Impact of CAP Animal Premiums on Cattle and Ewe Stock in the Netherlands

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ABSTRACT
This paper examines the influence of animal premiums under the CAP beef and ewe regime on beef and sheep meat farming in the Netherlands concerning instruments like stock density limits, quota on premium rights and premium payments. On the basis of econometric models, equations are estimated for beef cows[1], bulls and ewes. Then, the impacts of the different policy instruments on the stocks are decomposed. At last, prospects of Agenda 2000 on the Dutch beef and ewe sector are calculated up to 2010. For policy makers, the study offers information on the effectiveness of animal premium instruments to manipulate beef and sheep meat production. For Dutch farmers, the study offers information to what extent premium instruments might influence the decision to incline or reduce their stocks.

The Netherlands/beef cattle and ewes stock/CAP beef and ewe regime/impact study

1. Introduction

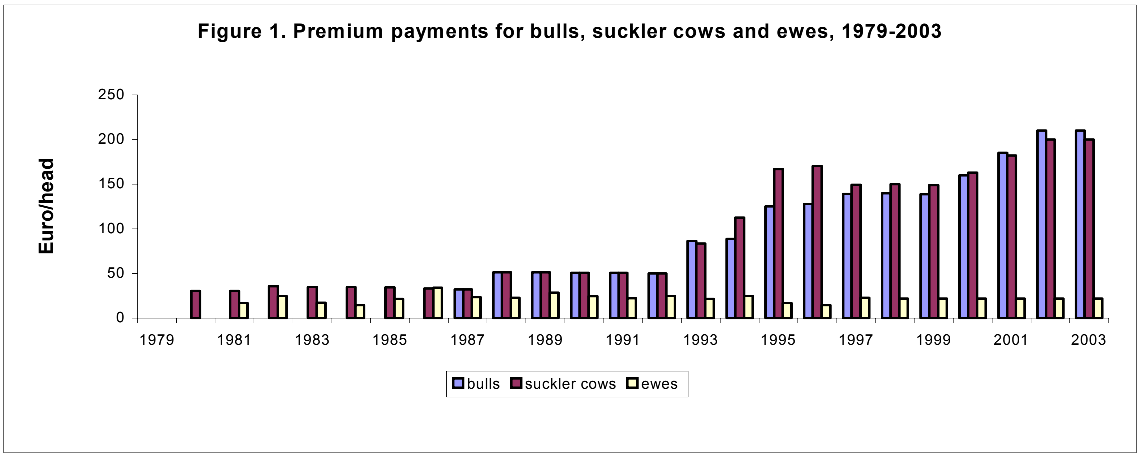
This paper describes the impact of livestock premiums under the CAP beef and ewe regime on beef and sheep meat farming in the Netherlands. First, we will examine the historical development of these premiums in section 2. Then, section 3 emphasizes the characteristics of Dutch beef and sheep meat farming in terms of holding structure, sector profitability and contribution to EU production. Section 4 presents an econometric model for the Dutch beef and ewe stock, gives a decomposition of the impacts of current policy instruments on the stocks, and examines the prospects of Agenda 2000 reforms. The paper ends up with some conclusions in section 5.

2. Animal premiums under the CAP beef and ewe regime

The Suckler Cow Premium (SCP) was first introduced by the EEC in 1980. It's purpose is to support a form of beef production which is traditionally linked with relatively low financial returns, and particularly to compensate farmers for a fall in beef prices following CAP reforms. The Special Beef Premium (SBP) was introduced in 1987. Payment can be claimed twice in the life of male cattle. The Ewe Premium (EP) was introduced in 1980 as an important support to sheep farmers, especially in disadvantaged areas. The premium was intended as a deficiency payment to supplement the market price received by farmers and to maintain it in the face of fluctuations in the price of sheep meat. Similar to SCP and SBP, payments are made per animal. In 1991, the EU introduced a quota regime on premium rights in order to restrict supply so as to re-establish market prices, which had tended to fall pre-1992 (European Commission, 1993).

The first significant change in the CAP came in 1984 with the introduction of the milk super levy, which penalised milk production above certain levels. The milk super-levy effectively limited further development and entry into dairy farming. Farmers responded to EEC direct payments of suckler cows and the ewe premium scheme for sheep. As a result, number on suckler cow and sheep have risen since 1984.

[1] In this paper, we mean the same by 'beef' cows, 'suckler' cows and 'other' cows.



The CAP reforms of 1992 under Mac Sharry represented a second significant shock. Since the reforms came into effect, emphasis on agricultural schemes and payments as instruments to support farm incomes increased, while price and market supports declined. For supply control and environmental reasons the SCP, SBP and EP were tied to historical references and subject to a maximum stocking density phased in over three years[2]. It followed that the greater the forage area, the greater the amount of livestock subsidies which could be claimed. Quotas were introduced for suckler cows, bulls and ewes to curb increases in livestock numbers throughout the EC. In fact, however, beef and sheep farmers could continue to produce more than the quotas imposed, but they could not avail of EC aid.

The Agenda 2000 reforms meant a third shock to EU agriculture. In particular, there was consensus about the need to amend the beef regime because of projections that supply would outstrip demand. Surpluses would be difficult to dispose of on the world market without conflicts with GATT. Reform emphasis was on higher cow and bull headage payments and reduced market prices, which must encourage farmers to finish their stock earlier but to maintain the same number of animals as before 2000. The ewe regime was not reformed, because it was generally considered that the amendments made in 1992 have succeeded in halting the increase in ewe numbers. In several member states sheep numbers have declined since a peak in the early 1992.

At last, the Agricultural council reached an agreement to modify the EU beef market again (the so-called 7-point plan) in June 2001. This must lead to another important step towards a more extensive beef production and the need to restore the balance on the beef market. Consumption was still considerably below the normal levels and a significant part of the EU export was blocked. As consumption and exports were limited, the package should reduce production in order to create that space on the market that will allow the sale of the intervention stocks (Commission, 2001). First, in order to encourage extensive production the number of animals qualifying for SBP and SCP will be limited to a stocking density of 1.8 LU/ha from 2003. Second, in order to discourage production, for the years 2002 and 2003, the premium rights for the special beef cattle will be reduced and will be fixed based on average payments in 1997, 1998 and 1999. Figure 1 gives an overview of the development of suckler cow, bull and ewe premiums in the period 1979-2003.

