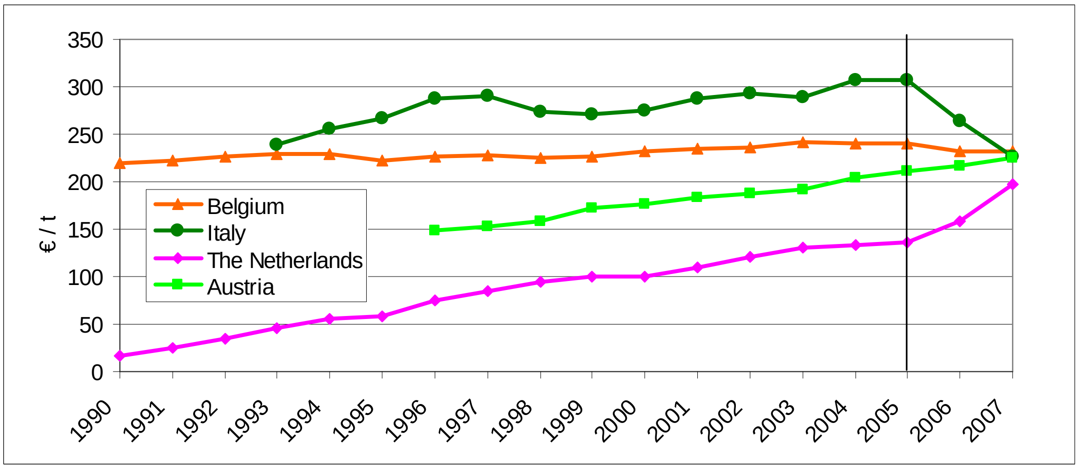


Figure 1.2: Annual marginal costs of milk for dairy farms in Austria, Belgium, Italy and the Netherlands (1990-2007)

In France, the mean observed absolute marginal cost of milk output varies among the three regions under consideration. It amounts to 249 €/ton (83% of the observed farm gate price), 144 €/ton (48% of the observed farm gate price), 255 €/ton (48% of the observed farm gate price) in Brittany, Pays de la Loire and Basse-Normandie, respectively (Table 1.2). The marginal cost of milk in Brittany decreases between 1991 and 2006 from 260 €/ton to 230 €/ton whereas in Pays de la Loire and Basse-Normandie it increases with the same trend from 115 €/ton to 185 €/ton and from 230 €/ton to 300 €/ton, respectively (Figure 1.3).

In Germany, the mean observed absolute marginal cost for milk output amounts to 283 €/ton (90% of the observed farm gate price), which is the highest (Table 1.2), and 106 €/ton (35% of the observed farm gate price) for Bavaria and Lower Saxony, respectively. Figure 1.3 shows that the marginal cost of milk production in Bavaria decreases slightly in the years from 1991 to 1994, then starts again to increase slightly to reach the maximum in 2000 (about 304 €/ton or 92% of the farm gate price) followed by a slight decline. The marginal cost of milk in Lower Saxony, which is lower than in Bavaria for all years, shows an increasing trend until the year of 2001 followed by a slight decrease. The maximum marginal cost of milk for Lower Saxony is 145 €/ton (50% of the observed farm gate price) for the year 2002.

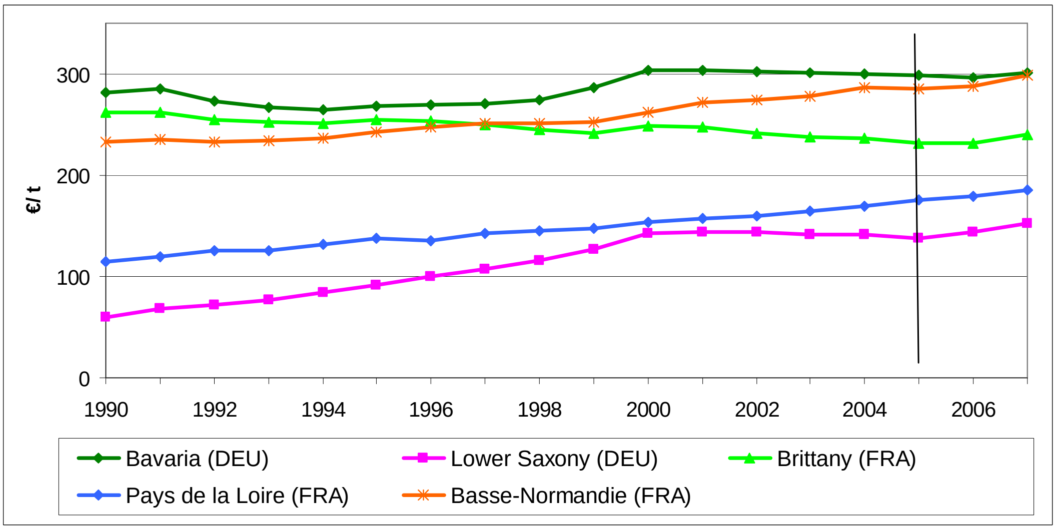


Figure 1.3: Annual marginal costs of milk for dairy farms in selected German and French regions (1990-2007)

The mean observed average variable cost for milk output is more or less similar to the mean observed marginal cost in most of the countries under consideration. The only slight difference observed is in the two regions of France; Brittany and Pays de la Loire.

In sum, among the selected countries, dairy farms in the Netherlands, Lower-Saxony and Pays de la Loire show on average marginal and average costs of milk between 84 and 144 €/ton while dairy farms in Austria, Belgium, Brittany and Basse-Normandy between 188 and 255 €/ton, and northern Italy and Bavaria between 275 and 283 €/ton. While there is a general upward trend in the means of the average marginal and average cost of milk from 1990 to 2007, that upward trend slows down since the implementation of the Mid-Term Review in 2005 for most of the selected countries. In particular, that trend reverses for northern Italy, Belgium and Bavaria.

6 Cost flexibility, scale and scope economies

6.1 Cost flexibility

Both the overall average cost flexibility and the yearly average cost flexibility of milk output are statistically significantly different from one in Austria, Belgium, France (Pays de la Loire and Basse-Normandie), Germany (Bavaria and Lower Saxony) and the Netherlands. There is thus economy of size among these respective regions and countries. In the French region of Brittany and northern Italy, the overall average cost flexibility is not statistically significant and consequently no economies of size among dairy farms in these two regions are detected.

6.2 Scale economies

Table 1.5 shows that the average overall return to scale (ORTS) and product-specific return to scale (PSRTS) in Belgium, Brittany (France) and the Netherlands are all statistically significant larger than one, which indicates the presence of economies of scale among dairy farms in these regions or countries. Yearly averages of ORTS are all statistically significant larger than one, except in Belgium between 2000 and 2005, in Brittany (France) during 1990-1994, and in the Netherlands in 2007.

There are no economies of scale in dairy farms in Austria, France (Pays de la Loire and Basse-Normandie), Germany (Bavaria and Lower Saxony) and northern Italy. In Germany, the average ORTS and PSRTS in both regions of Bavaria and Lower Saxony are statistically significantly less than one. Yearly averages of ORTS are less than one except for the years 1990-1998 and 2007 in Bavaria and 1990-1997 in Lower Saxony. In Austria, France (Pays de la Loire and Basse-Normandie) and northern Italy, average ORTS and PSRTS are not significantly different from one and the yearly averages of ORTS are all smaller than one.

Table 1.5: ORTS and PSRTS of milk output for dairy farms

Country	Region	ORTS	St.Dev	PSRT	St.Dev
Austria		0.99	0.036	1.006	0.030
Belgium		1.00	8.2 e-5	1.002	5.3 e-5
France	Brittany	1.03	0.04	1.04	0.05
France	Pays de la Loire	0.82	0.07	0.80	0.07
France	Basse-Normandie	0.98	0.01	0.99	0.01
Germany	Bavaria	1.00	4.03e-02	1.013	3.27e-02
Germany	Lower Saxony	0.98	7.71e-02	0.996	4.21e-02
Italy	Veneto, Lombardy & Piedmont	0.99	0.0002	0.999	0.0002
The Netherlands		1.06	0.070	1.065	0.067

6.3 Scope economies

According to Table 1.6, the average economies of scope are statistically significantly less than one for Belgium, France (Brittany) and northern Italy. There are thus no economies of scope for dairy farms in these regions and countries.

In contrast, there are economies of scope (ECSP) among the dairy farms in Austria, France (Pays de la Loire and Basse-Normandie), Germany (Bavaria and Lower Saxony), and the Netherlands, as the ECSP is statistically significantly larger than one in respective regions or countries.

Table 1.6: ECSP of milk output for dairy farms

Country	Region	ECSP	St.Dev
Austria		2.15	1.090
Belgium		0.99	2.9 e-5
France	Brittany	0.99	0.01
France	Pays de la Loire	1.00	0.001
France	Basse-Normandie	1.00	0.001
Germany	Bavaria	1.18	1.71 e-2
Germany	Lower Saxony	3.30	1.64
Italy	Veneto, Lombardy & Piedmont	0.99	7.0e-06
The Netherlands		6.16	4.24

7 Indicators of technological change

7.1 Rate of marginal cost diminution

The overall average rate of marginal cost diminution is statistically significantly different from zero for milk in Austria, Belgium, France (Brittany, Pays de la Loire and Basse-Normandie), Germany (Bavaria and Lower Saxony), and the Netherlands, but not in northern Italy.

In Belgium, on average the marginal costs for milk increase with 0.1% per year (s.d. 0.002 %). Averaged by year, this rate slightly worsens with time from 0.1% per year in 1990 to 0.2% per year in 2007. In addition, it exhibits a cost increasing shock in 2005 at the year preceding the full implementation of the 2003 Fischler reform. In northern Italy, the annual rate of marginal cost diminution rate is negative until 2004, and exhibits a cost decreasing shock at the year preceding the full implementation of the 2003 Fischler reform (Figure 1.4), while in Austria, the rate is more or less constant throughout the years. In the Netherlands, the annual rate of marginal cost diminution is negative in all years as shows a cost increasing shock in 2005.

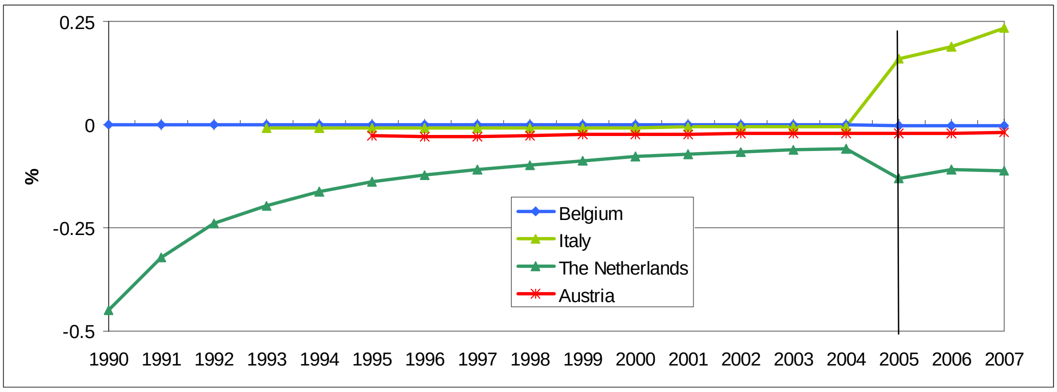


Figure 1.4: Annual rate of marginal cost diminution of milk for dairy farms in Belgium, Italy, the Netherlands and Austria

In France, on average marginal cost for milk diminishes in Brittany but increases with less than 0.1% and more than 0.2% per year in Pays de la Loire and Basse-Normandie, respectively (Figure 1.5). In Brittany from 1990 to 2004, the rate of marginal cost diminution decreases until the year 2004, then exhibits a cost increasing shock in 2005 followed by a slight decrease in 2007. In Pays de la Loire, the overall average rate of marginal cost diminution for milk is negative and fluctuates around 0.3% per year until 2005 where it exhibits a cost decreasing shock. In Basse-Normandie, the rate is negative and decreases slightly from 0.2% in 1990 to 0.3% in 2004 and reveals a cost decreasing shock in 2005.

In Germany, on average marginal costs for milk increase with 0.1% per year (s.d. 0.00516 %) in Bavaria and 0.5% per year (s.d. 0.0514%) in Lower Saxony. Figure 1.5 shows that the marginal cost diminution for milk exhibits a cost decreasing shock in 2000 and 2005 in Bavaria and in 2000 in Lower Saxony. In contrast, for the year 2005 the marginal cost diminution for milk shows a cost increasing shock in Lower Saxony. It clearly shows the reversal effect of the policy change in 2000 on the increasing marginal cost diminution in both regions. The 2005 policy change seems to have a setback effect on the marginal cost diminution in Bavaria while it lets the costs further to increase in Lower Saxony.

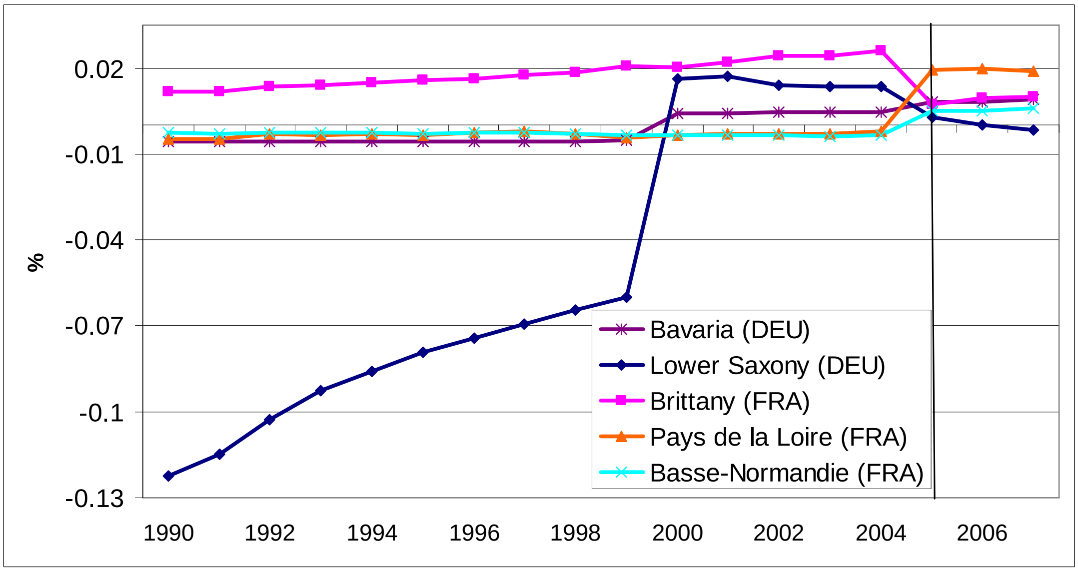


Figure 1.5: Annual rate of marginal cost diminution for dairy farms in selected German and French regions

7.2 Rate of cost diminution

The overall average rate of cost diminution is statistically significantly different from zero for milk in all countries except in northern Italy.

In Austria, the rate of cost diminution is almost constant across the years. In Belgium, on average costs increase with 1.1% per year (Figure 1.6). Averaged by year, this rate slightly deteriorates over time from 0.7% per year in 1990 to 3% per year in 2007 and exhibits a cost increasing shock in 2005. Figure 1.6 also shows the rate cost diminution of milk in the Netherlands continuously increases until 2004 and further aggravates in 2005 and exhibits a cost decreasing shock as the result of policy change in 2005.

