STRUCTURAL CHANGE IN EUROPEAN CALF MARKETS:

POLICY DECOUPLING AND MOVEMENT RESTRICTIONS

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Abstract: We analyse weekly calf prices from 2003 to 2009 to assess the impact of two important events which changed the structure of European cattle markets. We find the four European calf markets studied to be integrated. The decoupling of farm payments in the framework of the 2003 reforms of the Common Agricultural Policy is found to reduce prices. We ascertain that the outbreak of the Blue Tongue disease induced a structural change in some of the markets. Using counterfactual scenarios, we provide an indication of the effects resulting from granting member states a high degree of discretion in implementation.

Keywords: 2003 CAP reform, cattle market, decoupling, European Union, market integration.

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1 INTRODUCTION

Reforming the European Union's (EU) Common Agricultural Policy (CAP) has been an ongoing process. The first major effort was the MacSharry reform of 1992. This was followed by Agenda 2000 and its mid-term review, which was eventually repackaged into the fundamental Fischler reforms of 2003. A key element of the 2003 reforms was decoupling, which aimed to sever the link between direct payments and production decisions. Unlike previous reforms, member states were allowed discretion over the timing and degree of decoupling. While differential implementation decisions were granted in almost all major European agricultural subsectors, they were most strongly apparent in the cattle sector of the Union. Since payments were no longer tied to the amount of slaughtered animals, decoupling impacted beef production profitability as different production incentives were provided. This transmitted to the calf markets in the form of a reduced willingness to pay for calves used in beef or veal production, thus affecting the quantities and prices animals traded. As the heterogeneity in the implementation can be expected to influence the relationships of prices in space, important implications for market integration are likely. In this paper, we seek to empirically explore how different policy choices impacted spatial price relationships and the integration of national calf markets. Furthermore, European cattle markets were subject to restrictions on animal transports which resulted from battling the outbreak of the Blue Tongue (BT) disease from 2006 onwards. Hence, we also regard potential effects of such trade restrictions, which peaked in Central Europe in late summer 2007.

Within a multivariate cointegration framework, we use weekly price data from 2003 to 2009 to assess interdependencies among the four national EU calf markets of France, Germany, the Netherlands and Spain. While a large number of market integration studies have been carried out on U.S. and international agricultural markets, few have studied intra-EU price relations (Zanias, 1993; Gordon *et al.*, 1993; and Serra *et al.*, 2006 are among the exceptions). We know of no recent investigation of spatial price relationships among EU calf markets. Given the unique treatment of the cattle sector in the 2003 reforms, we are presented with an interesting situation for the study of how a changed policy environment impacted spatial price relationships. To our knowledge, we are the first to empirically assess the effects of policy decoupling in this area of research.

The assessment of market integration represents an important means to study spatial market networks. The main interest lies in the question of whether price shocks emerged in one of the markets are passed to the other ones so that trade flows which counteract the initial shock are triggered. Furthermore, consequences for consumers or producers are also of interest. If markets are not integrated, they do not share the same information set, in the sense that they are not driven by one common“pushing force” (Juselius, 2008: 88). In this case, price signals are not effectively passed through. Even if markets are integrated, price signals may spread only very slowly. Thus, since economic agents do not have complete information, welfare losses can result from the inefficient allocation of resources. Lacking integration of markets or weak transmission of price signals among them may be due to trade or domestic policies, exchange rate rigidities, or transactions costs. If the causes of these impairments are known, actions can be taken to improve the relationships of markets across space. Hence, the results can aid in the design of regional policy or trade policy. Moreover, evidence of well-functioning markets can help traders or policy makers in their markets assessments. On the other hand, policy makers and economists have strong interests in assessing the effects of certain policy measures in order to evaluate whether the actions adopted led to the desired consequences.

Market relationships can change due to major external shocks. In this context, the BT disease, which was first detected in Northern latitudes in August 2006, greatly impacted European cattle markets. The sample period studied covers the outbreak of the disease which falls near its midpoint. Hence, the time series analyzed are likely to contain structural breaks. Under such circumstances, standard unit root and cointegration tests are misleading. They inflate test statistics and suffer from considerable losses of power (Aparicio *et al.*, 2006, and Gregory and Hansen, 1996). Consequently, we assess the time series data properties with a recently developed unit root test which is robust to potential structural breaks. We further seek to identify and to account for breaks in the cointegration relationships. The empirical results provide evidence that BT caused a structural break.