[2] The stock density is calculated as number of livestock units (LU) per hectare of forage area. Numbers of animals are converted to livestock units as follows: suckler cows, dairy cows, male bovines and heifers over 24 months: 1 LU; male bovines and heifers 6-24 months: 0.6 LU; ewes and hogget ewes: 0.15 LU. The forage area includes grassland and land under fodder corps. Density limits under CAP reform: 3,5 LU/ha in 1993, 3 LU/ha in 1994, 2,5 LU/ha in 1995 and 2 LU/ha since 1996.

3. Beef and sheep meat farming in the Netherlands

3.1 Beef farming

Figures 2 and 3 show the development in livestock cattle on respectively EU15 and Dutch level in the period 1979-1999.

Figure 2. Development of livestock cattle in the EU15

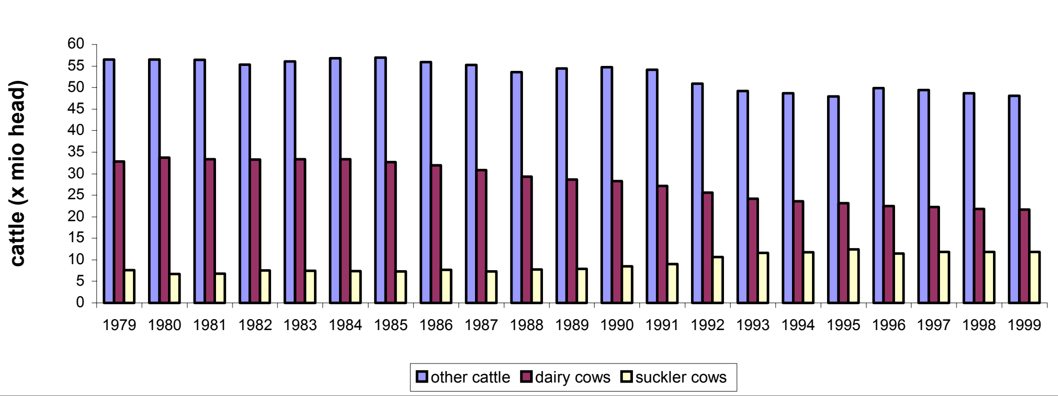
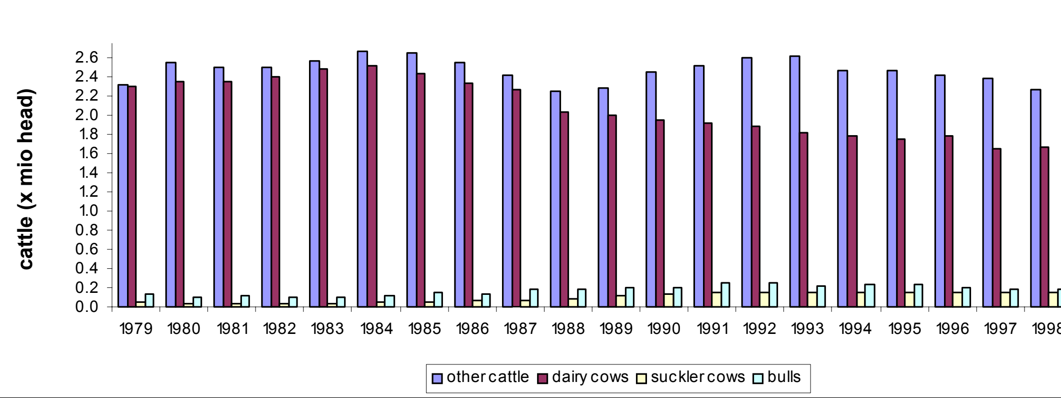


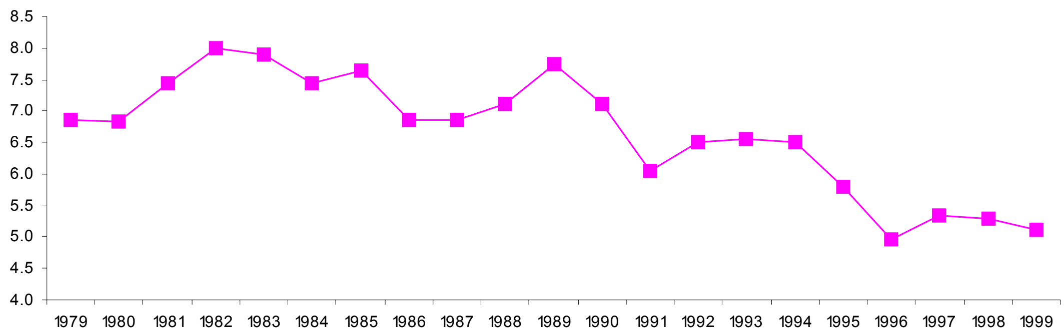
Figure 3. Development of livestock cattle in the Netherlands



The number of suckler cows in the EU15 strongly increased in the period 1990-93, which meant an important compensation for the decrease in dairy cow numbers. This decrease was an influence of both the introduction of the dairy quota and an increase of the yield per cow, while the higher suckler cow premium payments under the Mac Sharry reforms seemed to be another important factor. Since 1993, the number of granted cow premiums has been quoted on base of the number of suckler cows in a particular reference year. To receive a higher quota, the member states already increased their stocks in the reference year 1992. Two third of the EU suckler herd is concentrated in France, UK and Spain, while the dairy herd is more evenly spread between the member states. About 65% of the suckler herd is kept in less favoured areas.