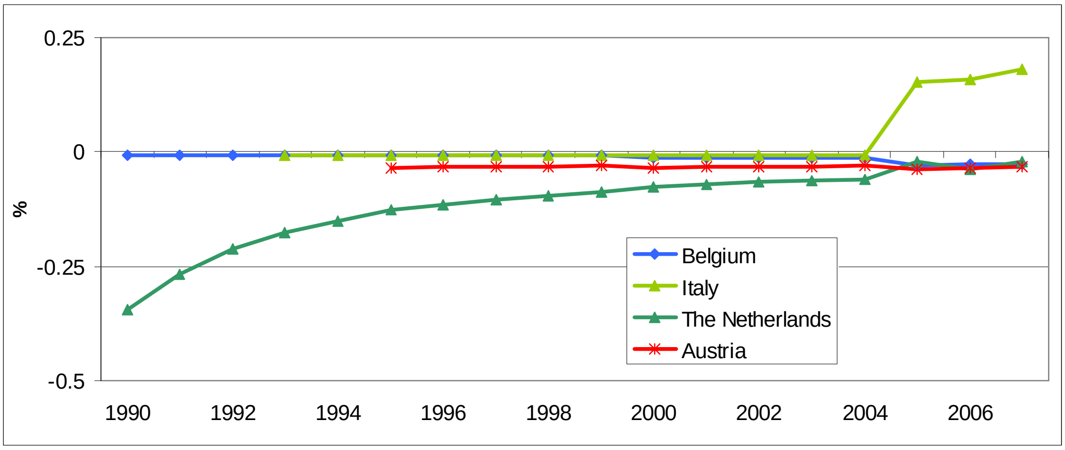


Figure 1.6: Annual rate of cost diminution of milk for dairy farms in Belgium, Italy, the Netherlands and Austria

According to Figure 1.7, the costs on average increase with 0.1% and 0.3% per year for Bavaria and Lower Saxony, respectively. The rate of cost diminution for milk exhibits similar shock as that of marginal cost diminution. That is a cost increasing shock in 2000 and 2005 in Bavaria, and a cost decreasing shock in 2000 in Lower Saxony while increasing in 2005.

In France, on average the rate of cost diminution for milk decreases with 0.9% per year in Brittany, but increases with 0.7% and 0.3% per year in Pays de la Loire and Basse-Normandie, respectively. In Brittany from 1990 to 2004, the rate of cost diminution slightly decreases until 2004, and then exhibits a cost increasing shock in 2005. Both Pays de la Loire and Basse-Normandie show a cost decreasing shock in 2005 as the result of the policy change.

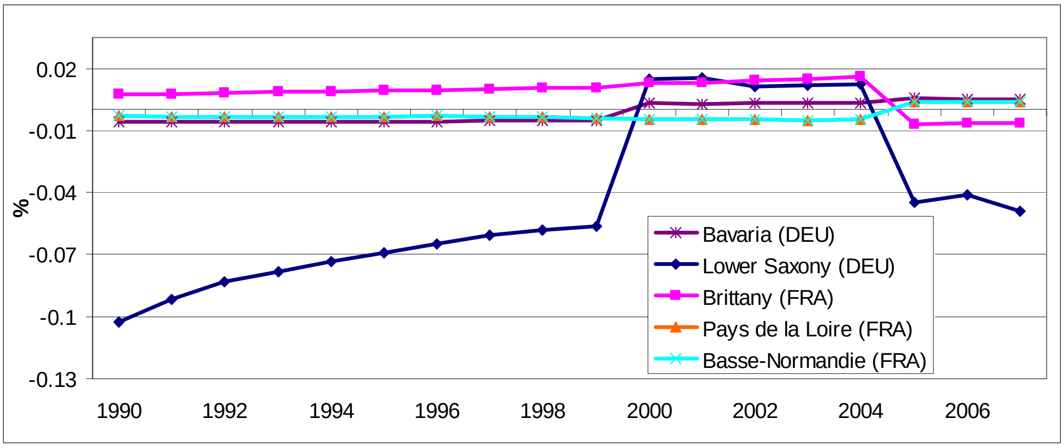


Figure 1.7: Annual rate of cost diminution for dairy farms in selected German and French regions

7.3 Rate of technical change

In Austria, on average there is a statistically significant technological change during the period 1995-2007 with no clear effect of the 2005 policy change on the technical change among Austrian dairy farms (Figure 1.8). In Belgium, on average there is a statistically significant technological regression of 0.5% each year for milk output. Averaged by year, this rate slightly deteriorates over time from 0.5% per year in 1990 to 1.7% per year in 2005. In addition, it exhibits a regressive shock in 2005 as shown in Figure 1.8. In northern Italy, on average there is regression of 0.2% each year. Averaged by year, this rate is negative until 2004, and then it becomes positive. Figure 1.9 also shows a continuous slight increase of the rate of technical change with a clear increasing shock in 2005 for the Netherlands.

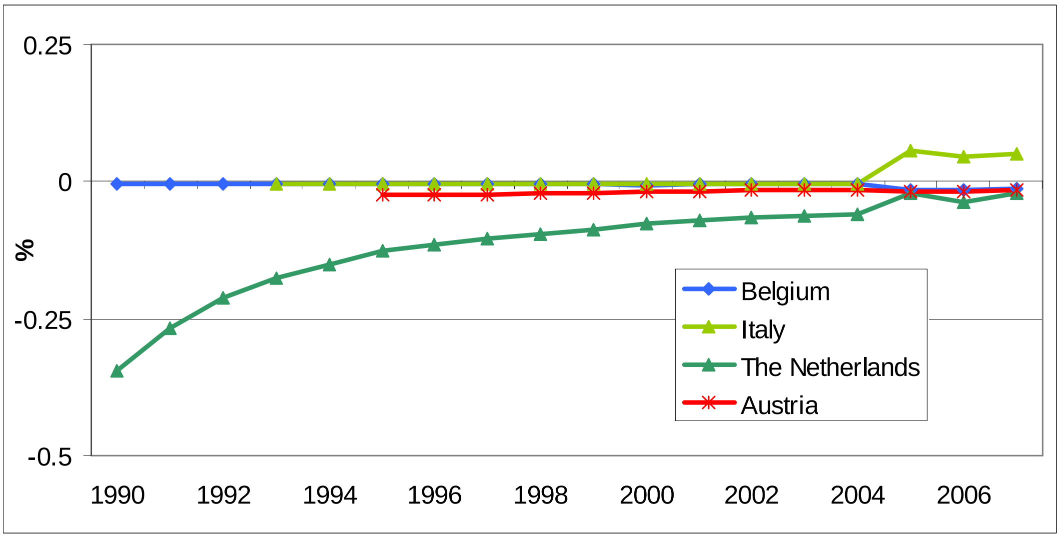


Figure 1.8: Annual rate of technical change of milk for dairy farms in Belgium, Italy, the Netherlands and Austria

There is a statistically significant technological regression of 0.3% and 0.2% in Pays de la Loire and Basse-Normandie regions of France, respectively. Where as in Brittany on average there is a technological progression of 0.6% each year. Figure 1.9 also shows, averaged by year, the rate of technical change is slightly increases over time from 0.5% per year in 1990 to 1% per year in 2004 in Brittany, remains around -0.5% per year until 2004 in Pays de la Loire, and fluctuates around -0.2% per year until 2004 in Basse-Normandie. A shock in 2005 changes the sign of the rate for all regions.

In Germany, on average there is a statistically significant technological regression of 2% in Lower Saxony and 0.2% in Bavaria each year. However, unlike the policy effect of 2000, the rate of technical change in 2005 deteriorates again in Lower Saxony as shown in Figure 1.9.

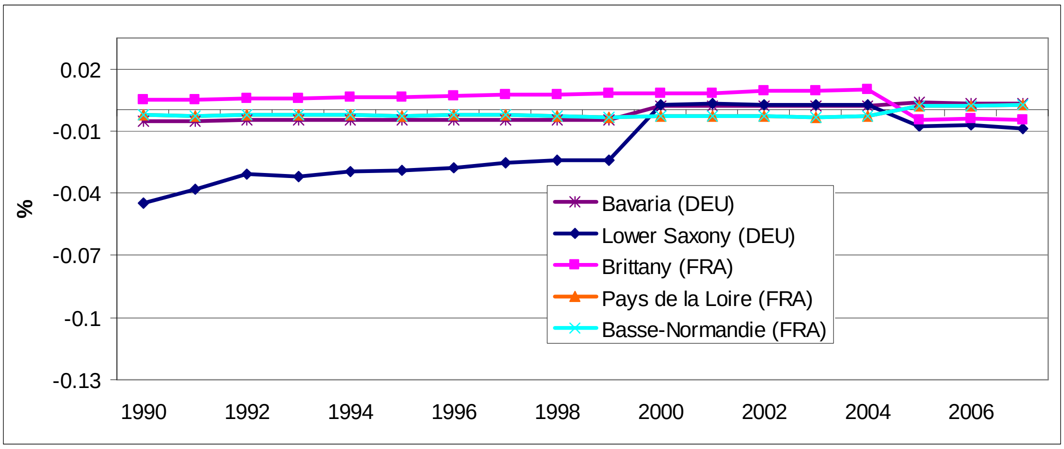
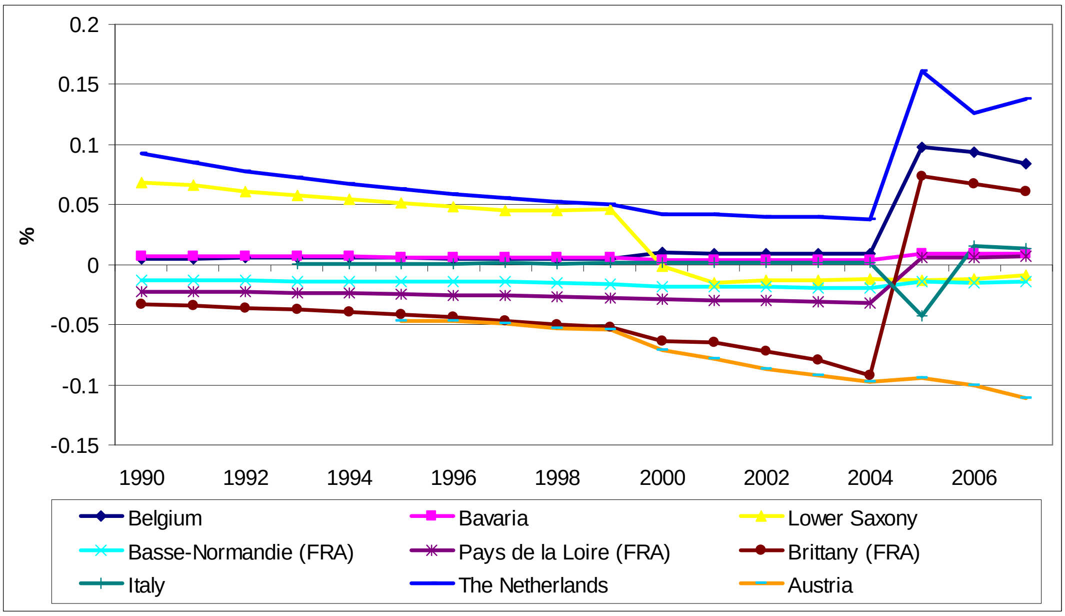


Figure 1.9: *Annual rate of technical change of milk for dairy farms in selected German and French regions*

7.4 Factor-biased technical change

In Belgium and Bavaria (Germany), on average the technological change increases the use of animal-specific inputs, crop-specific inputs, and intermediate inputs and purchased feeds and decreases the use of cow inputs. In Lower Saxony (Germany) all inputs are increased by the technological change. Similarly the use of three inputs, crop-specific inputs, cow inputs and intermediate inputs, are lifted up by the technological change in dairy farms in Austria. In contrast, the technological change in dairy farms in northern Italy and France increases only the use of one input while saving the use of all inputs in the Netherlands.

Figure 1.10 shows an input decreasing shock in 2000[1] for animal specific inputs in Lower Saxony (Germany). The impact of the 2005 policy change is more evident and causes an upward shock in the use of animal specific inputs in Belgium, Brittany (France), Pays de la Loire (France) and the Netherlands and a decreasing shock in northern Italy and Austria.



[1] Note that the break point 2000 in dairy is imposed to account the introduction of auction system in Germany.

Figure 1.10: Annual factor-biased changes in animal specific inputs for dairy farms

There is a decreasing shock in the use of crop specific inputs in Lower Saxony (Germany) during 2000 and northern Italy and the Netherlands during 2005 while an increasing shock in Lower Saxony (Germany) during 2005 as shown in Figure 1.11.

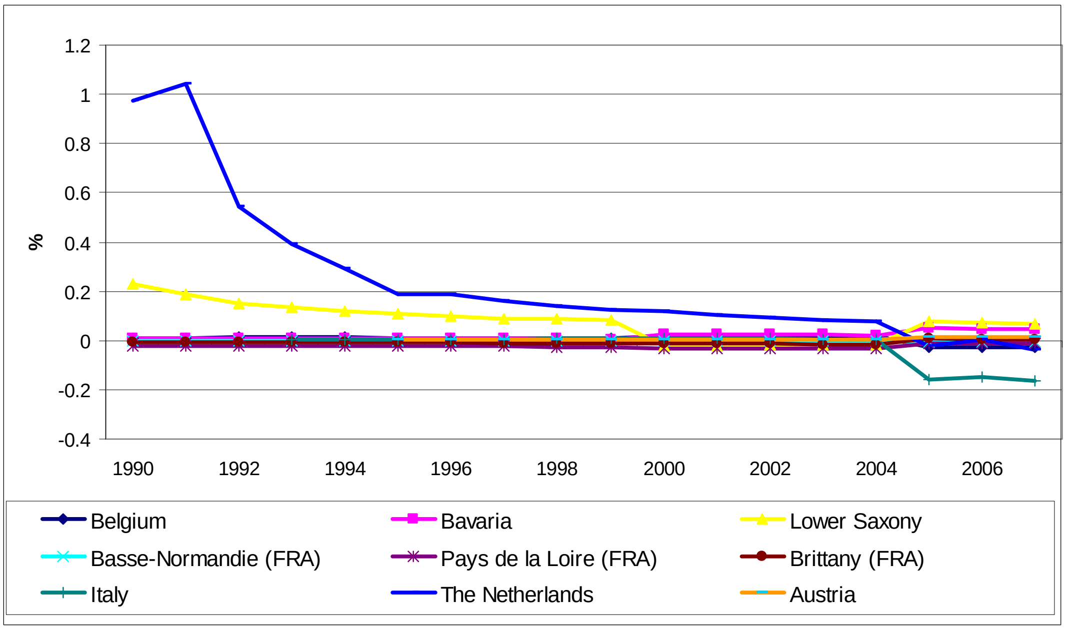


Figure 1.11: Annual factor-biased changes in crop specific inputs for dairy farms

According to figure 1.12, there is apparent decreasing shock in the use of cow inputs among dairy farms in Belgium, Bavaria (Germany), Lower Saxony (Germany), northern Italy, the Netherlands and Austria during 2005. The high fluctuation in the use of cow inputs in the Netherlands before the year 2005 is not attributed to the policy changes under consideration.