In the upcoming section, the data is described. The post-2003 EU policy environment is elaborated upon since some of the variables of the analysis are constructed in order to quantify these policies. We go further to present the methodology employed to assess market integration and price transmission. We examine the EU slaughter calf market with the outlined methodology and discuss the empirical findings in detail. Finally we provide conclusions and policy implications.

2 THE DATA AND POLICY ENVIRONMENT

We use weekly post-2003 CAP reform data to investigate the dynamics and interrelationships in four major EU live calf marketswhich are Germany (DE), France (FR), the Netherlands (NL) and Spain (ES) (Figure 1). This choice of countries is mainly motivated by their role in the EU calf trade. The Netherlands and Spain are the largest importers while Germany is large net exporter. France as the largest exporter acts also as the fourth largest importer (ZMP, 2009a, 2009b).

The sample includes prices of young male calves aged eight days to four weeks from week 20 of 2003 to week 17 of 2009, i.e., 310 observations from May 15, 2003, to April 30, 2009. The data are collected by each member state and transmitted to the European Commission (European Commission, 2002). The prices used are representative averages from each country's regions weighed by the relative importance of each breed and quality. While we assume commodity homogeneity in the analysis, we recognize that different breeds and animal types exist among countries. However, animal numbers data suggest that the mixture of animals in each country has remained constant over the sample period. Next, we describe the construction of the two important variables which are designed to quantify the decoupling policies and the appearance of BT.

------------------------------------ Figure 1 about here ------------------------------------

2.1 Policy variables

The 2003 reforms in the cattle market eliminated the link between headage and payments; it was replaced with a single farm payment (SFP) which was based on historical entitlements between 2000 and 2002. While the aim of the reform was decoupling, individual member states had the option to either fully or partially decouple payments. If the SFP was partially implemented, farmers could apply for various slaughter premia: steers 150€ (up to two payments), bulls 210€, adult animals 80€ and calves 50€ per animal.

The number of animals of each category receiving slaughter premia each year is reported by the European Commission (2009b). Using the values of the headage premia reported above, total annual monetary payments are computed for each country. Based on these numbers, we construct three policy indices pol_{DE}, pol_{FR} and pol_{NL} reflecting the degree of decoupling in Germany, France and the Netherlands, respectively[1] (Table 1). The variables are constructed for each year between 2005 and 2009, relative to the average coupled payments in the base period 2002-2004. They are calculated for country *Z* and year *t* according to the formula

$$pol_Z^t = \frac{1-premia\ payed\ by\ Z\ in\ t}{average\ premia\ payed\ by\ Z\ in\ base\ period} \qquad (1)$$

such that the closer the index value to 100, the higher the degree of decoupling, that is, 0 and 100 mean fully coupled and fully decoupled, respectively.

------------------------------------- **Table 1 about here** -------------------------------------

The SFP was implemented in Germany in 2005, while France, Spain and the Netherlands started one year later. Germany chose to fully decoupled payments in 2005 already. France and Spain partially decoupled in 2006 while the Netherlands decoupled payments also in the same year, but to a much limited extent. Slaughter premia for calves and adult animals partially remained in France, Spain and the Netherlands, whereas in Germany they were included in the SFP. As noted earlier, these different approaches are likely to yield different production incentives, since payments are differently linked to the production of beef in different countries.

Economic theory suggests an inverse relationship between decoupling and calf prices. Beef production can be thought of as a function of a number of inputs, including young calves. The demand for calves is given by the marginal value product of calves in beef production. The headage premia is paid to the company delivering the cattle to the slaughterhouse, i.e. in most cases the cattle farmer or fattener. Since the premia used to be coupled to production; the premia shifts the demand for calves, as an input, outward. If the premia are reduced or eliminated, the derived factor demand curve for calves shifts downward due to a reduction in the marginal value product of an additional calf[2]. If the marginal cost of calf production does not change, the price of calves will fall. Thus, we expect a *negative* effect of the decoupling in a country to be reflected in its equilibrium price for calves.