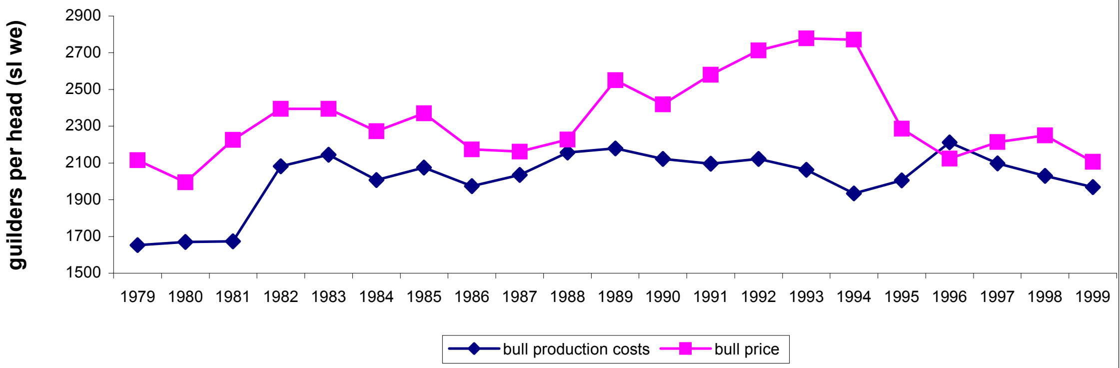
CAP reforms have influenced the holding structure in the Netherlands as well. Number of dairy enterprises declined with almost 30% during the 90s, but cows per holding grew with 14%. Compared with 1984, the Dutch dairy stock was 37% lower in 1999, while the suckler cow herd more than tripled. Nevertheless, Dutch beef production has remained narrowly related with dairy production because two third is still depending on the slaughtering of dairy cows. Little information is available on the specific farm structure of female beef cattle as this category is a by-product of dairy farming not only in terms of (dairy) animal origin but also because most of it is fattened there. On the other hand, despite the average number of suckler cows per holding is less than 10, this category has been useful to exploit the excess supply of roughage feed from dairy farming. Figure 4 shows a pluriannual cycle for the slaughtering price of cows, which is more or less opposite to the beef supply cycle.

Figure 4. Price cows for slaughtering (guilders per kg) in the Netherlands, 1979-1999



For most EU bull enterprises the higher premium payments would probably be enough to compensate the lower beef price under the CAP reforms. These enterprises are not restricted by the requirements on stock density and the maximum number of bull for which a premium could be received. On the other hand, for the specialized bull enterprises in the Netherlands (5% of all enterprises with bulls, which produces the half of Dutch bulls) the high stock density standards, the ceiling on granted premium, and the lower intervention price set income under pressure. Most Dutch cattle enterprises, however, have a limited bull herd and contribute for a relatively small part to beef production. Despite the 80% incline of the bull herd in the period 1984-1995, bull farming is a by-product of dairy farming as well (one third of bulls is produced on such enterprises). From year to year, returns from this type of farming can strongly fluctuate in terms of prices, feed prices and calf price. Profitability of the sector tended to decline in the nineties, which brought the continuation of bull beef farming under pressure (figure 5).

Figure 5. Returns and production costs of bull farming in the Netherlands, 1979-1999

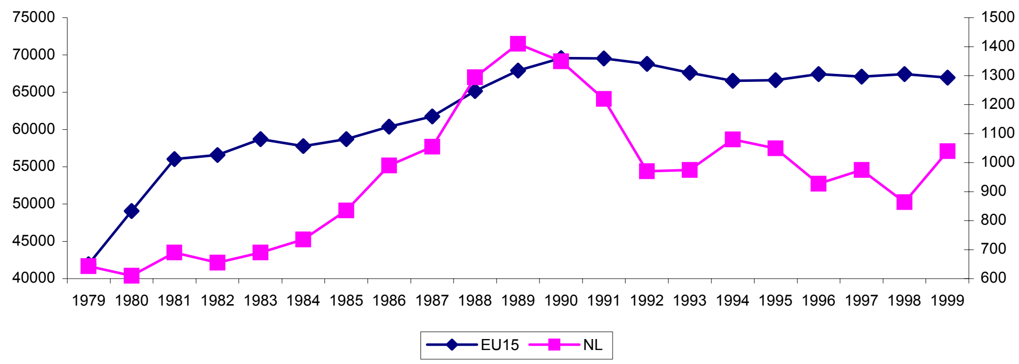


Since 1995, returns have fallen due to impact of BSE en FMD crises. Holdings with bulls declined with 46% from 18,000 in 1990 to 9,700 in 2000, which followed the development in the number of bull herd (CBS, 2000). All to all, shares of suckler cows and bulls in total cattle livestock are still not more than respectively 4% and 6% in 2000. At the end of the nineties, the Netherlands contributed just 4% to the EU beef production of 7.5 mio tonne.

3.2 Sheep meat farming

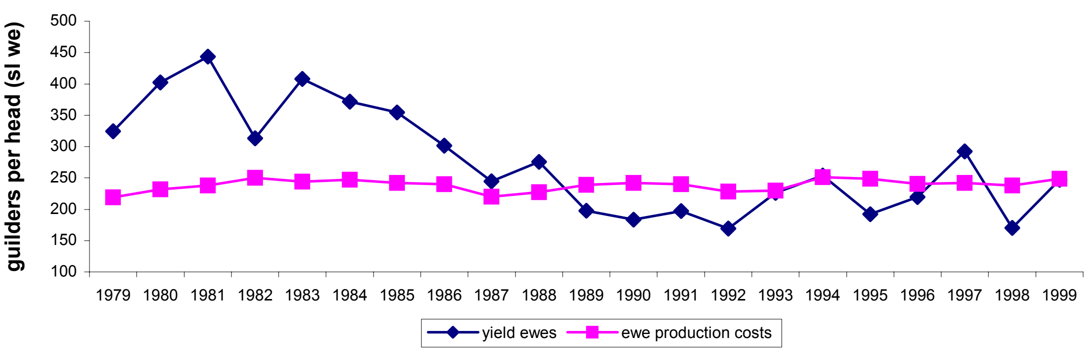
Number of ewes in the EU15 and the Netherlands strongly increased in the period 1984-99 with respectively 16 en 40 per cent. After introduction of the dairy quota, ewe holding became a substitute for grazing land (figure 6).

Figure 6. Ewes stock (1.000 head) in the EU15 and the Netherlands, 1979-1999



Dutch ewe production especially inclined after 1984, resulting in a 70 per cent higher stock level in 1999. So far, the Netherlands has contributed not more than 1.5% to EU15 ewe production. In general, holdings with sheep have a mixed production structure in which the sheep production plays just a small role. The number of holdings with sheep declined from 25,000 in 1990 to 16,800 in 2001 (3,5% per year). More than half of these holdings kept less than 25 sheep, while the 7,500 holdings with more than 25 sheep together had 83% of the sheep herd. Figure 7 outlines the development in profitability for Dutch ewe production in the period 1979-1999. Similar to bull beef farming, the pattern of ewe production costs is relatively stable compared to its return pattern.