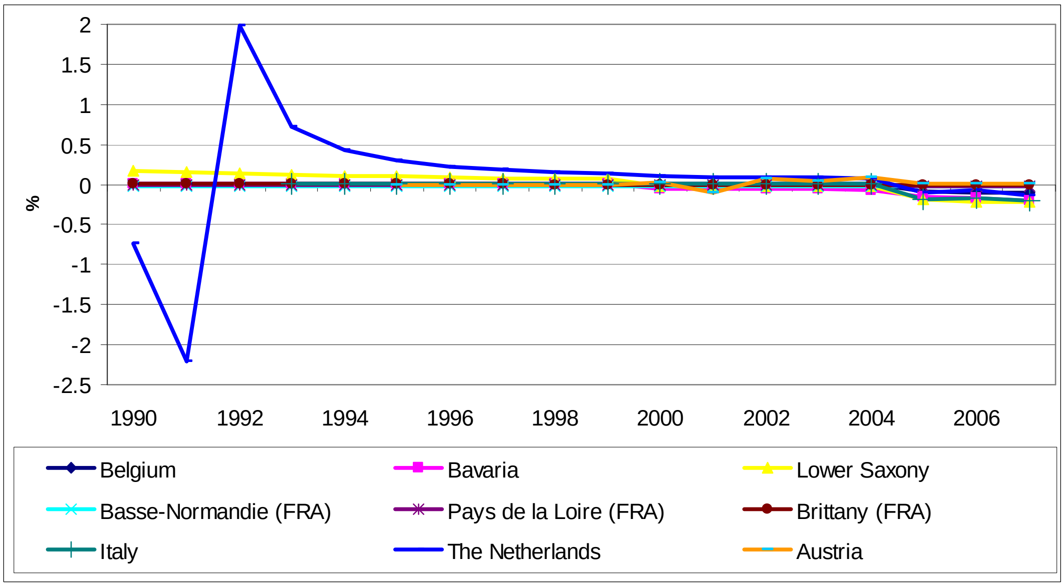


Figure 1.12: Annual factor-biased changes in cow inputs for dairy farms

The use of intermediate inputs is decreased by the shock in 2000 in Lower Saxony and Bavaria (Germany). The decreasing effect in the use of intermediate inputs is evident in northern Italy, France and the Netherlands after the full implementation of the 2003 Fischler reform or Mid-Term Review. In Belgium the Mid-Term Review induces an upward shift in the use of intermediate inputs among Belgian dairy farms as shown in Figure 1.13.

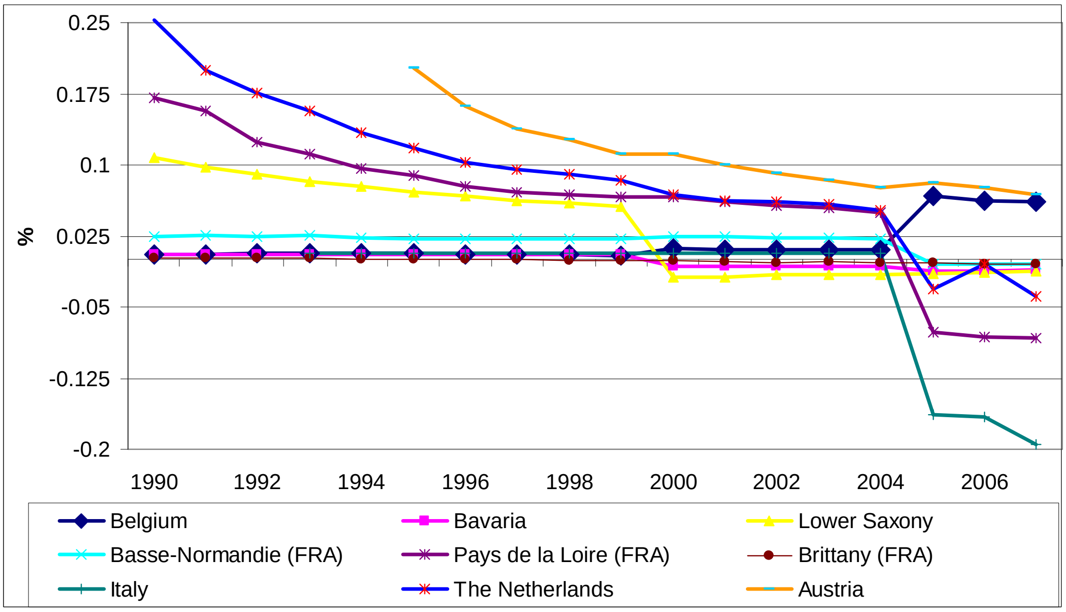


Figure 1.13: Annual factor-biased changes in intermediate inputs for dairy farms

The policy impact of the Mid-Term Review induces an increasing shock in the use of purchased feed among dairy farms in Lower Saxony (Germany), Brittany (France), Pays de la Loire (France) and the Netherlands whereas dairy farms in northern Italy seem to save more purchased feeds as shown in Figure 1.14.

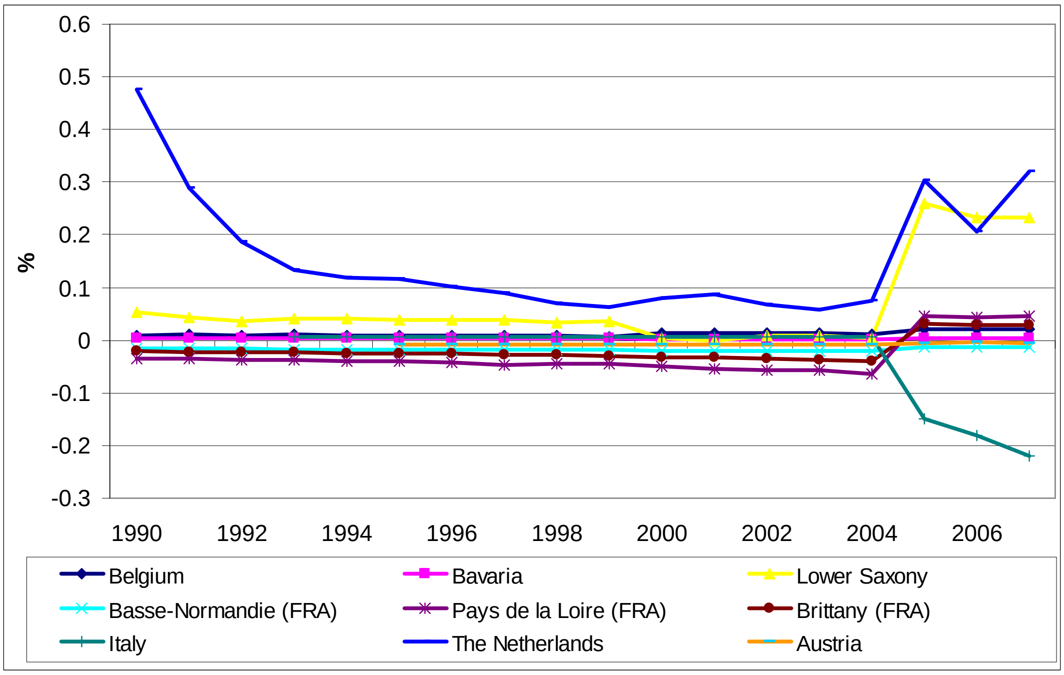


Figure 1.14: Annual factor-biased changes in purchased feeds for dairy farms

In sum, the analysis shows that dairy farms in all countries or regions under consideration, with the exception of farms in France (Brittany) and northern Italy, seem to undergo an average (marginal) cost increasing and technologically regressive evolution with an increase in the use of almost all inputs in Austria, Belgium and Germany (Bavaria and Lower Saxony) and decrease or saving of most of inputs in France (Pays de la Loire and Basse-Normandie), northern Italy and the Netherlands. In the majority of the analysed countries, the 2005 MTR reform increases the use of purchased feed, while it is input-saving with respect to the use of cow inputs. In Germany, the introduction of a milk quota auction system in 2000 causes an increase in the rate of of technical change, especially in dairy farms in Lower Saxony. At the same time it increases the use of crop inputs and decreases the use of cow inputs in Bavaria and decreases the use of all inputs in Lower Saxony.

8 Concluding remarks

8.1 Cost function estimates

Table 1.7 provides a summary of model estimations for dairy farms across countries. Both curvature and monotonicity restrictions on input prices are respected with the selected long-run cubic specification in Belgium and Brittany (France) and long-run quadratic specification in Bavaria (Germany), Lower Saxony (Germany) and the Netherlands, whereas in northern Italy and Austria monotonicity restrictions are not respected with the selected long-run cubic and quadratic specifications, respectively. In Pays de la Loire and Basse-Normandie, farms are less homogeneous in their technological process and estimations are not robust.

Table 1.7: Summary of model estimations for dairy farms across selected EU countries

Country	Region	Econometric specification	% significant coefficients	Economies of			RMCD	RCD	RTC	Factor-biased technical change	
				Size	Scale	Scope				Input using	Input saving
Austria		Quadratic	61	Yes	No	Yes	-	-	-	X2, X3, X4	X1, X5
Belgium		Cubic	50	Yes	Yes	No	-	-	-	X1, X2, X4, X5	X3
France	Brittany	Cubic	58	No	Yes	No	+	+	-	X3	X1, X2, X4, X5
France	Pays de la Loire	Quadratic	29	Yes	No	Yes	-	-	-	X4	X1, X2, X3, X5
France	Basse-Normandie	Quadratic	50	Yes	No	Yes	-	-	-	X4	X1, X2, X3, X5
Germany	Bavaria	Quadratic	78	No	No	Yes	-	-	-	X1, X2, X4, X5	X3
Germany	Lower Saxony	Quadratic	46	No	No	Yes	-	-	-	X1, X2, X3, X4, X5	
Italy	Veneto, Lombardy & Piedmont	Cubic	71	No	No	No	+	+	-	X1	X2, X3, X4, X5
The Netherlands		Quadratic	44	Yes	Yes	Yes	-	-	-		X1, X2, X3, X4, X5

X1: animal specific inputs; X2: crop specific inputs and farm land; X3: cow inputs; X4: intermediate inputs; X5: purchased fe
RMCD: Rate of marginal cost diminution
RCD: Rate of cost diminution
RTC: Rate of technical change

The long-run cubic specification provides more reasonable estimates of marginal costs than the medium-run quadratic specification in Belgium. The mean quota rent relative to the milk price is 20%, a reasonable estimate compared to previous studies (Wieck and Heckelei, 2007; Bouamra-Mechemache et al., 2008).

The marginal cost estimates of dairy in Germany (106 €/ton in Lower Saxony and 283 €/ton in Bavaria) are different from the results estimated by Wieck and Heckelei (2007) for the medium term (139 €/ton in Lower Saxony and 111 €/ton in Bavaria), in particular for Bavaria. Also, the difference in marginal costs between Lower Saxony and Bavaria seems too large, and does not match the results from the GECOM model developed in the in FACEPA project (compare Berner et al., 2011).

Marginal cost elasticities are close to zero for both output categories in all regions and countries.

As indicated in Table 1.7 there are economies of size among dairy farms in Belgium, France (Pays de la Loire and Basse-Normandie), the Netherlands and Austria. There are economies of scale only among the dairy farms of Belgium, France (Brittany) and the Netherlands. There are economies of scope among dairy farms of Germany (Bavaria and Lower Saxony), France (Pays de la Loire and Basse-Normandie), the Netherlands and Austria.

All, except in northern Italy and France (Brittany) dairy farms seem to undergo an average (marginal) cost increasing and technologically regressive evolution with an increase in the use of almost all inputs in Belgium, Germany and Austria and decrease or saving of most of inputs in northern Italy, France and the Netherlands.

8.2 Summary of the impacts of policy changes

The model results on the impact of Mid-Term Review are quite diverse across the analysed countries. The reform has a cost decreasing and rate of technical change increasing effect in dairy farms in France (Pays de la Loire and Basse-Normandie), northern Italy and the Netherlands, while it increases costs and slows down technical change in Belgium, Germany (Lower Saxony) and France (Brittany). Cost functions of dairy farms in Austria and Germany (Bavaria) show no impact of the reform. In the majority of the analysed countries, the reform increases the use of purchased feed, while it is input-saving with respect to the use of cow inputs.

Table 1.8: Impact of 2005 MTR reform on costs and technical change for dairy farms

Country	**Region**	**Rate of marginal cost diminution**	**Rate of cost diminution**	**Rate of technical change**	**Factor-biased technical change**	
					Input using	**Input saving**
Austria		o	o	o	Animal, crop, intermediate inputs & feed	Cow inputs
Belgium		o	(-)	(-)	Animal inputs, intermediate inputs & feed	Crop inputs, cow inputs
France	Brittany	-	-	-	Anmal, crop inputs, feed	Cow & intermediate inputs
France	Pays de la Loire	+	(+)	(+)	Anmal, crop inputs, feed	Cow & intermediate inputs
France	Basse-Normandie	(+)	(+)	(+)	Animal, cow inputs & feed	Crop & intermediate inputs
Germany	Bavaria	o	o	o	Crop inputs	Cow inputs
Germany	Lower Saxony	(-)	-	-	Crop inputs, feed	Cow inputs
Italy	Veneto, Lombardy & Piedmont	+	+	+		All inputs
The Netherlands		-	+	+		All inputs

Table 1.9 shows the impact of changing the national milk quota scheme in 2000 on costs and technical change of dairy farms in Germany. This change cuases an increase in the rate of marginal cost diminution, the rate of cost diminution, and the rate of technical change, especially in dairy farms in Lower Saxony. At the same time it increases the use of crop inputs and decreases the use of cow inputs in Bavaria and decreased the use of all inputs in Lower Saxony.

Table 1.9: Impact of changing the national milk quota scheme in 2000 on costs and technical change of dairy farms in Germany

Country	Region	Rate of marginal cost diminution	Rate of cost diminution	Rate of technical change	Factor-biased technical change	
					Input using	Input saving
Germany	Bavaria	(+)	(+)	(+)	crop inputs	cow inputs
Germany	Lower Saxony	+	+	+		all inputs

Part 2: Cattle farms

1.1 Data preparation

The cost functions estimated for cattle farms includes other animal output (Y2) and aggregated milk and crop outputs (Y1+Y3) while on the input side it includes animal specific inputs (X1), crop specific inputs and farm land (X2), cow inputs (X3), intermediate inputs (X4) and purchased feed (X5). The construction of the output and input variables is similar across the countries and regions under consideration.

1.2 Sample specification

For all countries under consideration, samples of cattle farms (TF equal to 4210, 4220 or 4320) include farms for which at least two observations are present from 1990 to 2007. Cost functions were estimated for cattle farms in Austria, Belgium, France (Limousin), Germany, Italy (Veneto, Lombardy and Piedmont) and the Netherlands.

This leads to unbalanced panels of 761 observations in Austria, 2006 observations in Belgium, 2267 observations in France (Limousin), 1646 observations in Germany, 1840 observations in northern Italy and 85 in the Netherlands.

2 Empirical specifications

For Austria, France (Limousin), Germany and the Netherlands, the quadratic specification with fixed-effects and global positive restriction on marginal costs provides the best fit, while for Belgium and northern Italy, the cubic specification is found to be the best fit.

To account for the policy impact of the 1992 Mac Sharry reform and Agenda 2000 reform of the CAP, splines are added in 1995 and 2001 (2002 for Germany), respectively.

In Belgium and Italy, two out of four free cubic output parameters of the cubic cost function are significant. Five and three out of the ten quadratic parameters are statically significant in France and Austria, respectively, while none of the ten free quadratic parameters are statistically significant in Germany and the Netherlands.

3 Econometric estimations

3.1 Estimation results

The econometric specification used is quadratic specification in all countries except in Belgium and Italy where cubic specification found to be the best fit. Although the range of the uncentered R^2 is low in France, it has the highest percentage of significant coefficients. The econometric model with quadratic specification produces the lowest number of significant coefficients in the Netherlands, followed by Germany (Table 2.1)

Table 2.1 Specifications and econometric results for cattle farms

Country	Region	Econometric Specification	Uncentered R^2 Range		% significant coefficients
			Minimum	Maximum	
Austria		Quadratic	0.007	0.203	41
Belgium		Cubic	0.020	0.31	44
France	Limousin	Quadratic	0.01	0.09	51
Germany		Quadratic	0.091	0.092	11
Italy	Veneto, Lombardy and Piedmont	Cubic	0.19	0.35	32
The Netherlands		Quadratic	0.02	0.32	3

3.2 Splines

The splines indicate a statistically significant break in both 1995 and 2001 in Belgium for the parameter vector b, i.e. the coefficients of the linear input prices. Only G parameters are statistically significant for the break point 1995 in France (Limousin).