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[1] We use the pol_{FR} variable for both French and Spanish policies since both countries adopted virtually the same policy. For 2008 and 2009, no expenditure figures were available. Thus, we were forced to find a pragmatic approach for extrapolation because some variability in the policy variables is needed in order to avoid perfect multicollinearity. Animal numbers receiving premia are extrapolated by drawing from a normal distribution with mean and standard deviation of the animal numbers of 2006 and 2007. We are aware that the chosen approach is rough. However, it suffices to meet the targets of giving meaningful estimates and allows for some variability in the animal numbers, which are known to closely resemble the numbers for the two previous years, but are not identical.

[2] The approximate portion between 2002and 2004 of the monetary value of the total headage premium going to young calves isin Germany 2 percent, in France10 percent, in Spain1 percent and in the Netherlands 20 percent. Source: European Commission (2009b).

2.2 The Blue Tongue outbreak in Central Europe

Non-policy shocks can also impact market relationships. BT is a seasonal non-contagious viral disease of ruminants mainly transmitted by a midge species that can cause mouth ulcers and in some cases a "blue tongue" in the animal (Conraths *et al.*, 2009). It is prevalent in Sub-Saharan Africa, but has also been observed for many decades in the Mediterranean region. With global warming, the disease spread northward and was first detected in Central Europe, specifically, the Southwest of the Netherlands in August 2006. It rapidly spread into the neighbouring countries, and, in 2007, to the UK. The disease occurs in various versions (serotypes). Serotype 8 was the version of BT which first occurred in Central Europe. Other serotypes spread in the following months.

Although the number of animals infected with BT serotype 8 in Central Europe remained low in 2006, it became an important topic in the media. In August 2007 a massive outbreak was recorded in Germany, France and the Netherlands (Conraths *et al.*, 2009). Subsequently, the number of cases in Germany and the Netherlands declined due to the introduction of vaccination programs from 2008 onwards. Before January 2008, Spanish cattle were only infected with BT serotype 1; but later serotype 8 began to spread from the Southwest of France into the Northeast of the country.

Although fatality rates due to the disease are low for cattle, it has important consequences for the milk and cattle sectors. It reduces dairy milk yields by up to 50 percent and the fertility of cows. Due to its potentially severe consequences for cattle, severe implications of the disease for calf prices can be expected. Table 2 shows the means and standard deviations of prices before and after the peak outbreak of BT in August 2007. It is clear that both the means and standard deviations of prices were considerably lower in the period after than before.

------------------------------------- Table 2 about here -------------------------------------

In an effort to control the spread of BT across the Union, the Commission adopted strict control measures which included vaccinations and restrictions on the movement of cattle, sheep and goats (European Commission, 2007). When a confirmed case is identified, restriction and surveillance zones with radii of 100 and 150 km, respectively, are established (European Commission, 2000). Movement of animals out of the restricted zones is not allowed. Additionally, national import restrictions were occasionally issued by several member states, e.g., by France and Spain for German exports. However, Germany was able to continue calf export to the Netherlands, the most important destination of German calves. As both countries were subject to restricted zones of the same serotype, no movement restrictions applied and neither side issued national import restrictions.

3 METHODOLOGY AND ECONOMIC BACKGROUND

In order to avoid ambiguities, we elaborate on the notions of market integration and price transmission since they are understood differently in the literature (Fackler and Goodwin, 2001). According to the Law of One Price (LOP), prices of a homogenous commodity in one market can differ by at most the costs τ_t^{XY} of moving them from location X to location Y. This condition is also termed the *spatial arbitrage condition* or the *weak form* of the LOP. If this relationship holds as an equality, then it is referred to as the *strong form* of the LOP, i.e., it holds then

$$p_t^Y - p_t^X = \tau_t^{XY} . \qquad (2)$$

where p_t^X and p_t^Y denotes prices of a homogenous commodity in markets X and Y in time t (Fackler and Goodwin, 2001). Since this notion is a long-run concept, prices can deviate from equality in the short-run due to various sources of shocks. When such a disequilibrium situation occurs, price signals will elicit the movement of products between surplus and deficit markets, thus restoring the long-run equilibrium.

The economic notion of equilibrium can be empirically investigated in the framework of cointegration analysis, where the cointegrating relationship is interpreted as the long-run equilibrium. The existence of such a relationship implies a stationary residual term which is interpreted as the temporary and stochastic deviations from the equilibrium. Hence, such prices show the long-run tendency towards the cointegration relationship, i.e., the series do not drift apartfrom each other. Such behaviour corresponds to the economic understanding of an equilibrium which economic variables are attracted to in the long-run.