Figure 7. Returns and production costs of ewe farming in the Netherlands, 1979-1999



4. Modelling the Dutch beef and ewe stock

The goal of this section is to model the influence of livestock premium schemes on Dutch livestock production. We have estimated ending stock equations for beef cows, bulls and ewes and have incorporated the policy instruments related to these premium schemes like premium level, quota on premium rights and stock density limits. The estimated models have been based on a theoretical framework provided by microeconomic theory.

4.1 Model specification

The livestock supply (stock) function can be derived from the short-run profit function, which is a solution of the profit maximization problem of the farmer. We assumed that the farmer maximizes the profit from animals breeding subject to some technical restrictions concerning production factors and produced output. One of the production factors is a size (beginning stock) of breeding herd, because the bred animals can be used for slaughter or retained for further production. The beginning stock is a sluggish production factor, because it is a subject of the availability constraint. Therefore, the farmer's profit function is a short-run function[3] and the resulting livestock supply (stock) is depending on the livestock price, prices of production factors and the beginning stock of the breeding herd. The policy instruments related to the premium schemes enter to this function in order to explain both the additional payments made to farmers and the restrictions connected with these payments. As mentioned in section 2, the introduction of the milk quota in 1984 has resulted in a tripling of beef cows in 1999. Bull production almost doubled in the period 1984-1995, but suffered from BSE crises in the years after 1995. At last, the ewe stock increased by 40% because the holding of ewes became a good substitute for cows on the grazing land. Therefore, we introduced a dummy variable (equal to 1 in the milk quota period) to all stock equations.

There are some differences in the final specification of stock equations for particular animal types caused by specific characteristics of production processes and availability of data. Usually, the profitability of livestock production is explaining the animal stock which is measured by a price to cost relation for a particular animal type. Because these production costs for beef cows were not available, we used a milk production cost variable as proxy. Under a dairy quota regime, dairy cows production can be easily replaced by beef cows production. Therefore, we introduced a change of the milk quota level per dairy cow as measure of this substitution. The dummy variable for 1984 explains a "pre-quota introduction shock". Finally, the beef cows equation is specified as follows:

$$\begin{aligned}LOG(BECOES) = {} & C(1)*LOG(BECOES(-1))+C(2)*LOG(BECOPR/MILKCK) \\ & + C(3)*SUCOPE+C(4)*ANIMDERA+C(5)*(SUCOPE/SUCOQU) \\ & +C(6)*D(MILKQU/DACOBS)+C(7)*DUM8500+C(8)*DUM1984\end{aligned}$$

where:

C(i)	- parameters of the equation
BECOES	- beef cows ending stock (1000 heads)
BECOPR	- price for cows for slaughtering (guilders per kilogram)
MILKCK	- proxy for suckler cow costs
SUCOPE	- suckler cow premium (guilders per head)

[3] To use the long-run cost function, two prices of the breeding herd should be distinguished: price of the breeding herd as a final product and price of the breeding herd as a production factor. Lack of data availability makes such a distinction hardly possible.

ANIMDERA - animal density ratio equal to 0 before 1993 and to observed stock density divided by stock density limit after 1993
SUCOQU - suckler cow quota[4] (1000 heads)
MILKQU - milk quota (1000 tons)
DACOBS - dairy cows beginning stock (1000 heads)
DUM8500 - dummy variable equal to 1 for the milk quota period (1985 -2000)
DUM1984 - dummy variable equal to 1 for 1984.

The bulls equation includes a 3-year lagged dairy and beef cows herd to measure the inflow of new bulls to the herd. The equation for bulls has the form:

LOG(BULLES) = C(1)*LOG((DACOES(-3)+BECOES(-3)))+C(2)*LOG(BULLES(-1))
+C(3)*LOG(BULLPH/BULLCH)+C(4)*BULLPE+C(5)*ANIMDERA
+C(6)*(BULLPE/BULLQU)+C(7)*DUM8500

where:
BULLES - bulls ending stock (1000 heads)
DACOES - dairy cows ending stock (1000 heads)
BECOES - beef cows ending stock (1000 heads)
BULLPH - bull price (guilders per head, slaughtering weight)
BULLCH - bull production cost (guilders per head, slaughtering weight)
BULLPE - bull premium (guilders per head)
BULLQU - bulls quota[5] (1000 heads)

Finally, the stock equation for ewes is specified as follows:

LOG(EWESES) = C(1)+C(2)*LOG(EWESES(-1))+C(3)*LOG(EWESYI/EWESCH)
+C(4)*EWESPE+C(5)*ANIMDERA+C(6)*DUM8500
+C(7)*D(MILKQU/DACOBS)+C(8)*DUM1992
where:
EWESES - ewes ending stock (1000 heads)
EWESYI - yield from ewes production[6] (guilders per head)
EWESCH - ewe production cost (guilders per head)
EWESPE - ewe premium (guilders per head)
DUM1992 - dummy variable equal to 1 for 1992.

Similarly to the beef cows equation, we explained the ewes stock by a change of the milk quota level per dairy cow because the holding of ewes became a substitute of cows for the grazing land after milk quota introduction. The dummy variable for 1992 explains the "pre-MacSharry reform shock".

4.2 Estimation results

To estimate the stock equations, data from different sources have been collected and a database has been constructed. We have collected data for the years 1973 - 2000, using the

[4] There was no quota limit before 1993. Therefore, we assumed "infinite quota" before 1993 and we used a large number as a proxy variable.
[5] See footnote 4.
[6] Yield from ewes production is equal to a lamb price (guilder per kilogram of slauthering weight) times lamb slaughtering weight times number of lambs per ewe per year.

EUROSTAT's New Cronos databases of agricultural data, various issues of "Agricultural and Horticultural Figures" (CBS, LEI) and various issues of "Agricultural Situation in the EU" (European Commission). Equations have been estimated and tested using EViews 4.0 package. The estimation results are presented in table 1[7].