The parameter vector a (coefficients of the linear output quantities) in Belgium and parameter vector b in northern Italy, France (Limousin) and Austria also exhibits a significant break in 2001. However, none of the three parameter vectors (a, b and G) or splines for the break points of 1995 and 2001 are statistically significant in Germany and the Netherlands.

4 Input demand and marginal cost elasticities

4.1 Input demands

The results in Figure 2.1 show that in Belgium, for inputs X1 (animal-specific inputs), X3 (cow inputs), and X5 (purchased feeds), more than 5% of the observations have a negative estimated input demand, while the other input demands are positive. In Germany, all the input demands are positive with the exception of a high share of observations (47%) with negative input demands for purchased feed inputs. All inputs except X3 (cow inputs) have negative signs in Austria, France (Limousin) and northern Italy. The percentage of negative estimated input demands are about 40% and 80% for X4 (intermediate inputs) and X3 (cow inputs), respectively, in Austria, and about 60% for X3 (cow inputs) in France (Limousin). In the Netherlands, the estimated input demands of all inputs except are positive, with the exception of X2 (crop specific inputs and farm land), for estimated input demand is negative for 38% of observations. It should be noted that these estimated input demands are net of the fixed effects.

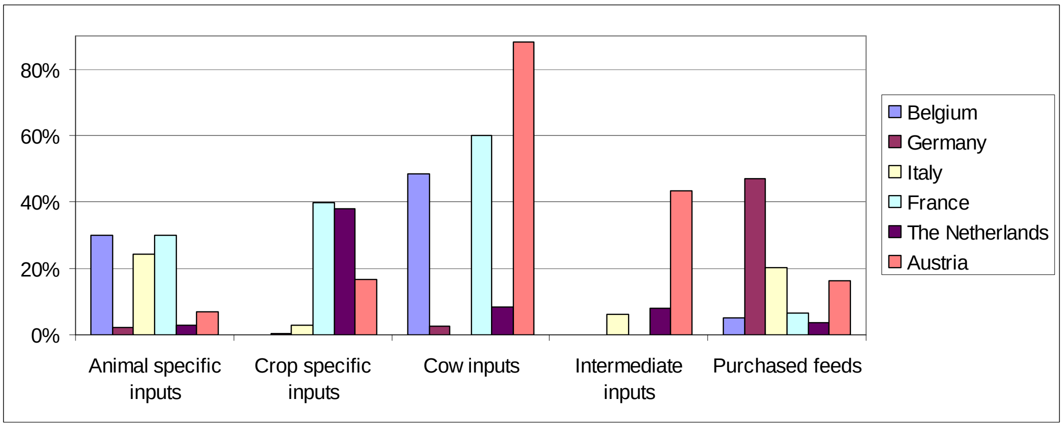


Figure 2.1: Percentage of negative input demands for cattle farms

4.2 Own input demand cost elasticities

Table 2.2 shows medians of all input demands. In particular in Belgium, input demands for X2 (crop-specific inputs and farmland) and X4 (intermediate inputs) are inelastic. In France (Limousin), Germany and northern Italy, input demands for X1 (livestock-specific inputs) and X4 (intermediate inputs) are inelastic, whereas in the Netherlands , input demands for X1 (livestock-specific inputs), X2 (crop-specific inputs and farmland) and X4 (intermediate inputs) and in Austria for and X1 (livestock-specific inputs) and X4 (intermediate inputs), are inelastic.

Table 2.2 Own input demand elasticities for cattle farms

Country	Region	Median own input demand elasticities				
		Elx1_px1	Elx2_px2	Elx3_px3	Elx4_px4	Elx5_px5
Austria		0.000	-0.074	-0.105	-0.044	-0.107
Belgium		-0.455	-0.009	-0.305	0.000	-0.368
France	Limousin	-0.026	-0.241	-0.223	-0.020	-0.173
Germany		0.000	-0.049	-0.036	0.000	-0.183
Italy	Veneto, Lombardy and Piedmont	-0.001	-0.737	-0.025	-0.008	-0.392
The Netherlands		0.000	0.000	-0.010	0.000	-0.007

4.3 Own marginal cost elasticities

The average marginal cost elasticities for both outputs in Austria, Belgium, Germany, France (Limousin) and the Netherlands are positive, which indicates that cattle farms are on average on their upwards sloping curve of marginal costs (Table 2.3). The average marginal cost elasticity for Ya (other animal outputs) in Italy is negative, which indicates cattle farms in Italy are on average on their downwards sloping curve of marginal costs. These average elasticities are, however, all close to zero.

Table 2.3: Own marginal cost elasticities for cattle farms

Country	Region	Median own marginal cost elasticities	
		ElMCya_ya	ElMCyb_yb
Austria		6.78E-04	7.48E-03
Belgium		3.60E-05	2.10E-05
France	Limosin	9.00E-12	1.70E-07
Germany		2.70E-16	5.70E-06
Italy	Veneto, Lombardy and Piedmont	-2.10E-09	2.20E-07
The Netherlands		1.20E-07	5.50E-05

5 Marginal and average costs

In Austria, as shown in Table 2.4, the mean observed absolute marginal cost for Ya (other animal outputs) amounts to 45 €/head (3% of the observed farm gate price). Mean marginal costs steadily rise from 9 €/head in 1995 to 105 €/head in 2007.

In Belgium, the mean observed absolute marginal cost for other animal outputs amounts to 133 €/head (8% of the observed farm gate price). As shown in Figure 2.2, yearly averages steadily rise from 3.5 €/head in 1991 to 426 €/head in 2007. The yearly mean of relative marginal costs for other animal outputs increases steadily from 0.2% in 1991 to 22% in 2007.

Table 2.4: Marginal and average costs of cattle output for cattle farms

Country	Region	Marginal cost (€/head)	Marginal cost (% of farm gate price)	Average cost (€/head)	Average cost (% of farm gate price)
Austria		45	3	44	3
Belgium		133	8	133	8
France	Limousin	174	12	174	12
Germany		117	10	117	10
Italy	Veneto, Lombardy and Piedmont	324	19	324	19
The Netherlands		262	28	262	28

In Germany the mean observed absolute marginal cost for other animal outputs amounts to 117 €/head (10% of the observed farm gate price). Yearly averages steadily rise from 25 €/head in 1990 to 254 €/head in 2007. As it is apparent in Figure 2.2, the yearly average of relative marginal costs for other animal outputs steadily increases by about 2% until 1993; then the rate of increment drops to less than 1% in 1994 and 1995 followed by a gradual increase of more than 10% each year until 2007.

In France (Limousin) the mean observed absolute marginal cost for other animal outputs is 174 €/head (12% of the observed farm gate price). Three different phases in the evolution of mean absolute marginal costs can be distinguished: an increase from zero in 1990 to 297 €/head in 1995, a decrease to 95 €/head in 2001, and an increase in the following years..

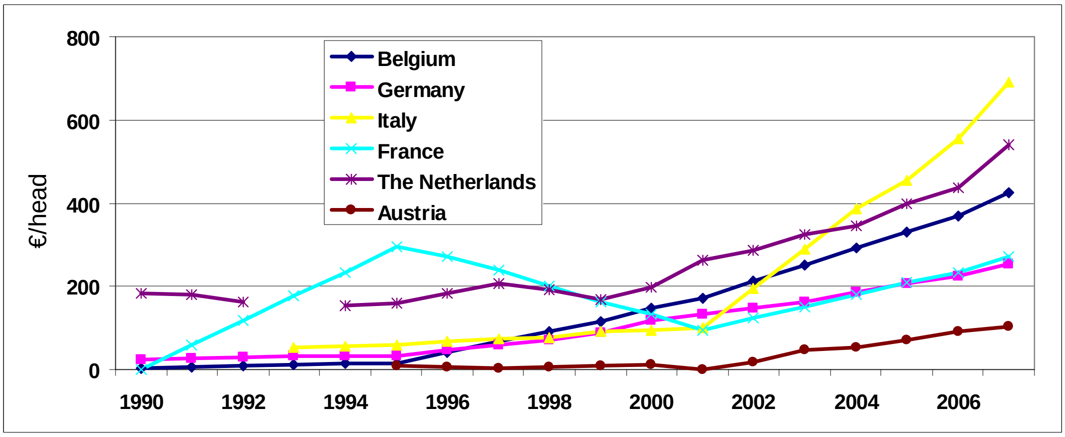


Figure 2.2: Marginal costs of cattle output for cattle farms

The mean observed absolute marginal cost for other animal outputs in northern Italy amounts to 324 €/head (19% of the observed farm gate price). Yearly averages increase from 55 head in 1993 to 691 €/head in 2007.

The mean observed absolute marginal cost for Ya (other animal outputs) in the Netherlands is 262 €/head (28% of the observed farm gate price). The development of mean observed absolute marginal costs is rather discontinuous: it goes down to zero in 1993 (due to lack of observations), then increase steadily till 1997, goes down till 1999, an since then linearly increases by about 20 €/head per year as shown in Figure 2.2.

6 Cost flexibility, scale and scope economies

6.1 Cost flexibility

The estimates shown in Table 2.5 indicate no economy of size for other animal outputs in Austria, France (Limousin), Germany, northern Italy, and the Netherlands, while for Belgium the overall average cost flexibility of other animal outputs is significantly less than one, which indicates the presence of economies of size.

Table 2.5: Cost flexibility of cattle farms in selected EU countries

Country	Region	Cost flexibility	St. Dev.
Austria		1.011	0.8897
Belgium		0.9985	0.0002
France	Limousin	1.00	5.2e-08
Germany		1.075	0.0996
Italy	Veneto, Lombardy and Piedmont	0.9999	0.0007
The Netherlands		1.005	0.0122

6.2 Scale and scope economies

In Belgium, the average overall return to scale (ORTS) of other animal output is significantly smaller than one, as shown in Table 2.6. Thus, no economies of scale were detected. The average product-specific return to scale (PSRTS) for other animal outputs is significantly smaller than one. In addition, the overall average economies of scope (ESCP) is evidently not greater than one and stays constant over the period of observation indicating that cattle farms in Belgium exhibit diseconomies of scope.

In Germany, ORTS for other animal output is significantly smaller than one (Table 2.6), indicating no economies of scale among cattle farms in Germany. However the average PSRTS and average ESCP for other animal outputs are significantly greater than one. There are thus economies of scope in cattle farms in Germany

Table 2.6 also shows that no economies of scale nor economies of scope were detected for cattle farms in northern Italy and France (Limousin). While cattle farms in the Netherlands show both economies of scale as well as scope, the Austrian cattle farms exhibit only economies of scope.

Table 2.6: ORTS and PSRTS of other animal output for cattle farms

Country	Region	ORTS	St.Dev	PSRT	St.Dev	ECSP	St.Dev
Belgium		0.9915	0.0002	0.9997	7e-5	0.9996	2e-5
Germany		0.9749	0.038	1.0162	0. 038	6.77	4.87
Italy	Veneto, Lombardy and Piedmont	0.9996	0.0008	1.000	0.0001	0.999	6 e-6
France	Limousin	0.9892	5.2E-08	1	0.018	1	0.000
The Netherlands		1.1472	0.0490	1.0588	0.1354	1.984	2.038
Austria		0.8118	0.17537	0.9585	0.4831	4.2797	4.305

7 Indicators of technological change

7.1 Rate of marginal cost diminution

In Austria, the yearly average marginal cost diminution discontinuously decreases from 0.9% in the year of 1995 to -0.17% in the year 2007.

In Belgium, the overall average rate of marginal cost diminution for other animal outputs is statistically significantly different from zero at a 5% significance level. As Figure 2.3 shows, average marginal costs of other animal outputs in Belgium increase 26% per year. This rate strongly decreases over time from 76% per year in 1991 to 9% per year in 2007.

Figure 2.3 also shows that the marginal costs of other animal outputs in France decrease since 1995, while in Germany they on average increase by 11% per year. The rate of marginal cost diminution shows a cost decreasing shock as the result of the 2002 policy changes.

In northern Italy, the rate of marginal costs of other animal outputs is positive throughout the years except from 1993 to 2000. In 2001 the costs show a decreasing shock in response to the 2001 policy change.

On average, the marginal cost diminution decreases by 4% per year in the Netherlands.

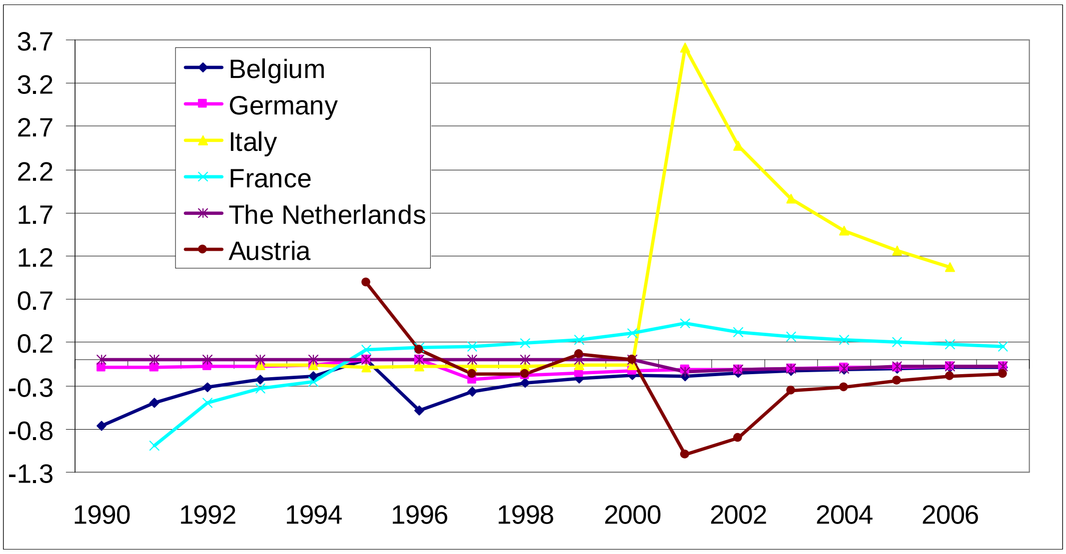


Figure 2.3: Annual rate of marginal cost diminution of other animal outputs in cattle farms

7.2 Rate of cost diminution

In Austria, the rate of cost diminution decreases over time from 0.07 in 1995 to -0.16 in 2007 (Figure 2.4). The rate of cost diminution exhibits a decreasing shock as the result of the policy changes in 2001.

The overall average rate of cost diminution in Belgium, France and Germany is statistically significantly different from zero at 5% significance level. On average the costs increase with 25%, 9.5%, and 13% in Belgium, France and Germany, respectively. This rate strongly declines over time from 56% per year in 1991 to 9% per year in 2007 in Belgium, and from 8.5% per year in 1991 to 7.2% per year in 2007 in Germany (Figure 2.4). The rate of cost diminution shows high fluctuations, and exhibits a decreasing shock as the result of the policy changes in Belgium and Germany in 1995, and in 2001 in France.