If prices are found to be cointegrated, the system can be written as a vector error correction model (VECM) as follows,

$$\Delta p_t = \alpha\beta' p_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta p_{t-i} + \varepsilon_t = \Pi p_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta p_{t-i} + \varepsilon_t \qquad (3)$$

where p_t is a n-dimensional vector of prices of a homogenous product in n spatially spread markets, and $\Delta p_t = p_t - p_{t-1}$. The matrix β of dimension $n \times r$ contains the coefficients of r linear combinations of the prices p_t. These combinations are interpreted as stationary long-run relationships between the prices. α denotes the $n \times r$ loading matrix containing the rates at which the price differences Δp_t react on the deviations from the long-run equilibrium. These deviations, which are induced by short-term shocks to the market system, are quantified by $\beta' p_{t-1}$. The matrix α contains hence relative magnitudes at which the jth, $j = 1,\ldots,r$ disequilibrium is adjusted for by each of the n prices in each period, i.e., the speeds of adjustment. The $n \times n$ matrices Γ_i contain the short-run reactions of the price differences on past differences. ε_t denotes a Gaussian white noise error term of appropriate dimension. Since calf trade among the four countries studied is likely to exhibit complex interdependencies, we adopt a multivariate approach. By considering all price series simultaneously in a single model, we overcome the omitted variable problem typical of pair-wise cointegration studies that have excluded relevant price series and error correction terms.

As mentioned, a common shortcoming in the market integration literature is the inconsistent usage of terminology. Fackler and Goodwin (2001: 978) refer to market integration as "a measure of the expectation of the price transmission ratio". However, Barrett and Li (2002) define the concept as tradability of a commodity as either established by trade flows or the indifference of agents to trade. Our understanding comes closest to the definition of Gonzalez-Rivera and Helfand (2001: 576) who define it as "the set of locations that share both the same commodity and the same long run information". While we see market integration as a dichotomous quantity, price transmission is regarded as a gradual measure. The mere tradability condition does, in our opinion, not suffice to ensure that markets are integrated. For example, the setting in which a state trading agency uses prohibitive border protection measures to disconnect domestic from international markets, while still exporting domestic products, can hardly be viewed as integrated markets.

The theoretical conceptualization we adopt lends itself to a cointegration interpretation. A set of n markets is called integrated if all of them are connected by either direct or indirect trade flows and if they are driven by one and only one common factor implying the existence of $r = n-1$ cointegration relationships (see also Fackler and Goodwin, 2001). In this sense, market integration appears to be a dichotomous measure, that is, either *n-1* long-run relationships exist among *n* markets or not.

While market integration is a long-run concept, price transmission is, in our opinion, best viewed as having both a long- and a short-run dimension. Price transmission in the long-run is quantified by the slope parameters of the prices in a certain cointegration relationship j, $j \in \{1,...,r\}$, i.e., by the jth column of the cointegration matrix β[3]. Hence, long-run price transmission is a gradual measure since the respective β coefficients can take continuous values. The closer the measure is to zero, the weaker is the price transmission in the long run. In the special case in which these coefficients can be restricted to unity, the long-run price transmission is said to be complete. This implies that the price transmission elasticity does not statistically differ from one. Hence, a one percent change in one of the prices leads to a change of the same magnitude in the other price.

The short-run dimension of price transmission refers to the sizes of the parameters in the jth row of the loading matrix α. They quantify the magnitudes to which each of the n prices reacts on the jth disequilibrium relationship from period to period, i.e. the speed of adjustment of a price shock. The sign of the respective parameter in α signals the direction of the adjustment while its absolute magnitude usually lies between 0 and 1. Thus, price transmission in the short-run is also a gradual measure. Even with complete price transmission in the long-run, the short run speed of adjustment may be slow which illustrates that it is important to distinguish between these time horizons. Each of these characteristics describes one aspect of interrelationships of markets in space.