Table 1. Estimation results

Dependent Variable: LOG(BECOES), Sample(adjusted): 1980 1999, Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(BECOES(-1))	0.787431	0.059271	13.28536	0.0000
LOG(BECOPR/MILKCK)	0.299524	0.112915	2.652652	0.0211
SUCOPE	0.001022	0.000576	1.773849	0.1014
ANIMDERA	-0.096122	0.151017	-0.636495	0.5364
SUCOPE/SUCOQU	-0.030393	0.064485	-0.471323	0.6459
D(MILKQU/DACOBS)	-0.068444	0.009867	-6.936831	0.0000
DUM8500	0.477229	0.083707	5.701157	0.0001
DUM1984	0.357869	0.047272	7.570451	0.0000
R-squared	0.987402	Durbin-Watson stat		1.826742

Dependent Variable: LOG(BULLES), Sample(adjusted): 1977 1999, Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG((DACOES(-3) +BECOES(-3)))	0.439841	0.076659	5.737646	0.0001
LOG(BULLES(-1))	0.251014	0.131211	1.913050	0.0799
LOG(BULLPH/BULLCH)	0.779642	0.130124	5.991524	0.0001
BULLPE	0.003129	0.000767	4.079260	0.0015
ANIMDERA	-0.133433	0.143749	-0.928239	0.3716
BULLPE/BULLQU	-0.273145	0.088020	-3.103202	0.0091
DUM8500	0.173540	0.056326	3.080973	0.0095
R-squared	0.913537	Durbin-Watson stat		1.767296

Dependent Variable: LOG(EWESES), Sample(adjusted): 1974 1999, Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.433059	1.315534	1.089336	0.2904
LOG(EWESES(-1))	0.760952	0.195976	3.882882	0.0011
LOG(EWESYI/EWESCH)	0.221292	0.130063	1.701414	0.1061
EWESPE	0.001604	0.000669	2.398342	0.0275
ANIMDERA	-0.060843	0.050370	-1.207935	0.2427
DUM8500	0.229274	0.080479	2.848866	0.0107
D(MILKQU/DACOBS)	-0.022076	0.010702	-2.062824	0.0539
DUM1992	-0.215520	0.036469	-5.909680	0.0000
R-squared	0.956897	Durbin-Watson stat		1.841216

Most policy related variables have significantly influenced animal stocks. On the contrary, the stock density ratio (ANIMDERA) is hardly significant in the estimated equations (significance levels lies between 25% for ewes and 65% for beef cows). A possible explanation could be that the stock density limit is calculated on the farm level in practice, whilst we have used the macro levels in the equations. On the macro level the stock density is only 15-20% higher than the stock density limit, while higher differences can be observed on farm level. In addition, the quota on premium rights for suckler cows (that enters the equation via SUCOPE/SUCOQU) is hardly significant (53% significance level). Suckler cows

[7] See appendix for models validation.

breeding is not a widespread production in the Netherlands, which takes shape in a breeding herd lower than the quota limit. This could explain the low significance of the quota variable. On the other hand, the existence of such a quota might be a factor as it is limiting the growth on suckler cow production in the Netherlands.

4.3 Impact of animal premium schemes

To compare the impacts of the animal premium schemes on the animal stocks, we have calculated elasticities for animal stock in respect to policy variables (see figures 8, 9 and 10).