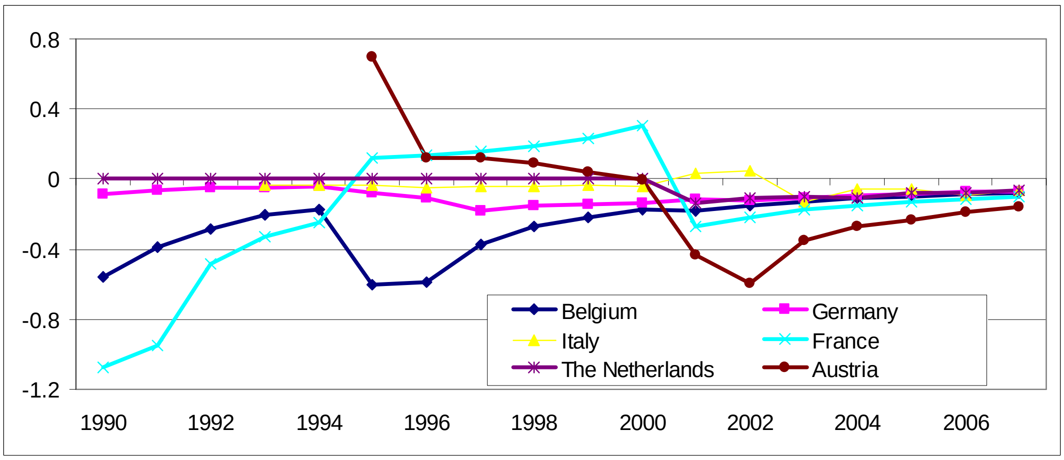


Figure 2.4: Annual rate of cost diminution of other animal outputs in cattle farms

In contrast, the average overall rate of cost diminution is not statistically different from zero in northern Italy and the Netherlands. The rate is positive only in 2001 and 2002 in northern Italy and there is no evidence of any trend or effect in the Netherlands until 2001, where a slight decrease of the rate is evident.

7.3 Rate of technical change

On average, there is a statistically technological regression each year of 10% in Austria, 12% in Belgium, 7.7% in France (Limousin), 6.4% in Germany, 2.6% in northern Italy, and 3% in the Netherlands. The yearly averages of this rate decrease over time from 15% per year in 1990 to 7% per year in 2007 in Belgium and from 5% per year in 1990 to 4% per year in 2007 in Germany (Figure 2.5). France and Austria exhibit strong annual fluctuations in the rate of technical change.

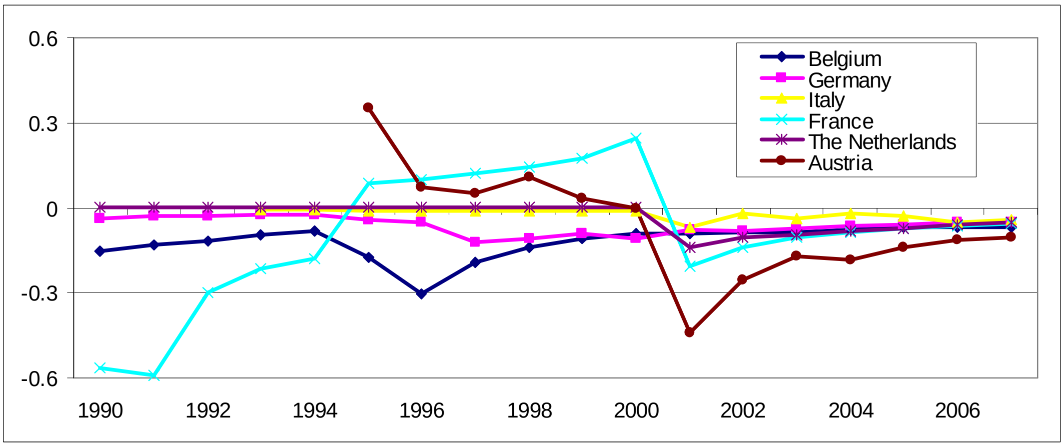


Figure 2.5: Annual rate of technical change of other animal outputs in cattle farms

7.4 Factor-biased technical change

In Austria, technical change on average increases the use of crop specific inputs, cow inputs and intermediate inputs while it reduces the use of animal specific inputs and purchased feeds. As shown in Figure 2.6, technical change on average increases the use of all inputs in Belgium, and increases the use of all inputs except cow inputs in Germany and northern Italy, whereas in France (Limousin) and the Netherlands the technological change reduces the use of crop specific inputs and increases the use of other inputs.

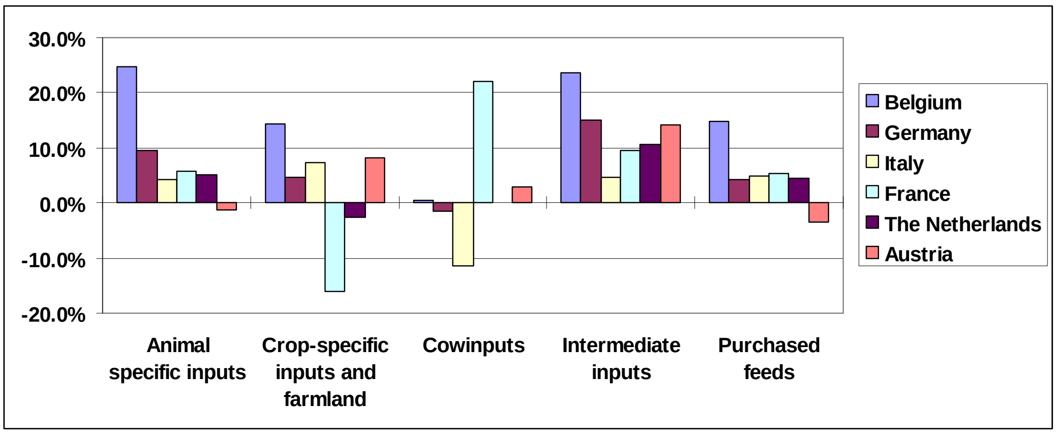


Figure 2.6: Annual factor-biased technical change in cattle farms

8 Concluding remarks

8.1 Cost function estimates

Table 2.7 provides a summary of model estimations for cattle farms across countries. In all countries under consideration, monotonicity restrictions on input prices are not respected with the selected long-run cubic and quadratic specification. In addition, this specification provides unrealistic low marginal and average costs for other animal outputs. According to the summary table 2.7, there are economies of size and scope only among the cattle farms in Belgium and the Netherlands, and economies of scope only among the cattle farms of Germany, the Netherlands and Austria.

Livestock farms in Belgium, Germany, the Netherlands and Austria exhibit (marginal) cost increases at a rate that diminishes over time. For all countries, a regressive technological change with an increase in the use of most of the inputs was estimated.

Table 2.7: Summary of model estimations for cattle farms

Country	Region	Econometric specification	% significant coefficients	Economies of			RMCD	RCD	RTC	Factor-biased technical change	
				Size	Scale	Scope				Input using	Input saving
Austria		Quadratic	41	No	No	Yes	-	-	-	X2, X3, X4	X1, X5
Belgium		Cubic	44	Yes	No	No	-	-	-	X1, X2, X3, X5	
France	Limousin	Quadratic	51	No	No	No	+	-	-	X1, X3, X4, X5	X2
Germany		Quadratic	11	No	No	Yes	-	-	-	X1, X2, X4, X5	X3
Italy	Veneto, Lombardy & Piedmont	Cubic	32	No	No	No	+	-	-	X1, X2, X4, X5	X3
The Netherlands		Quadratic	3	No	Yes	Yes	-	-	-	X1, X3, X4, X5	X2

X1: animal specific inputs; X2: crop specific inputs and farm land; X3: cow inputs; X4: intermediate inputs; X5: purchased feed
RMCD: Rate of marginal cost diminution
RCD: Rate of cost diminution
RTC: Rate of technical change

8.2 Summary of the impacts of policy changes

The 1992 MacSharry reform lowered beef prices and introduced headage payments as compensation. According to the model estimates (Table 2.8), the impact on cost functions for cattle farms differed between countries. While no significant impacts were detected for cattle farms in Italy and the Netherlands, the rates of cost diminution decreased and the rate of technical change slowed down in Germany and Belgium. In contrast, the MacSharry reform increased the rates of cost diminution in France, with input-saving technical change for all inputs.

Table 2.8: Impact of 1992 MacSharry reform on costs and technical change for cattle farms

Country	Region	Rate of marginal cost diminution	Rate of cost diminution	Rate of technical change	Factor-biased technical change	
					Input using	Input saving
Belgium		+	-	-	Animal, crop, intermediate inputs & feed	
France	Limousin	+	+	+		All inputs
Germany		(+)	(-)	(-)	Animal inputs & feed	Intermediate inputs
Italy	Veneto, Lombardy & Piedmont	o	o	o	Cow inputs	
The Netherlands		o	o	o		Intermediate inputs

The Agenda 2000 continued the MacSharry reform with further price cuts and premium increases. For Austria, clear negative effects of the policy change were identified. Surprisingly, the model results shown in Table 2.9 imply that the Agenda 2000 had the exact reverse effects than the MacSharry reform in Belgium, France and Germany. In the Netherlands, costs increased and technological change accelerated, while in Italy, the picture of the direction of Agenda 2000 impacts is ambiguous. As a general note of caution it has however be taken in into account that during this period, the beef market was significantly effected by the BSE crises, which may prevent the proper identification of the Agenda 2000 impacts.

Table 2.9: Impact of Agenda 2000 reform on costs and technical change for cattle farms

Country	Region	Rate of marginal cost diminution	Rate of cost diminution	Rate of technical change	Factor-biased technical change	
					Input using	Input saving
Austria		-	-	-	Animal inputs and Feed	Crop, cow & intermediate inputs
Belgium		o	(+)	(+)	Animal inputs & feed	Intermediate inputs
Germany		o	(+)	(+)		Cow inputs & feed
Italy	Veneto, Lombardy & Piedmont	+	(+)	(-)	Crop inputs	Animal and cow inputs
France	Limousin	+	-	-	Cow, itermediate inputs & feed	crop inputs
The Netherlands		(-)	(-)	-	Animal inputs & feed	Crop & intermediate inputs

Part 3: Crop farms

1 Data preparation and statistics

1.1 Data preparation

The outputs for the ex-post evaluation of crops include the aggregate of pulses, oilseeds and non-wheat cereals (Ya as the aggregate of Y1 and Y2), potatoes (Yb = Y3), sugar beet and other industrial crops (Yc = Y4) and wheat (Yd = Y5). In France, pulses and oilseeds (Y1) and non-wheat cereals (Y2) are not aggregated.

Variable inputs include fertilizers (X1), pesticides (X2), seeds (X3), services (X4), capital inputs (X5) and farmland (X6).

1.2 Sample specifications

For all countries under consideration, samples of crop farms (TF equal to 1110, 1120, 1130, 1210, 1220, 1243 and 1244 up to 1993 and TF equal to 1310, 1320, 1330, 1410, 1420 or 1443 from 1994) include farms for which at least two observations are present from 1990 to 2007 for all countries except for Italy where only farms from 1993 to 2007 are considered. This leads to unbalanced panels of 3774 observations in Austria, 1778 observations in Belgium, 4842 in the region of Centre (France), 3005 observations in Bavaria (Germany), 4022 observations in Lower Saxony (Germany), 12,056 observations the regions of Veneto, Lombardy and Piedmont (northern Italy) and 4217 observations in the Netherlands.

In Austria the lowest and highest numbers of observations are 242 and 320 during the years 1995 and 2002, respectively.

In Belgium, the lowest number of 89 observations are recorded in 1993, 1995 and 2007 and the highest number of 109 observations in 2003. Among these farms 22 are recorded each year during the whole period from 1990 to 2007.

In Germany, the lowest numbers of observations in Bavaria and Lower Saxony amount to 111 in 1995 and 181 in 2003, respectively, while the highest numbers of observations in Bavaria and Lower Saxony amount to 213 in 1993 and 300 in 1993, respectively. None of the farms in Bavaria but 12 farms in Lower Saxony are recorded in the sample during the whole period from 1990 to 2007.

In Italy, the regions analyzed include Veneto, Lombardy and Piedmont where the lowest number of 586 observations in 2003 and the highest number of 970 observations in 1996 are recorded. None of these farms are recorded each year during the whole period from 1990 to 2007.

In the Netherlands, the lowest number of 167 observations is recorded in 2005, and the highest number of observations of 297 is recorded in both 1991 and 1992.

2 Empirical specifications

In all countries under consideration, the best fit of the estimation model was achieved with the quadratic long-run specification with fixed effects and global positive restriction on marginal costs. Positive restriction on input demands is imposed in the case of Austria and Germany. The cubic, long-run specification converges for Belgium, Germany and the Netherlands, but does not improve the fit.

To account for the policy impact of the 1992 Mac Sharry reform and the Agenda 2000 splines are added in 1995 and 2001 in all countries. Out of the ten free quadratic parameters, two in Austria, four in Belgium, two in Bavaria, eight in Lower Saxony and seven in northern Italy are statistically significant.

3 Econometric estimations

3.1 Estimation results

Table 3.1 provides an overview of the specifications and econometric results for crop farms. In all study countries, a quadratic form was chosen.

Table 3.1: Specifications and econometric results for crop farms

Country	Region	Econometric Specification	Uncentered R^2 Range		% significant coefficients
			Minimum	Maximum	
Austria		Quadratic	0.10	0.175	49
Belgium		Quadratic	0.03	0.39	65
France	Centre	Quadratic	0.07	0.21	51
Germany	Bavaria	Quadratic	0.096	0.23	29
Germany	Lower Saxony	Quadratic	0.034	0.37	53
Italy	Veneto, Lombardy & Piedmont	Quadratic	0.02	0.74	71
The Netherlands		Quadratic	0.047	0.17	20

3.2 Splines

In Belgium, the splines indicate a statistically significant break in 1995, but only so for the parameter vectors a and G, i.e. the intercept and slope of the marginal cost curves. The policy reform of 2001 did result in a marginally significant change in all parameter matrices fitted with a spline function. In France (Centre), the splines indicate a statistically significant break in 1995 and 2001 for the parameter vectors a, vectors b while the slopes of the marginal cost curves (parameter G) are significant only for the break point in 2001. In Germany, the parameter vectors of the intercept (a) is statistically significant in both Bavaria and Lower Saxony, indicating a statistically significant break in 1995, and in Bavaria, 2001. The slopes of the marginal cost curves (parameter G) are significant for the break points in 1995 and 2001 only in Lower Saxony. In northern Italy, all the parameters (a. b. G) are statically significant which indicates a statistically significant break for break points 1995 and 2001. In contrast, none of the splines or break point parameters is statistically significant in the Netherlands and Austria.

4 Input demand and marginal cost elasticities

4.1 Input demands

As shown in Figure 3.1, in Belgium all estimated input demands are non-negative with the exception of input demand for seeds, which has a substantive fraction (92%) of negative observations. For the other inputs, the fraction of negative input demands is smaller than 1%. The percentage of negative input demands in Germany is less than 5% for all input equations with the exception of farm land. The percentage of negative input demands for farm land is 15 % and 17% for Bavaria and Lower Saxony, respectively. All input demands in Italy, France and Austria, except capital inputs in Austria and seeds in France, have fewer than 1% negative observations. In contrast, in the Netherlands the share of observations with negative input demand for fertilizers, seeds, services and capital inputs exceeds 20%.