3.1 Design of the model

Based on the above considerations, the final specification of the estimated VECM in (3) includes a number of variables. First, we augment the cointegration space by several variables: a constant, a time trend and the three policy variables pol_{DE}, pol_{FR} and pol_{NL}. Secondly, we include k=2 lags (AIC) of the price differences and a dummy variable for the year 2003 outside the cointegration space. With respect to the latter, there was a dramatic fall in calf prices in all countries during the first year of the sample period as a result of a number of exogenous events in the year 2003. These events include the ten country EU enlargement in early 2004. Another notable event was the response of calf prices to the peak in milk prices in 2002, which encouraged milk production and thus increased calf

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[3] When using logged data, as usually the case, these parameters can be interpreted as long-run price transmission elasticities.

numbers some time after. Additionally, the implementation of the Fischler reforms in each member state was not fully determined in early 2003. Seasonality was also included outside the cointegration space as significant seasonal patterns are suggested by Figure 1. Upon exploring this possibility, a likelihood-ratio test favoured the inclusion of 52 weekly dummies.

4 EMPIRICAL RESULTS

4.1 Unit Root Tests

A major challenge is dealing with potential structural breaks in the univariate series and in the cointegration relationships. In this case, such a break may be due to the occurrence of BT. Standard unit root tests do not yield reliable results in the presence of breaks because their size and/or power are affected. To provide valid inference on the time series properties of the data, we adopt a recently developed unit root test - the forward backward range unit root test (FB-RUR) - proposed by Aparicio *et al.* (2006). This nonparametric test counts the number of range extensions, i.e., the number of cumulative minima and maxima of the mean-adjusted time series. In contrast to a unit-root series , a stationary series is characterized by constant variance. This property translates into the fact that the number of range extensions will be small for a stationary series and large for a nonstationary series. The test statistic is robust to data problems such as structural breaks and outliers. Whenever the test statistic is smaller than the critical value, the null hypothesis of a unit root is rejected.

Table 3 shows that all series, except the Dutch series, exhibit a unit root. Although the Dutch series is found to be stationary, we regard it as nonstationary as recommended by Juselius (2008: 20)[4].

------------------------------------- Table 3 about here -------------------------------------

4.2 Cointegration Tests

As mentioned above, the cointegration relationships might also be subject to structural breaks. In such circumstances, standard cointegration tests such as the Johansen-trace test or the ADF test do not yield reliable results as the asymptotic distribution and the power of the test statistics are affected. The challenge of performing an adequate cointegration test under such circumstances is cumbersome since only few theoretical results have been

[4] She argues that the unit root property of economic variables is very useful for the empirical analysis of long- and medium-run macroeconomic relationships.

obtained on this up to now, to our knowledge. Gregory and Hansen (1996) develop several tests which are valid in the presence of structural breaks in the intercept and/or slope of the cointegration relationship. These tests however, are only suitable for single cointegration relationships. The only tests applicable to a multivariate setting are a modified version of the Johansen-trace test (Johansen, 1995) and the Saikkonen-Lütkepohl test (Saikkonen and Lütkepohl, 2000). The limiting distribution of the Johansen-trace test depends on deterministic variables and the number and the location of structural breaks and in the cointegration relationship. Thus, we draw upon the Saikkonen-Lütkepohl test since it is robust at least to breaks in the constants of the cointegration space. Strong evidence for three cointegration relationships is found in the four-variate system (Table 4). We conclude therefore that the four markets are integrated since we find n - 1 = 3 cointegration relationships which means that all cointegration relationships are bivariate and the 4-variate system is driven by only one stochastic trend.

------------------------------------- Table 4 about here -------------------------------------

Since we suspect that the intercept of the cointegration relationships might be subject to structural breaks induced by the outbreak of BT, we test for this possibility. Due to the absence of more appropriate test procedures on the evidence of structural breaks, we use the Gregory-Hansen-test for the four-variate system with one cointegration relationship.