Figure 8. Elsticity of beef cows ending stock in respect of policy variables

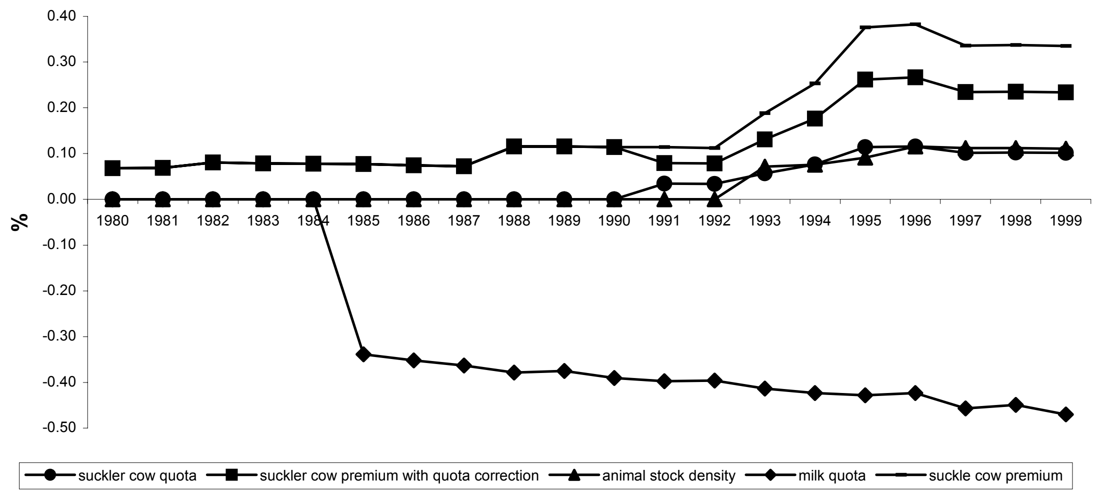
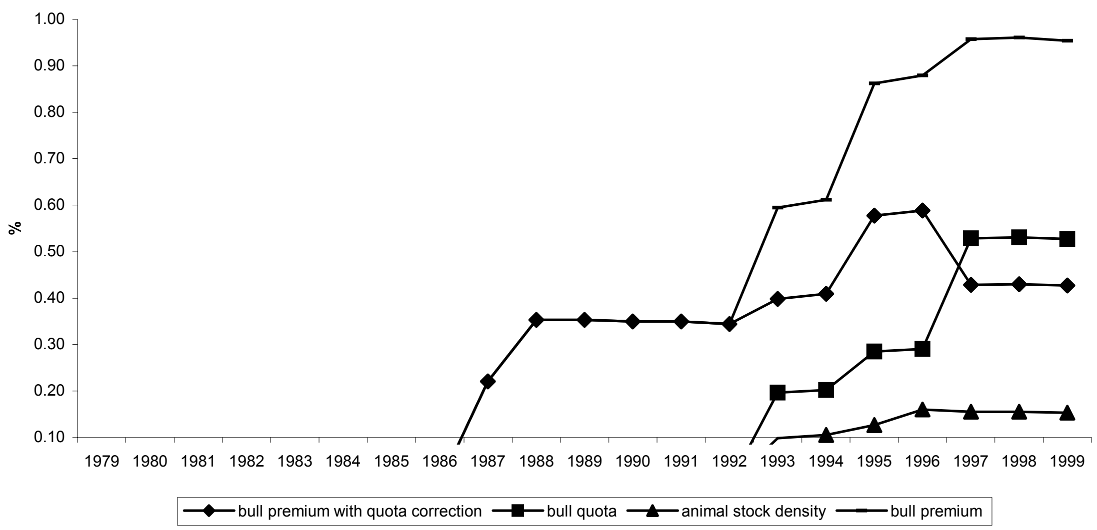
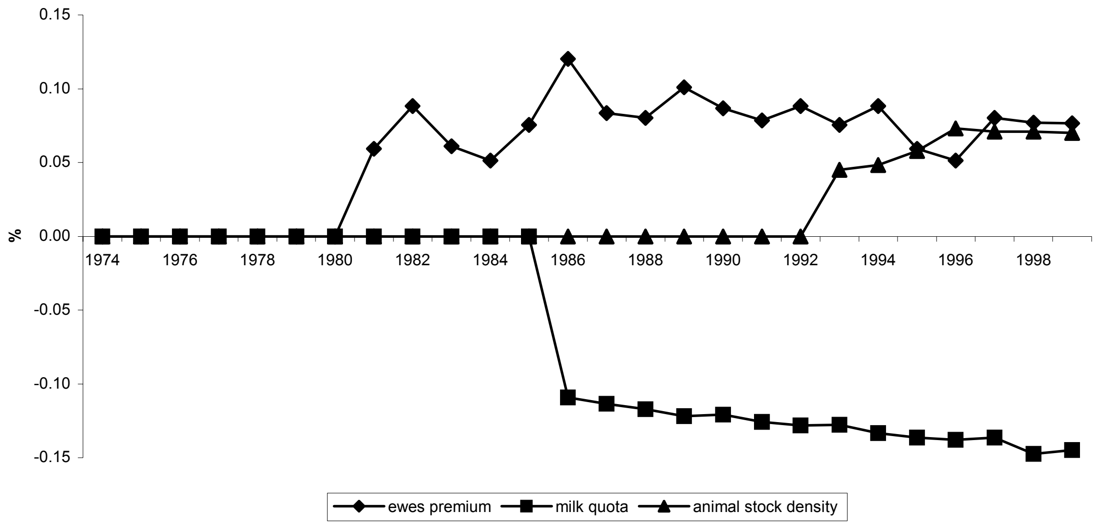


Figure 9. Elasticities of bulls ending stock in respect of policy variables



They indicate that the livestock premium has the biggest impact on bulls production, but the lowest on ewes production. The impact of the premium on bulls production, however, is considerably (two times) lowered by the quota limit. The influence of suckler cows quota on suckler cows production is much lower compared with the impact of bulls quota. The stock

Figure 10. Elsticity of ewes ending stock in respect of policy variables



density limit influences animal production similarly for all types. At last, a decline in milk quota has a positive impact on both suckler cows and ewes production[8]. The dairy quota elasticity is three times higher for beef cows than for ewes since the beef cows production is a 'closer' substitute for dairy production in comparison with ewes.

Further, we have examined the 'responsibility'[9] of particular policy variables for the animal stock level (see figures 11, 12 and 13). We concluded the following:

- since 1988, premium schemes and milk quota regime have been responsible for 60% of the beef cows herd, 30% of the bulls herd, and 40% of the ewes herd;
- since 1985 the milk quota has been the most important factor for stimulating beef cows and ewes production. It has been responsible for about 30% of the beef cows stock and 20% of the ewes stock, but for only 13% of the bulls production;
- premium payments are highly and increasingly affecting bulls production, because they deliver additional sources to the relatively low profitability of the Dutch bull sector. Their responsibility rose from18% of bulls stock in 1987, to 46% in 1993, and to almost 80% at the end of the 90s. The premium level for beef cows is responsible for 7% of the stock in 1980, and 22% in 1999. The impact of the premium level on the ewes herd is stable at 10% of the herd;
- since 1993 quota on premium rights and stock density limit have reduced the net impact of premium payments on bulls production to 30% of the bulls herd. Their negative impacts are with 14% and 6% on respectively beef cows and ewes much lower than for bulls;
- premium schemes also influence the animal stock via a lagged stock variable, which enters all stock equations. Since 1988 this lagged effect has been relatively high for beef cows and ewes stock with shares of respectively 20% and 10-15%. Share for bulls is lower than 6%, which is caused by the low regression coefficient for a lagged bulls stock in the bull equation.

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[8] The dairy quota abolition is not analyzed here. It influences also bulls production via a dummy (DUMM8500) variable.

[9] To compute the 'responsibility' of a particular policy variable for the animal stock we calculated the difference between the observed animal stock and the theoretical animal stock obtained from estimated equations under the assumption that no policy measures are applied to the animal sector. The total 'responsibility' of policy variables is proportionally divided on different policy instruments. Since the total 'responsibility' of policy variables can be calculated as $\Sigma_i C(i)X(i)$ where C(i) are model parameters and X(i) are the policy instruments then the share of the instrument "i" is given by $C(i)X(i)/\Sigma_i C(i)X(i)$.