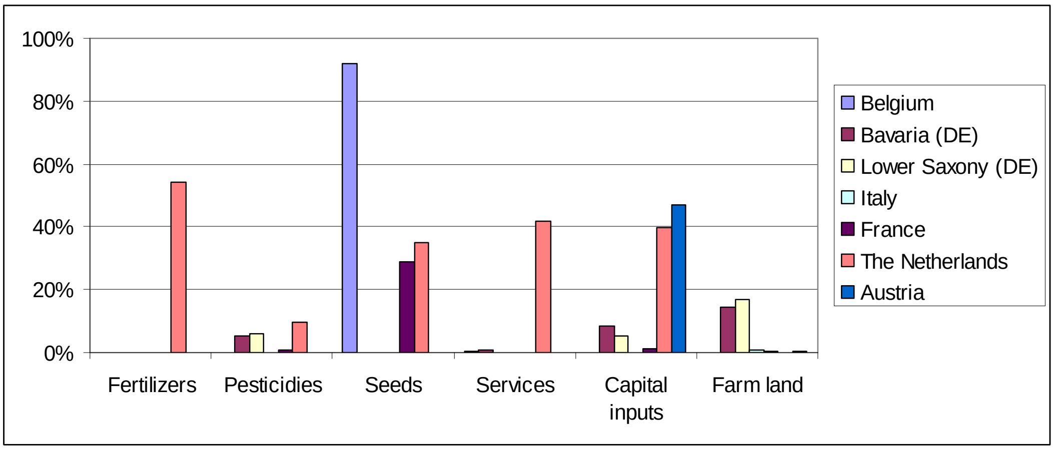


Figure 3.1 Percentage of negative input demands for crop farms

4.2 Own input demand cost elasticities

Table 3.2 shows that all medians of input demands are generally inelastic. In particular, the medians of input demand are inelastic in Austria for X1 (fertilizers), X2 (pesticides) and capital inputs (X5), in Belgium for X1 (fertilizers), X3 (seeds) and X4 (services), in France for X1 (fertilizers) and X4 (services), in Bavaria and Lower Saxony for X1 (fertilizers) and X3 (seeds), and in the Netherlands and northern Italy for X1 (fertilizers).

Table 3.2: Own input demand elasticities for crop farms

Country	**Region**	Median own input demand elasticities					
		Elx1_px1	Elx2_px2	Elx3_px3	Elx4_px4	Elx5_px5	Elx6_px6
Austria		-0.039	-0.001	-0.149	-0.176	-0.043	-0.292
Belgium		-0.013	-0.046	-0.013	-0.007	-0.249	-0.675
France	Centre	0.000	-0.109	-0.433	-0.002	-0.019	-0.454
Germany	Bavaria	-0.001	-0.554	-0.002	-0.103	-0.151	-0.689
Germany	Lower Saxony	-0.044	-0.834	-0.006	-0.132	-0.285	-0.856
Italy	Veneto, Lombardy & Piedmont	-0.001	-0.002	-0.003	-0.003	-0.130	-0.536
The Netherlands		-0.016	-0.103	0.000	-0.460	-0.075	-0.231

4.3 Own marginal cost elasticities

The marginal cost elasticities, averaged over all observations, are positive for all products and countries, indicating that crop farms are on their upwards sloping curve of marginal costs (Table 3.3). However, the effects are very low as these elasticities are on average close to zero.

Table 3.3: Own marginal cost elasticities for crop farms

Country		Median own input demand elasticities				
	Region	ElMCya_ya	ElMCyb_yb	ElMCyc_yc	ElMCyd_yd	ElMCye_ye
Austria		2.80E-08	4.30E-10	7.90E-07	1.06E-03	
Belgium		1.10E-07	8.00E-07	2.40E-07	7.00E-07	
France	Centre	3.60E-06	7.10E-06	8.90E-06	1.40E-06	8.10E-06
Germany	Bavaria	1.70E-06	2.10E-08	1.40E-05	6.80E-08	
Germany	Lower Saxony	6.90E-06	6.90E-06	2.90E-06	2.20E-06	
Italy	Veneto, Lombardy & Piedmont	7.00E-12	2.40E-04	2.40E-07	2.00E-07	
The Netherlands		2.60E-18	2.90E-07	2.30E-08	6.90E-07	

5 Marginal and average costs

Table 3.4 reports the marginal and average costs of crop products. The marginal costs of the aggregated output of pulses, oilseeds and non-wheat cereals in crop farms range from 8 Euro/ton for the Netherlands to 167 euro/ton for northern Italy. As a percentage of farm gate prices, this equals 30% in Austria, 39% in Belgium, 36% in Bavaria, 34% in Lower Saxony, 85% in northern Italy and 5% in the Netherlands. In France, pulses and oil seeds and non wheat cereals are disaggregated and estimated marginal costs equal 40 and 20 euro/ton, respectively. This amounts to 34% of the observed farm gate price of pulses and oil seeds and 17% for non-wheat cereals.

Table 3.4: Marginal costs of crop outputs for crop farms

Country	Region	MC Ya		MC Yb		MC Yc		MC Yd		MC Ye	
		€ / t	% FGP	€ / t	% FGP	€ / t	% FGP	€ / t	% FGP	€ / t	% FGP
Austria		42	30	29	25	26	49	61	52		
Belgium		50	39	21	29	21	46	31	24		
France	Centre	40	34	20	17	60	46	13	30		
Germany	Bavaria	56	36	38	44	10	18	69	51		
Germany	Lower Saxony	46	34	37	40	30	60	69	55		
Italy	Veneto, Lombardy & Piedmont	167	85	100	48	32	67	393	26		
The Netherlands		8	5	18	14	5	11	67	51	20	16

% FGP = marginal costs as a % of farm gate price

Figure 3.2 shows that for all countries except Italy (and Lower Saxony in 2006 and 2007), the marginal costs of pulses, oil crops and non wheat cereals remain below 100 Euro/ton throughout all years. In Italy, the marginal costs range from 117 Euro/ton in 1993 to 201 Euro/ton in 2007.

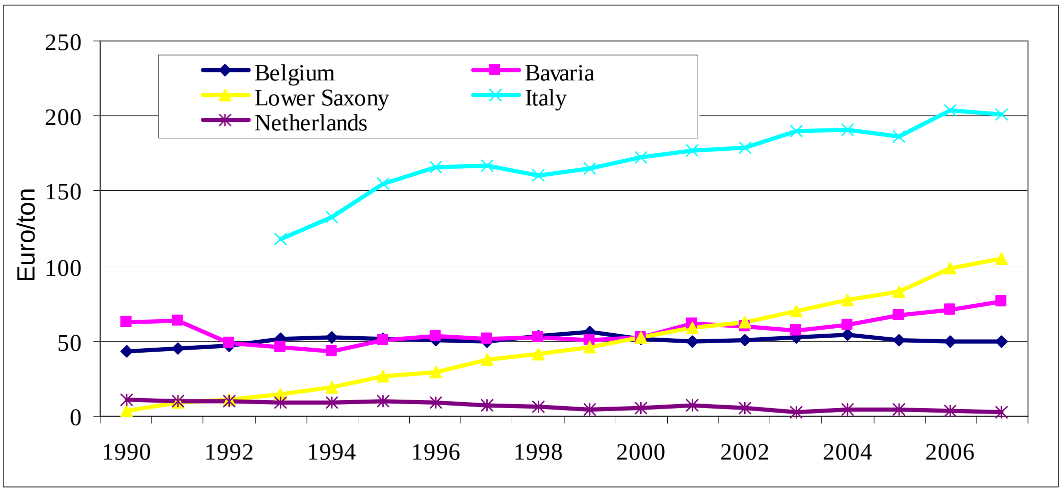


Figure 3.2: Annual marginal costs of pulses, oil crops and non wheat cereals in crop farms

As highlighted in Figure 3.3, the marginal costs of potato have the same trend across all countries with the exception of Italy, increasing slightly annually.

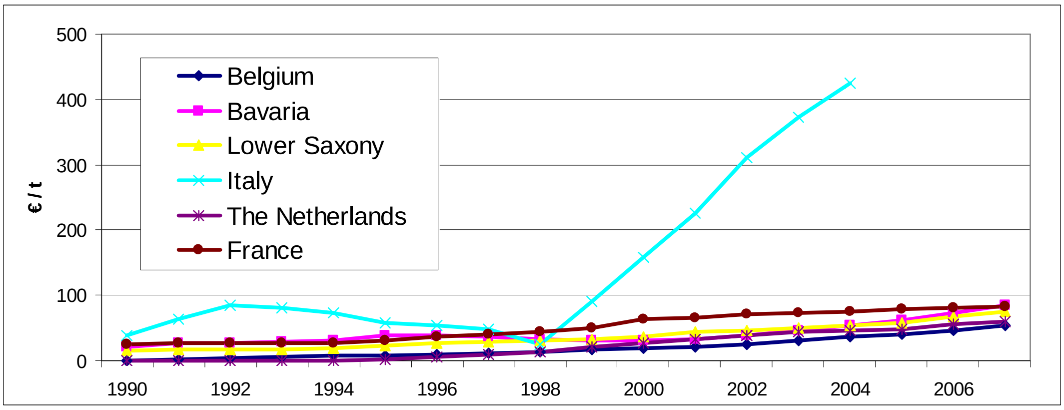


Figure 3.3: Annual marginal costs of potatoes in crop farms

Figures 3.4 highlights an increasing trend of the marginal costs of sugar beet for crop farms in Belgium, France (Centre) and northern Italy, stable marginal costs for the Netherlands, and a strong reduction in Lower Saxony from 1995 onwards.

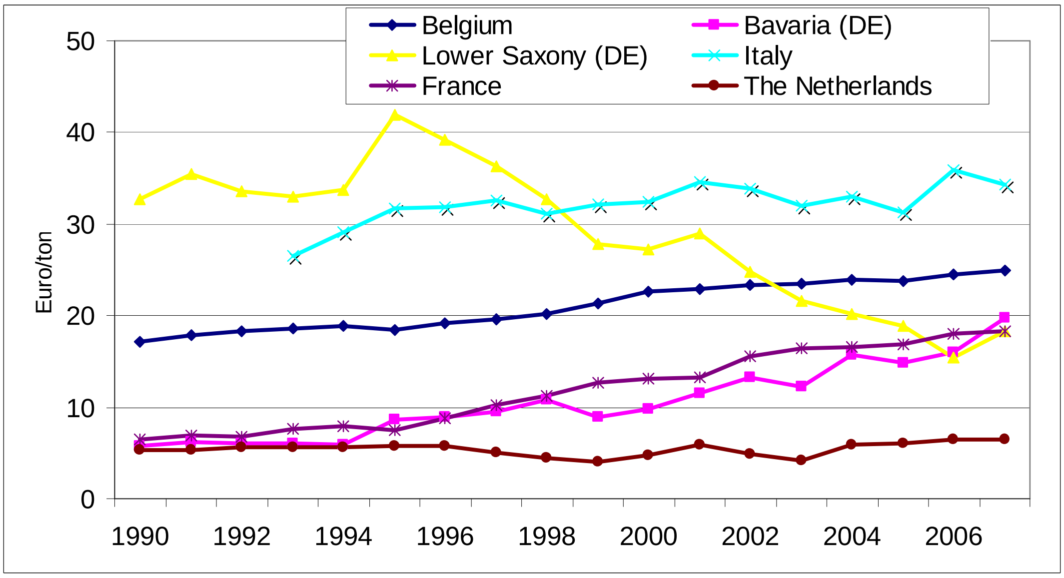


Figure 3.4: Annual marginal cost of sugar beet (Euro/ton) in crop farms

Figures 3.5 clearly shows that the marginal costs of wheat in crop farms in all selected countries except Italy, slightly fluctuate across the years and mostly stay below 100 Euro/ton. In Italy, the estimated marginal costs for wheat are significantly higher, which may also be related to the dominance of durum wheat.

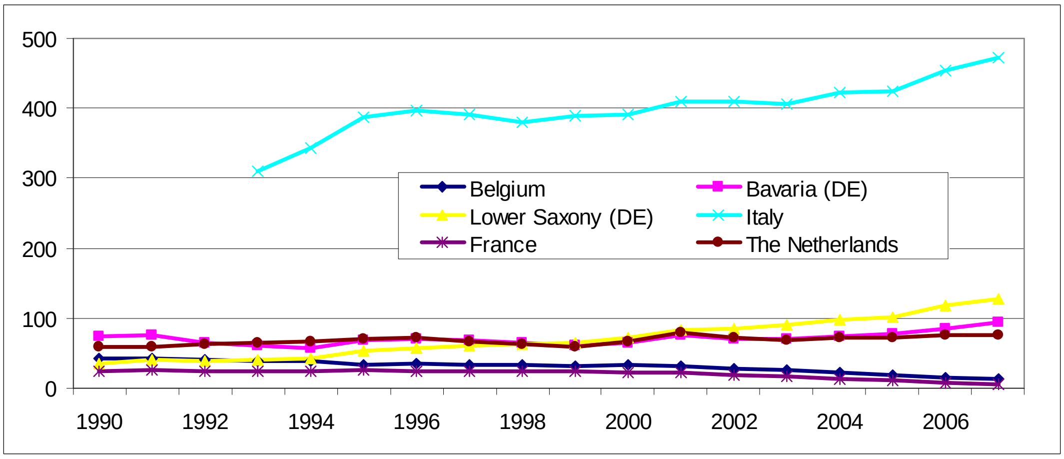


Figure 3.5: Annual marginal cost of wheat (Euro/ton) in crop farms

6 Cost flexibility, scale and scope economies

6.1 Cost flexibility

As shown in Table 3.5, cost flexibilities are statistically different from one for outputs Ya (pulses, oilseeds and non-wheat cereals) and Yd (wheat) in Belgium. There is thus economies of size for these outputs. In Germany (both Bavaria and Lower Saxony), Italy, the Netherlands and Austria the cost flexibilities of the all outputs are statistically less than one, and thus no economies of size could be detected for these outputs. However, in France, cost flexibilities of the five outputs are statistically different from one. The values are all greater than on, indicating the that costs are very flexible when the output quantity increases.

Table 3.5: Cost flexibility of crop outputs for crop farms

Country	Region	Ya	Yb	Yc	Yd
Austria		1.0002 (0.0001)	1.0008 (0.0013)	1.0214 (0.0154)	1.0902 (0.0610)
Belgium		0.9999 (0.0001)	0.9843 (0.7149)	0.9989 (0.0298)	0.98509 (0.066)
France	Centre		1.050 (0.079)	1.068 (0.070)	1.050 (0.054)
Germany	Bavaria	1.010 (0.014)	1.000 (0.0002)	1.365 (0.180)	1.0006 (0.0006)
Germany	Lower Saxony	1.041 (0.048)	1.045 (0.037)	1.089 (0.068)	1.015 (0.013)
Italy	Veneto, Lombardy & Piedmont	1 (1.4E-07)	1.018 (0.082)	1.008 (0.015)	1.0006 (0.0028)
The Netherlands		1 (0.00)	1.697 (6.1273)	1.0006 (0.0014)	1.00286 (0.0098)

Standard deviations are given in brackets. Ya is not aggregated in France.

6.2 Scale and scope economies

Table 3.6 shows that for Belgian crop farms, there are significant decreasing overall return to scale (ORTS) and decreasing product-specific returns to scale (PSRTS) for outputs pulses, oilseeds and non wheat cereals, potatoes, and sugar beet, whereas wheat exhibits increasing returns to scale. Economies of scope (ESCP) are not statistically significant.

Similarly there are significant increasing ORTS in Lower Saxony, while ORTS is decreasing in Bavaria. PSRTS are increasing in Bavaria except for sugar beet and other industrial crops, and decreasing for all output aggregates in Lower Saxony. ESCP are decreasing in both regions; however the estimates are not statistically significant.