Table 5 displays the ADF* test statistic for a structural break in the cointegrating relationship. We find significant structural breaks at the 5% level which fall into week 35 of 2007. This date closely corresponds to the peak outbreak of BT serotype 8 in the EU. This is, indeed, strong evidence that the massive outbreak of BT significantly impacted the long-run calf price relationships. Thus, we add a shift dummy d_{AUG07}, which equals 1 for week 35/2007 up to the end of the sample period, into the cointegration space of the multivariate VECM. The fully specified VECM hence becomes

$$\Delta p_t = \alpha\beta'\left(p'_{t-1} \quad const \quad trend \quad pol_{DE} \quad pol_{FR} \quad pol_{NL} \quad d_{AUG07}\right)' + \sum_{i=1}^{2}\Gamma_i \Delta p_{t-i} + \varepsilon_t . \quad (4)$$

------------------------------------- Table 5 about here -------------------------------------

4.3 VECM Results

We first estimate the unrestricted multivariate VECM (4) by the Johansen procedure (Johansen, 1995). We choose to normalize the bivariate cointegration relationships on DE, ES and FR, respectively, because the Netherlands was by far the largest importer of young calves among the four markets, as mentioned above. Hence, all long-run price equilibria are expressed with respect to the Dutch price. Based on our theoretical expectations, we impose several over-identifying restrictions on the unrestricted model. First, we test the strong form of the LOP as formulated in (2). We find that the coefficients of the Dutch price can only be restricted in the relationships with the Spanish and French prices, respectively (p-value of the according Wald test 0.11). Furthermore, German decoupling policy should not impact the ES-NL or the FR-NL relationships. However, the test for excluding the German price from the ES-NL relationship jointly with the other hypotheses is strongly rejected (p-value < 0.001). The expectation that French/Spanish policy should not play a role in the DE-NL relation is confirmed by the joint test (Wald test p-value 0.133). Lastly, we expect the BT outbreak in 2007 to not have an impact on the DE-NL relationship since both countries were subject to restricted zones of the same serotype. Since no bilateral trade restrictions were issued, the movement of animals between both countries was not affected. The Wald test of this exclusion restriction, together with the not rejected hypotheses from before, yields a χ^2-statistic of 8.05 which is not significant (p-value 0.153). Thus, we re-estimate the VECM with these restrictions imposed via a Generalized Least Squares (GLS) estimation as outlined in Lütkepohl and Krätzig (2004: 103).

In addition, we impose restrictions on the adjustment and the short-run parameters. Obviously, economic theory can hardly provide clear hypotheses about each of the 252 parameters. We thus choose a statistical approach to identify valid restrictions. Using a sequential elimination of these coefficients according to the largest reduction of the Hannan-Quinn criterion, we identify a set of 28 exclusion restrictions. The VECM is re-estimated with restrictions on the cointegration space, on the adjustment and on the short-run parameters via a two-stage procedure. This procedure uses the previous procedure for estimating the restricted cointegration relationships in the first step. In the second stage, it uses an estimated GLS estimator as discussed in Lütkepohl (2007: 197). A likelihood-ratio test indicates that these restrictions cannot be rejected (p-value 0.246).

We follow the recommendation of Hendry and Juselius (2001: 104), and identify several residuals as outliers by using identification criterion $|\hat{\varepsilon}_t| > 3.3\hat{\sigma}_{\hat{\varepsilon}}$. We include the eleven identified outliers as impulse or transitory dummies into the autoregressive part of the

VECM. Misspecification tests applied to the residuals of this model version demonstrate that the chosen specification describes the data generating process adequately (Table 6).

------------------------------------- Table 6 about here -------------------------------------

5 INTERPRETATION

Table 7 displays the final estimates of the cointegration relationships for the restricted and outlier-corrected VECM. The coefficients of NL in the second column represent the long-run price transmission elasticities. The LOP in its strong form is only found to hold in the relationships between Spain and the Netherlands, and France and the Netherlands, respectively. Thus, we conclude that price transmission in the long-run is complete for these pairs. Only the price transmission elasticity of the German-Dutch relationship cannot be restricted to one. However, it is reasonably close to 1.

The magnitudes of the remaining coefficients are also plausible. The coefficients of the policy variables denote the average change of the price in the first column in response to increased decoupling. For example, an increase in decoupling in Germany by 10 percentage points is expected to result in a 0.7 percent decrease of the German calf price. Thus, decoupling in Germany and France/ Spain led to price decreases in each of the countries. However, decoupling in the Netherlands had differing impacts on the calf prices of the other countries.

The estimated coefficients of the BT dummy are of plausible magnitude. They suggest that the massive outbreak of the disease in August 2007 as well as subsequent trade restrictions, which were issued as a result of the disease, indeed impacted spatial price relationships. These trade measures led to a near 14 percent drop in the Spanish price. This finding is plausible because while France was infected by serotype 8, Spain, as mentioned above, successfully curbed the spread for almost 1.5 years; the first case was detected in Spain only in January 2008. The BT dummy however, is not statistically significant in the French-Dutch relationship. Both countries suffered from the BT serotype 8 outbreak and thus belonged (partially) to the same restricted zone. Consequently, they were not subject to trade restrictions (European Commission, 2007).