Figure 11. Influence of policy variables on beef cows ending stock

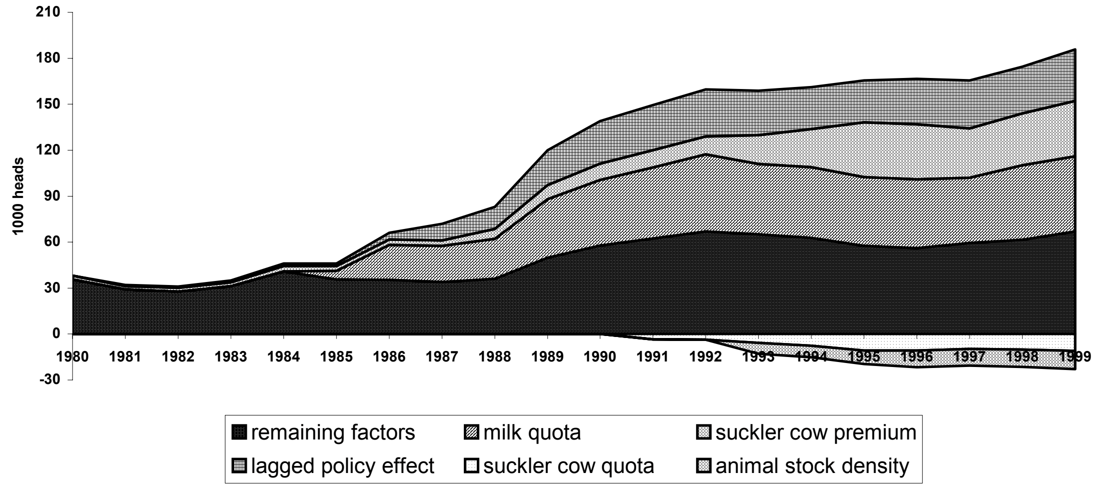


Figure 12. Influence of policy variables on bulls ending stock

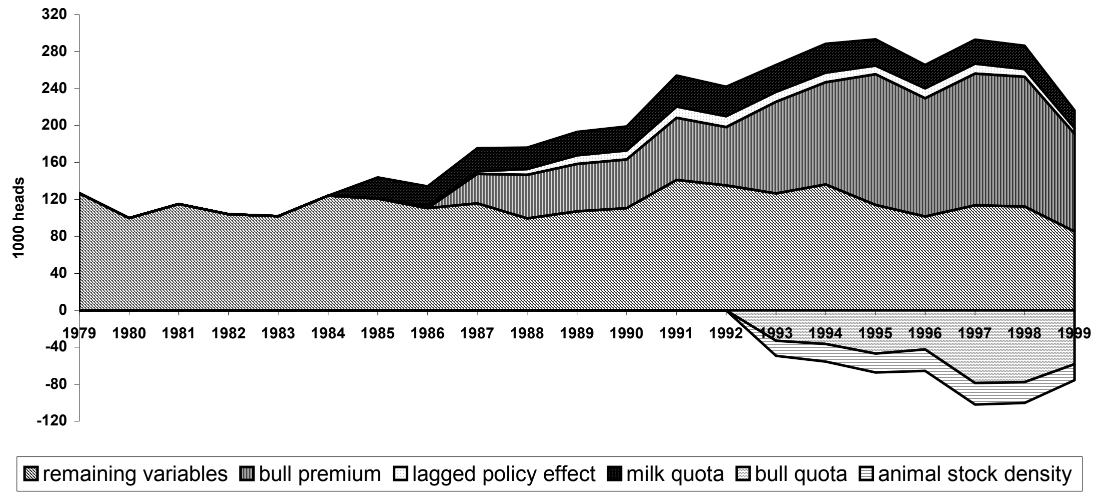
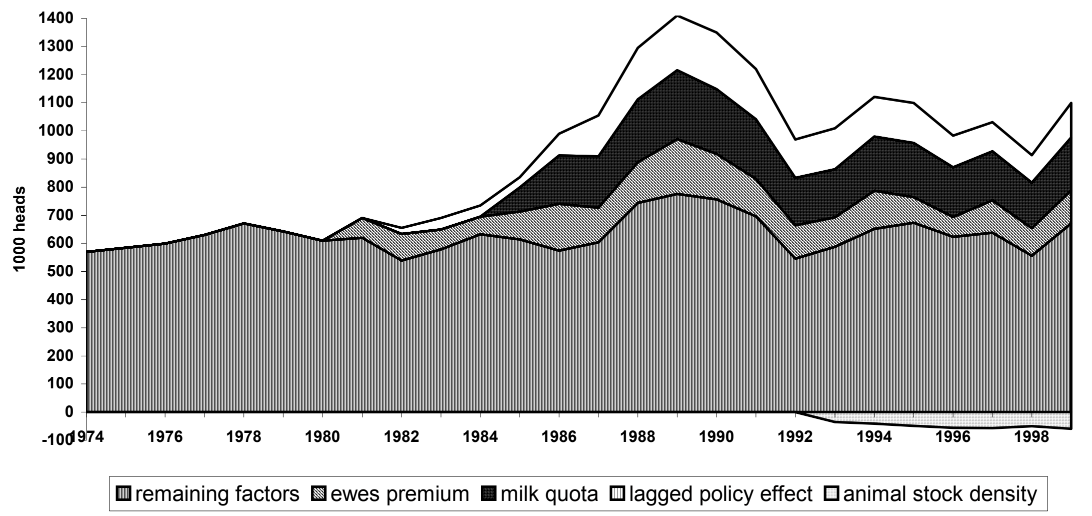