Table 3.6: ORTS, PSRTS and ESCP of crop outputs for crop farms

	Austria	Belgium	France (Centre)	Bavaria	Lower Saxony	Northern Italy	The Netherlands
ORTS	0.98 (0.033)	0.999 (0.014)	0.987	1.001 (0.069)	0.994 (0.063)	0.993 (0.005)	1.010 (0.061)
PSRTSya	1.004 (0.038)	0.999 (0.00003)	0.979 (0.020)	1.104 (0.069)	0.993 (0.037)	1 (4E-07)	1.202 (0.210)
PSRTSyb	1.022 (0.027)	0.995 (0.0139)	0.947 (0.052)	1.045 (0.038)	1.058 (0.068)	0.995 (0.009)	0.957 (1.134)
PSRTSyc	0.991 (0.043)	0.999 (0.0197)	0.961 (0.055)	0.848 (0.167)	0.968 (0.109)	0.993 (0.009)	1.108 (0.115)
PSRTSyd	0.903 (0.056)	1.006 (0.0357)	0.943 (0.056)	1.110 (0.069)	1.188 (0.113)	0.999 (0.002)	1.002 (0.872)
PSRTSye			0.951 (0.042)				
ESCP	1.014 (0.167)	1.0001 (0.0078)		1.001 (0.069)	3.789 (3.102)	1 (0.000)	2.900 (4.146)

For Italian crop farms all the indicators are not statistically different from 1, which indicates no economies of scale and scope and no PSRTS,

In France and Austria, there is a decreasing ORTS. There are decreasing PSRTS in France, for all products (Table 3.6), in particular for outputs Y2, Y4 and Y5. However, the yearly means increase for all outputs and values and exceed one after 2005. ESCP are are statistically significant in France and decreasing, while they are not statistically significant in Austria.

Table 3.6 also shows that there is a significant increase in ORTS and PSRTS for pulses, oilseeds and non-wheat cereals (Ya) and sugar beet and other industrial crops (Yc) in the Netherlands. ESCP exhibit a decreasing trend, which however is not statistically significant.

7 Indicators of technological change

7.1 Rate of marginal cost diminution

In Austria, as shown in Figure 3.6, the marginal cost diminution for Ya (pulses, oil seeds and non-wheat cereals), Yc (sugar beet and other industrial crops) and Yd (wheat) is almost constant through out the years. In contrast, the marginal cost diminution of Yb (potatoes) exhibits an increasing trend.

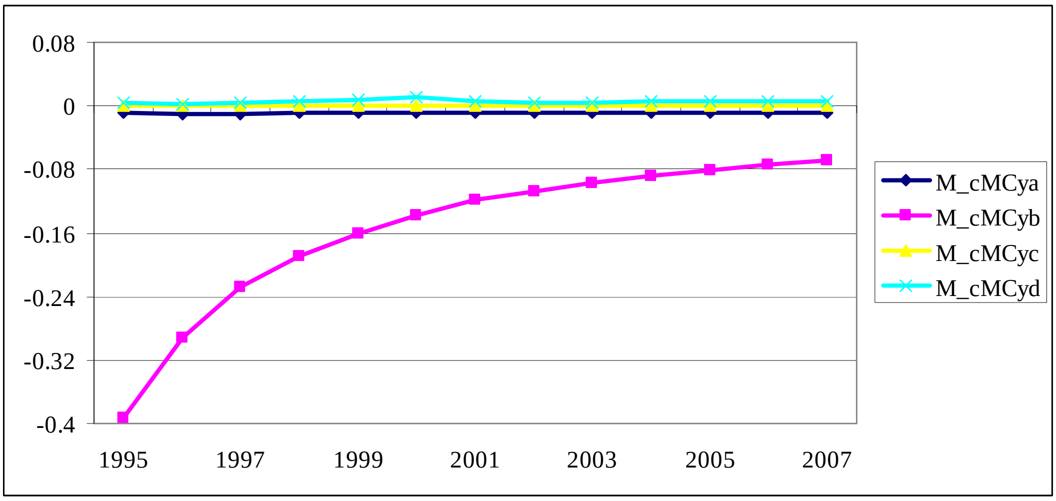


Figure 3.6: Annual rate of marginal cost diminution for crop farms in Austria

In Belgium, the overall averaged rates of marginal cost diminution are statistically significantly different from zero. Output Yb (potatoes) exhibits a yearly increase in marginal costs of 23% and Yc (sugar beet and other industrial crops) a yearly increase of 0.2%. In contrast, for Ya (pulses, oil seeds and non-wheat cereals) and Yd (wheat), there are yearly cost diminutions of 1.5%, respectively 8.9%. In addition, for Yc (sugar beet and other industrial crops) the 2001 reform seems to have reversed the yearly marginal cost increase into a yearly decrease of 0.3% (Figure 3.7).

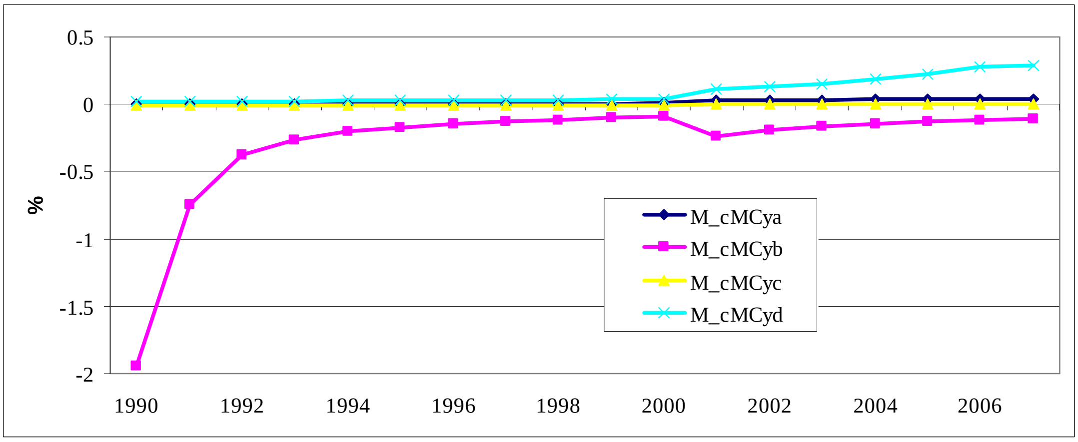


Figure 3.7: Annual rate of marginal cost diminution for crop farms in Belgium

In France (Centre), the overall average rates of marginal cost diminution are statistically significantly different from zero, and all for outputs exhibit a yearly increase in marginal costs after 1995 (Figure 3.8).

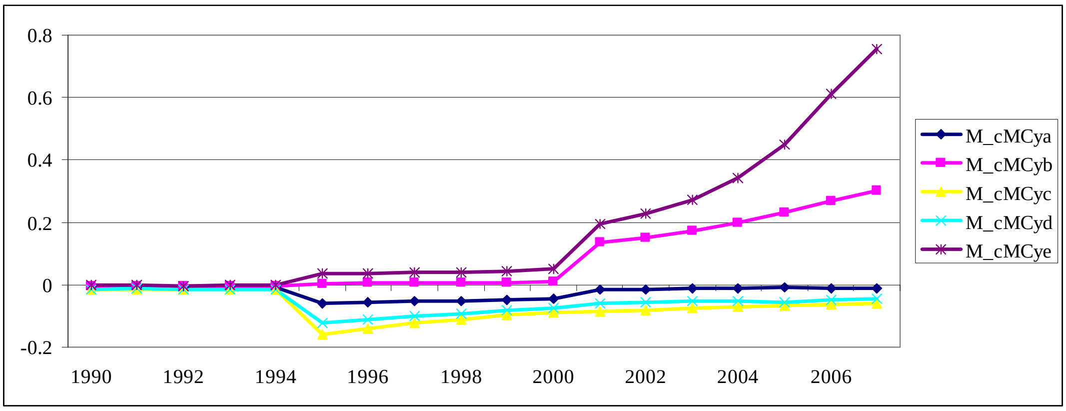


Figure 3.8: Annual rate of marginal cost diminution for crop farms in France (Centre)

As Figure 3.9 shows, the marginal cost diminution for Yb (potatoes) and Yc (sugar beet and other industrial crops) in Bavaria clearly indicate a cost decreasing shock in 1995 and 2001. The effect on other crops aggregates is very small.

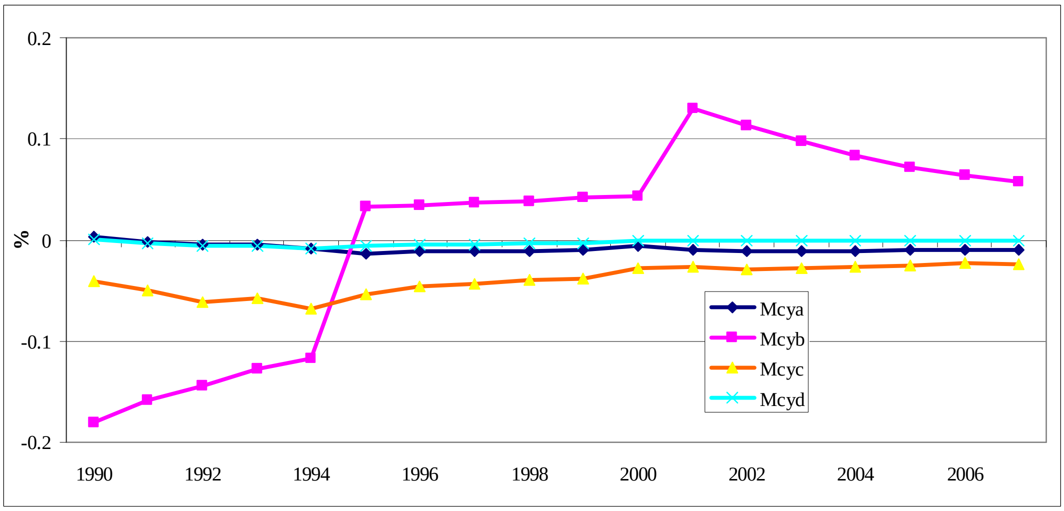


Figure 3.9: Annual rate of marginal cost diminution for crop farms in Bavaria

In Lower Saxony, for the first break point in the year 1995, the marginal cost diminution for Ya (pulses, oil seeds and non-wheat cereals), Yc (sugar beet and other industrial crops) and Yd (wheat) clearly exhibits a cost decreasing shock while for Yb (potatoes) it exhibits a cost increasing shock (Figure 3.10). For the break point in the year 2001, the marginal cost diminution for Ya, Yb (potatoes) and Yd shows a decreasing cost shock for while Yc (sugar beet and other industrial crops) it shows a increasing cost shock.

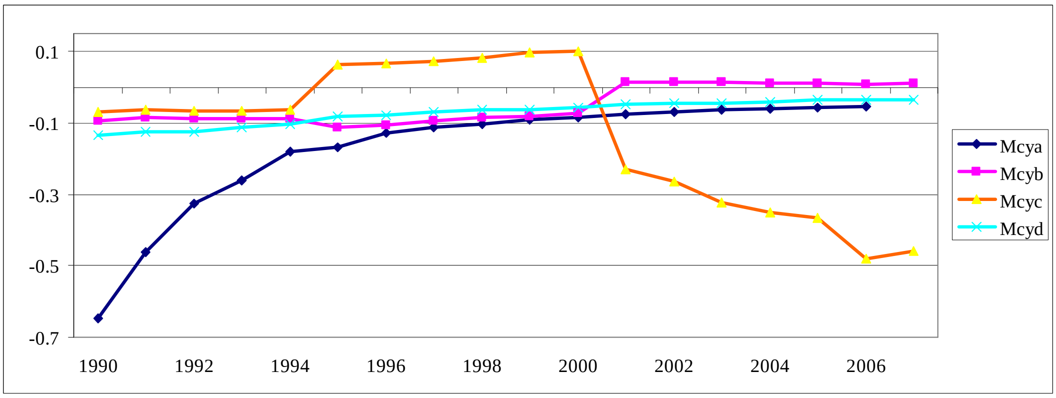


Figure 3.10: Annual rate of marginal cost diminution for crop farms in Lower Saxony

The overall average rate of cost diminution is not statistically significantly different from zero in northern Italy. On average, costs decrease with 0.07% per year. The annual rates are statistically different from zero, and negative until 2000, before turning positive in the following years (Figure 3.11).

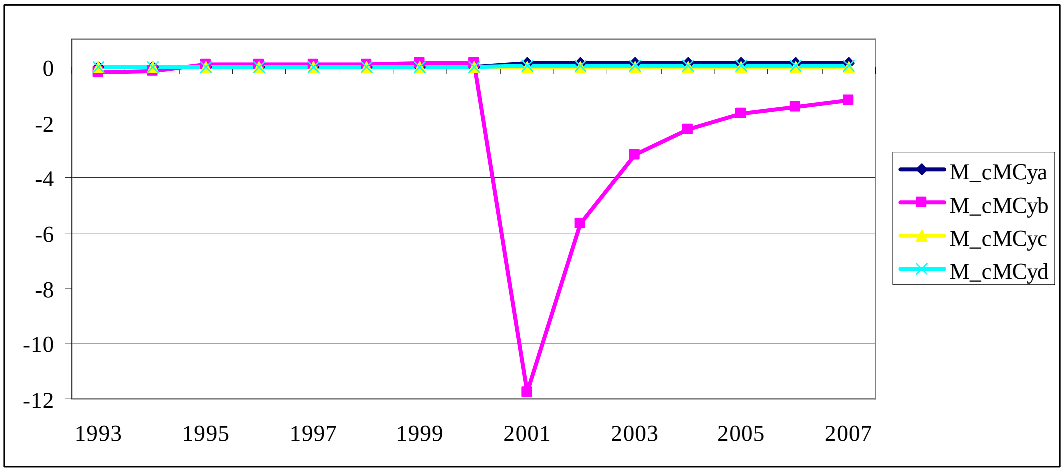


Figure 3.11: Annual rate of marginal cost diminution for crop farms in northern Italy

Figure 3.12 shows the marginal cost diminution for Yb (potatoes) and Ya (Pulses, oilseeds and non-wheat cereals) in the Netherlands. A cost increasing shock for potatoes is evident in 1995. In 2001, a small cost decreasing shock can be discerned for wheat.

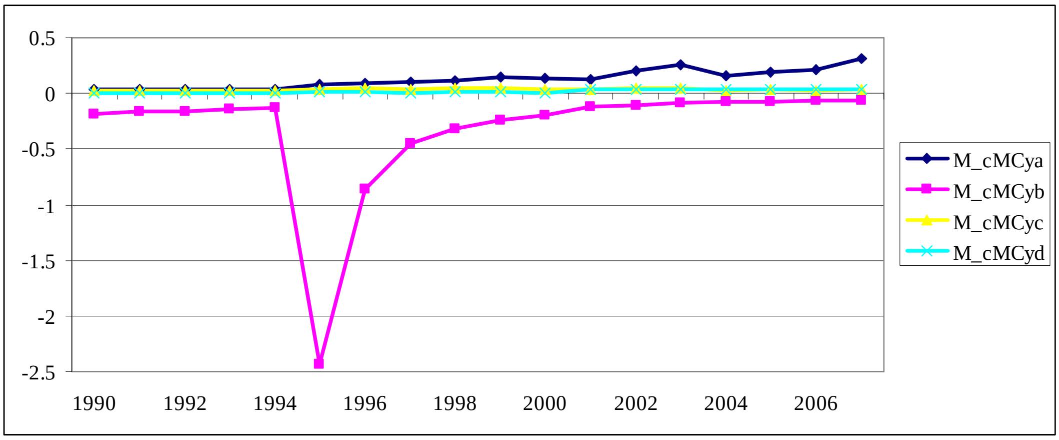


Figure 3.12: Annual rate of marginal cost diminution for crop farms in the Netherlands

7.2 Rate of cost diminution

Figure 3.13 provides an overview of the overall rate of cost diminution in crop farms in the study countries. In Austria, the rate of cost diminution exhibits little tendency of change. In the year 2000, there is a slight rise, followed by almost the same constant trend in the subsequent years. The overall average rate of cost diminution is not statistically significantly different from zero in Belgium and France (Centre). In Belgium, annual rates of cost diminution are negative before 2001, and turn significantly positive in the following years. The over all rate of cost diminution in Lower Saxony exhibits a cost decreasing shock in 1995. The effect of the policy change in 2000 seems to be lower in Bavaria than in Lower Saxony, where crop farms exhibit a cost increasing shock, followed by spiky decrease in costs for the subsequent years. The overall rate of cost diminution in the Netherlands shows an average reduction of -0.047%, with a clear reduction after the 1995 policy shock, while the break point in 2001 exhibits an increasing shock on the rate of cost diminution.