Figure 13. Influence of policy variables on ewes ending stock

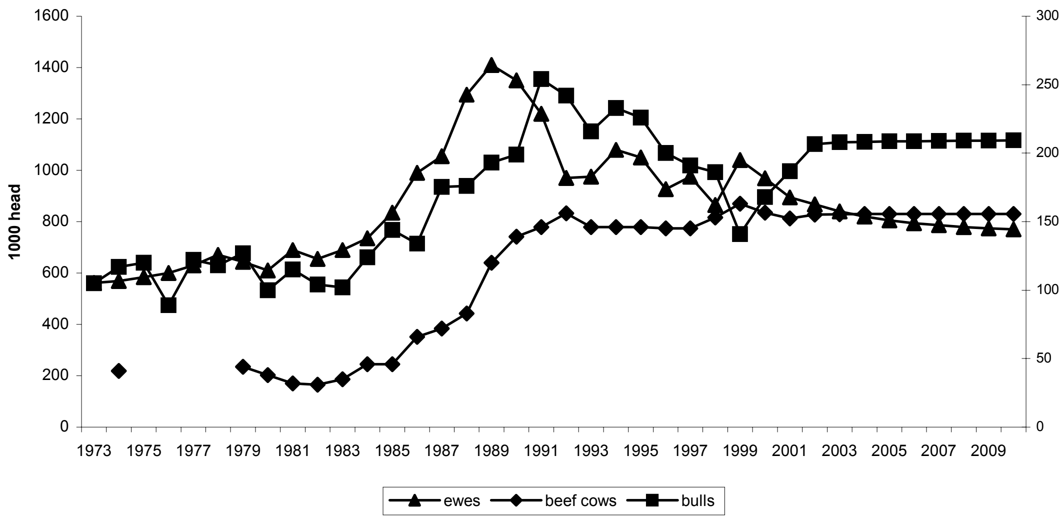


4.4 Prospects for Dutch beef and ewe stock after 2000

There is consensus that the Agenda 2000 measures will have a significant effect on the EU beef sector. Reduced market prices and changes in the SCP system are expected to outweigh the increase in direct payments to the beef sector and result in a slight decline in beef production. The fall in market prices is foreseen to boost consumption levels compared with production quantity, which will lead to a significant reduction in stock levels. The dairy sector is assumed to be an important influence on the post-Agenda 2000 beef sector. FAPRI has forecasted that a decrease in dairy cows of 10.5% by 2010 would be larger than the 3.2% drop in the suckler cow herd. This would in turn limit calf supplies and lead to a drop in animal availability of 6.3%. Combined with an incline in slaughter weight of 1.2%, the total beef production is expected to fall by 4.4% in 2010 compared with 2000. Beef domestic consumption will however benefit from the fall in domestic prices by 12.5% and will decline by only 4.0% relative to 2000 level to reach 18.1 kilograms per head. Since production will decrease more than consumption the total exports will be well below the Uruguay Round limits and beef intervention stocks would thus disappear by 2007.

To forecast the Agenda 2000 impacts on the Dutch beef and ewe stock up to 2010, we have used the estimated equations. We have assumed that stock profitability will remain unchanged after 2000, and that milk production per cow will yearly rise with 2%[10]. The Agenda 2000 reforms concerning premium payments, stock density limits and quota rights have already been described in section 2. The forecasted animal stocks are presented below (figure 14).

Figure 14. Observed and forecasted (since 2000) animal stockimal stock



According to our forecasts, Dutch suckler cow production will decrease less than the corresponding EU production. At the same time bulls stock will increase by 25% compared to 2000, but the herd will still be 7.5% lower than in the pre-BSE year 1995. The increase in bulls production is an effect of the higher bull premium payments. Impacts of the higher suckler cow premium on the suckler cow stock will be lower for two reasons. First, suckler cows production is less affected by premium level than bulls production (see estimation results in section 4.2). Second, the milk quota per dairy cow will increase as a result of higher quota level and productivity growth.

[10] This is the average increase of Dutch milk production per cow in the nineties.

For 2010, FAPRI has forecasted a 1.4% reduction of ewes production in comparison with 2000. According to our forecasts, Dutch ewes production will decrease by 20.5% in the same period and will reach the 1984-1985 levels. Future ewes premium payments will be insufficient to reverse the decreasing trend in ewes production since 1989 due to a fall in ewes production profitability. Price-cost relation of ewes production went down from 1.86 in 1981 to 0.75 in 2000.

5. Conclusions

This paper examined the influence of animal premiums under the CAP beef and ewe regime on beef and sheep meat farming in the Netherlands. On the basis of econometric models the impacts of the different policy instruments on the stocks have been decomposed. We found that changes in the dairy quota influenced the Dutch beef cow and ewe stock more than in premium payment level. On the other hand, premium level was increasingly influencing the bull stock as it provided the Dutch bull farmers with some highly necessary additional funds. Then, requirements on stock density limits and the maximum number of granted premium reduced again a major part of the initially positive premium impacts. These second order effects did less bother the average EU bull farmer due to his more extensive production circumstances.

The Agenda 2000 measures will negatively influence the suckler cow and ewes stock, but will have a positive impact on Dutch bull production up to 2010. For policy makers, the study gives insight in the effectiveness of animal premium instruments under the CAP regime to manipulate livestock production. For Dutch farmers, the study offers information to what extent instruments might influence the decision to incline or reduce their stocks.

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Appendix: model validation

Table 2. DF co-integration test

	DF Test Statistic*	1% Critical Value
Beef cows	-4.172075	-2.7057
Bulls	-4.588108	-2.7275
Ewes	-4.613114	-2.6649

Before estimating the stock equations, we examined whether the time series under consideration are individually non-stationary. The ADF tests results of each series strongly suggest that all variables are non-stationary in levels but are stationary in the first differences at 99% of significance level see. Therefore the condition necessary to estimate the co-integration relationship for these variables is met.

Next, the stock equations have been estimated and co-integration between the variables has been tested. Overall, the estimation results are satisfactory (see table 1 in the main text). The models fit the data quite good with an R^2 close to 0.99 for beef cows, 0.91 for bulls and close to 0.96 for ewes. All coefficients have the hypothesized sign and most of parameters significantly differ from zero at the significance level lower than 10%.

Table 3. Ramsey RESET Test*

Beef cows			
F-statistic	0.014662	Probability	0.905805
Log likelihood ratio	0.026641	Probability	0.870344
Bulls			
F-statistic	0.109196	Probability	0.747270
Log likelihood ratio	0.187681	Probability	0.664854
Ewes			
F-statistic	0.444465	Probability	0.513922
Log likelihood ratio	0.671034	Probability	0.412691

*One fitted term

Since there are lagged dependent variables on the right-hand side of each regression, the DW test for autocorrelation is no longer valid. Therefore, we have computed the Q-statistic, which does not reject the hypothesis of no serial correlation up to order three. This result is confirmed by the DF test for co-integration (see table 2). It rejects the hypothesis of no co-integration at a 99% significance level.

The computed Jarque-Bera statistic, which is equal to 0.23, 0.35 and 0.45 for respectively beef cows, bulls and ewes, does not lead to a rejection of null hypothesis of a normal distribution of residuals.

Specification errors and parameters stability have been tested using the RESET and CUSUM tests respectively (see table 3 and figure 15). According to test results in the following tables, the models have been correctly specified and their parameters are stable.

Figure 15. CUSUM tests