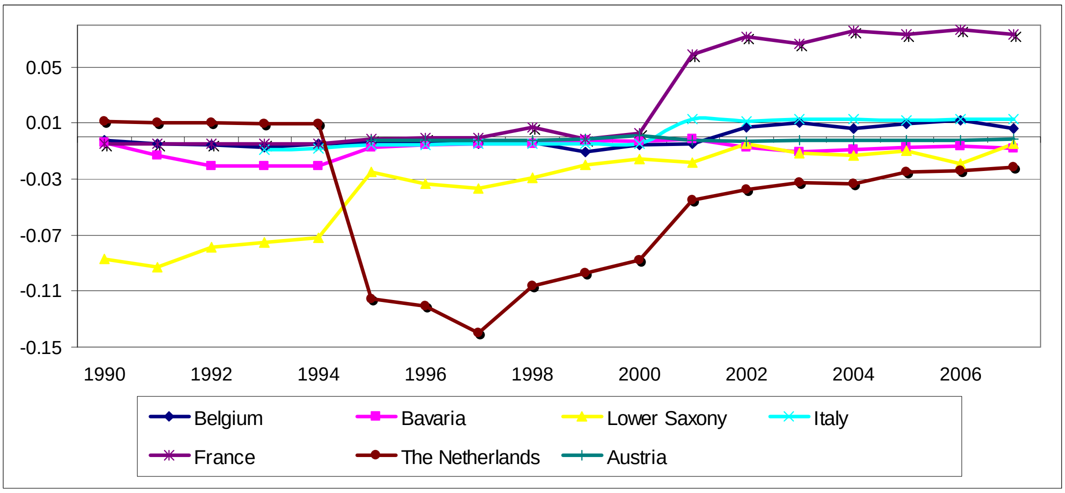


Figure 3.13: Annual rate of cost diminution for crop farms

7.3 Rate of technical change

Figure 3.14 provides an overview of the rate of technical change in crop farms in the study countries. The development of the rate of technical change in Austria very similar to that of the rate of cost diminution. On average, the rate of technical change in Belgium is statistically significantly, but marginally, smaller than zero. The significant technological regression before 2001 is turned into a non-significant progress in the subsequent years. In France (Centre), the average the rate of technical change is not statistically significantly different from zero. In Bavaria and particularly in Lower Saxony, the rate of technical change exhibits an increasing rate in 1995, while the effect in 2001 is minimal. In northern Italy, the average rate of technical change is not statistically significantly different from zero. Yearly averages are negative and statistically different from zero until 2000. From 2001 they are positive and statistically different from zero. The average rate of technical change in the Netherlands exhibits a decreasing and increasing shock during 1995 and 2000, respectively.

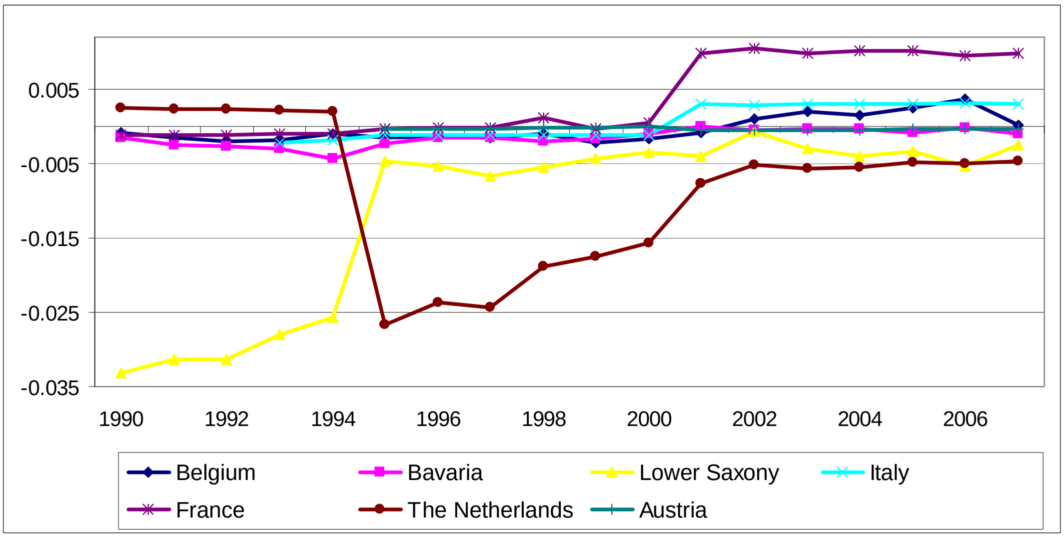


Figure 3.14: Annual rate of technical change for crop farms

7.4 Factor-biased technical change

Figure 3.15 provides an overview of factor-biased technical change in crop farms in the study countries.

In Austria, the technological change increases the use of all inputs except for capital inputs.

In Belgium, on average the technological change increases input demand for X2 (pesticides) and X6 (farmland), while it is input-saving for the other inputs. The 2001 reform makes a nontrivial fraction of farms input decreasing in X2 (pesticides) and X6 (farmland). In addition, a significant fraction of farms become input increasing after 2001 in X3 (seeds).

In France (Centre), the technological change increases the use of pesticides, seeds and farmland and saves fertilizers, services and capital inputs.

In both Bavaria and Lower Saxony the technological change increases the use of all inputs except for X5 (capital inputs).

In northern Italy and the Netherlands, technological change is input-increasing for inputs but fertilizer, but the effect is small.

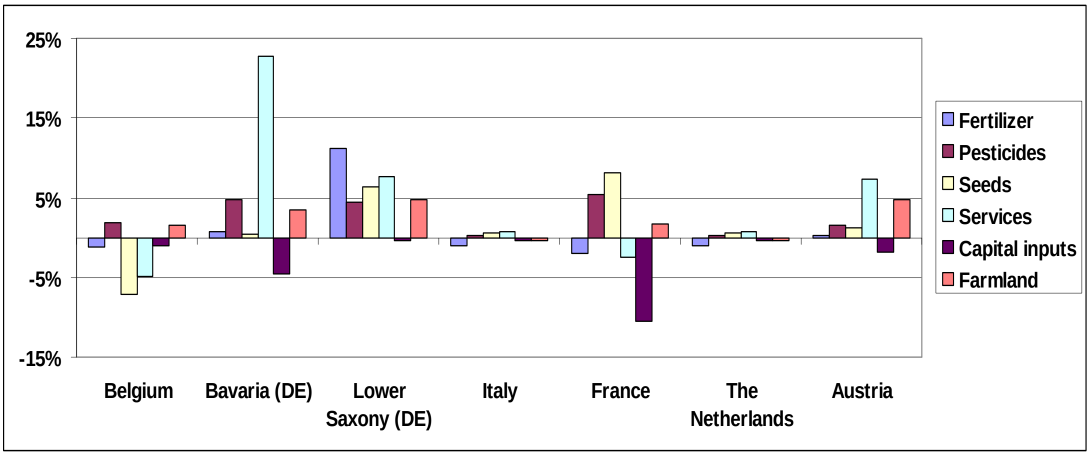


Figure 3.15: Annual factor-biased technical change in crop farms

8 Concluding remarks

8.1 Cost function estimates

Table 3.7 provides a summary of model estimations for crop farms across countries. For all countries or regions under consideration, the specification used is long-run quadratic specification. Monotonicity restrictions on input prices are generally not respected, and as a consequence, this specification needs to be used with great care in simulations and the results should be used with caution. Furthermore, the specification provides unrealistically low marginal and average costs for all output categories in all countries. The marginal cost elasticities for all aggregated outputs are all positive, indicating crop farms are on their upwards sloping curve of marginal cost. However, the effects are very small as the values are all close to zero.

In Belgium, there are economies of size in the output categories Ya (pulses, oil seeds and non-wheat cereals) and Yd (wheat). However, there are overall diseconomies of scale, overall and for output categories Ya, Yb and Yc. Only Yd (wheat) shows economies of scale. There are hardly any economies of scope among the Belgian crop farms. Belgian crop farms exhibit marginal cost diminution for Ya (pulses, oil seeds and non-wheat cereals) and Yd (wheat) (Table 3.7). The 2001 reform seems to have induced on average some cost diminution and technological progress.

In general the crop farms in Bavaria and Lower Saxony shows a marginal cost diminution as the result of the policy changes in 1995 and 2001 except for Yb (potatoes) and Yc (sugar beet and other industrial crops) in Lower Saxony that they clearly exhibits an increasing marginal cost diminution for the policy changes in 1995 and 2001, respectively. They do exhibit also technological change, with an increase of all inputs except X5 (capital inputs).

There are no return to scale and economies of scope and size among the Italian and French crop farms. Crop farms exhibit marginal cost diminution for Ya (pulses, oil seeds and non-wheat cereals) and Yd (wheat) in Italy and Yb (non-wheat cereals) and Yd (wheat) in France (Table 3.7).

According to table 3.7 Ya (pulses, oil seeds and non-wheat cereals) in Austria and Yb (potatoes) in Austria and the Netherlands show economies of scale and there is economies of scope among the Austrian and Dutch crop farms. There is a marginal cost diminution for Yc (sugar beet and other industrial crops) and Yd (wheat) in both countries. In addition the Dutch crop farms exhibit a marginal cost diminution for Ya (pulses, oil seeds and non-wheat cereals).

Table 3.7: Summary of model estimations for crop farms

Country	**Region**	**Econ. spec.**	**% sign. coeff.**	**Economies of**			**RMCD**	**RCD**	**RTC**	**Factor-biased technical change**	
				Size	**Scale**	**Scope**				**Input using**	**Input saving**
Austria		Quadr.	49	No	Yes (Ya, Yb)	Yes	- (Ya, Yb) + (Yc, Yd)	-	-	X1,X2, X3, X4, X5	X5
Belgium		Quadr.	65	Yes (Yd)	Yes (Yd)	No	- (Yb, Yc) + (Ya, Yd)	- * (up to 2001)	- (up to 2001)	X2, X6	X1, X3, X4, X5
France	Limousin	Quadr.	51	No	No	No	- (Ya, Yc, Yd) + (Yb, Ye)	+	-	X2, X3, X6	X1, X4, X5
Germany	Bavaria	Quadr.	29	No	Yes (all)	Yes	- (all)	-	-	X1, X2, X3, X4, X6	X5
Germany	Lower Saxony		53	No	Yes (Yb, Yd)	Yes	- (all)	-	-	X1, X2, X3, X4, X6	X5
Italy	Veneto, Lombardy & Piedmont	Quadr.	71	No	No	No	- (Yb, Yc) + (Ya, Yd)	+	-	X2, X3, X4	X1, X5, X6
The Netherlands		Quadr.	20	No	Yes (Yb)	Yes	- (Yb) + (Ya, Yc, Yd)	-	-	All inputs	

* not significant
X1: fertilisers; X2: pesticides; X3: seeds; X4: services; X5: capital inputs; X6: farmland
RMCD: Rate of marginal cost diminution
RCD: Rate of cost diminution
RTC: Rate of technical change

* Not significant

8.2 Impact of the MacSharry and Agenda 2000 reforms

With the exception of the Netherlands, the MacSharry reform decreases costs of crop farms in all the countries analyzed, and increases the rate of technical change. In many cases, technical change is input-saving with respect to seeds and plant protection.

The impact of the Agenda 2000 reform is similar in many cases, decreasing costs also for the Netherlands, and input-saving for most inputs. Only in Austria and Germany (Lower Saxony), costs of crop farm increase slightly.

Table 3.8: Impact of 1992 MacSharry reform on costs and technical change for crop farms

Country	Region	Crops	Rate of marginal cost diminution	Rate of cost diminution	Rate of technical change	Factor-biased technical change: Input using	Factor-biased technical change: Input saving
Belgium		Oilseeds & non-wheat cereals	o	(+)	(+)		Seeds
		Potatoes	(+)				
		Sugar beet	o				
		Wheat	o				
France	Centre	Oilseeds & non-wheat cereals	-	(+)	(+)	Pesticides & farm land	Seeds & capital inputs
		Non wheat cereals	(+)				
		Potatoes	-				
		Sugar beet	-				
		Wheat	+				
Germany	Bavaria	Oilseeds & non-wheat cereals	o	+	+		Pesticides, services
		Potatoes	+				
		Sugar beet	(+)				
		Wheat	o				
	Lower Saxony	Oilseeds & non-wheat cereals	+	+	+	Farm land	Fertilizers, pesticides, seeds, services & capital inputs
		Potatoes	(-)				
		Sugar beet	+				
		Wheat	(+)				
Italy	Veneto, Lombardy & Piedmont	Oilseeds & non-wheat cereals	o	(+)	(+)	Fertilizers, Capital inputs & farm land	Pesticides, seeds & services
		Potatoes	(+)				
		Sugar beet	o				
		Wheat	o				
The Netherlands		Oilseeds & non-wheat cereals	(+)	-	-	Pesticides, services, capital inputs & farm land	Seeds
		Potatoes	-				
		Sugar beet	o				
		Wheat	o				

Table 3.9: Impact of Agenda 2000 reform costs and technical change for crop farms

Country	Region	Crops	Rate of marginal cost diminution	Rate of cost diminution	Rate of technical change	Factor-biased technical change: Input using	Factor-biased technical change: Input saving
Austria		Oilseeds & non-wheat cereals	o	(-)	o		Services, capital inputs & farm land
		Potatoes	+				
		Sugar beet	o				
		Wheat	(-)				
Belgium		Oilseeds & non-wheat cereals	(+)	(+)	(+)	Seeds, services	Pesticides, farmland
		Potatoes	-				
		Sugar beet	(+)				
		Wheat	(+)				
France		Oilseeds	+	+	+		All inputs
		Non wheat cereals	+				
		Potatoes	(+)				
		Sugar beet	(+)				
		Wheat	+				
Germany	Bavaria	Oilseeds & non-wheat cereals	o	(+)	(+)	Capital inputs	Services
		Potatoes	+				
		Sugar beet	(+)				
		Wheat	o				
	Lower Saxony	Oilseeds & non-wheat cereals	o	(-)	(-)	Capital inputs	
		Potatos	+				
		Sugar beet	-				
		Wheat	o				
Italy		Oilseeds & non-wheat cereals	o	+	+		All inputs
		Potatoes	-				
		Sugar beet	o				
		Wheat	o				
The Netherlands		Oilseeds & non-wheat cereals	(-)	+	+		All inputs
		Potatoes	(+)				
		Sugar beet	o				
		Wheat	o				

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Annex

Due to its size, the Annex to the D9.3 is provided as a separate document. It contains the country studies for

- Austria
- Belgium
- Estonia and UK
- Germany
- France
- Italy
- The Netherlands

Farm Accountancy Cost Estimation and Policy Analysis of European Agriculture
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