------------------------------------- Table 7 about here -------------------------------------

Table 8 displays the estimated adjustment coefficients of the restricted and outlier-corrected VECM. These estimates give information on how the national prices reacted to deviations from long-run price equilibria. The prices of each equilibrium show adjustment of the expected sign and are significant and of reasonable magnitude. The Dutch price appears to be weakly exogenous in the DE-NL and FR-NL relationships. Interestingly, several prices which are not part of the respective cointegration relationship show significant adjustment, e.g., the French price significantly responds to deviations from the DE-NL long-run equilibrium. This underscores the adequacy of the multivariate approach chosen; important variables would be omitted if the VECM would have been estimated for price pairs separately.

French and Dutch calf prices respond the fastest, i.e., correction of 50% of a shock (half live) is taking place in approximately 5 to 6.5 weeks. Spanish and particularly German prices react much slower with half-lives of up to 11 weeks. The French price is hence not only sensitive in the long-run to policy changes, but also shows a similar sensitivity regarding its reactions on deviations from the price equilibria in the short run. The general picture is that market prices quickly respond to disequilibria. Adjustment speeds vary between 6% up to more than 13% of equilibrium errors which means that at least half of a shock is adjusted within no more than 11 weeks (less than 3 months). This finding shows that price transmission between the four calf markets is not only high in the long run, but also occurs at high rates in the short run.

------------------------------------- Table 8 about here -------------------------------------

5.1 Counterfactual Simulations

We conduct two counterfactual simulations which illustrate the effect of decoupling on the equilibrium prices of each cointegration relationship. We compare estimated equilibrium prices based on the values of the observed policy variables at certain points in time to the hypothetical levels of these policy variables. The two scenarios presented are based on the 12-weekly Dutch average price before the respective date. Although the equilibrium prices are calculated for the pair-wise cointegration relationships of the restricted model, it has to be considered that the model coefficients were estimated in a multivariate system. They therefore encompass both the effects of a country’s own policy choices on its domestic price and the effects of the policy choices of all other countries regarded in the system. Hence, a change in an equilibrium price cannot be interpreted as the sole consequence of the country’s own decoupling choice, but the choices of the other countries also play a role.

Scenario I evaluates the situation for January 1, 2005. It compares the actual setting with a more conservative one by assuming that each of the four countries would have decided for zero decoupling. However, Germany took the most liberal policy decision and completely decoupled on this date even though this decision could have been delayed until January 2007. Table 9 clearly shows that an increased degree of decoupling, which is equivalent to a decrease in coupled payments, had an expected depressing effect on the equilibrium price in each country. The variables of the actual policy choices are larger than the assumed ones. However, the equilibrium prices (A), based on the actual variables, are lower than the prices (B) in the hypothetical case of zero liberalization. The French equilibrium price appears to be the least impacted by the chosen decoupling policy. The German price would have been 8 percent higher without decoupling. In contrast, the Spanish equilibrium price could have been expected to be almost 30 percent higher if none of the countries would have decoupled.

------------------------------------ Table 9 about here ------------------------------------

Scenario II assesses the hypothetical scenario of the most protective choice of a decoupling policy on January 1, 2007. This was the date of mandatory movement toward decoupling for all countries. With the exception of the Netherlands, chosen national policies were quite liberalized. However, we assume for this case that a relatively high degree of coupled support remained. The hypothetical values of the policy variables are set to 25 percent, roughly the observed situation in the Netherlands at this point in time. In Table 10, it is apparent that the effects in Scenario II are much stronger than two years earlier in Scenario I. Equilibrium prices would have been much higher if Germany, France and Spain had opted for considerably more conservative policy choices[5]. Effects of decoupling are least for the German calf price and strongest for the French price.

------------------------------------ Table 10 about here ------------------------------------

5.2 Dynamic Analysis

A common way to assess system dynamics is to examine impulse response functions. However, impulse responses have been shown to have a number of weaknesses in a multivariate system (Pesaran and Shin, 1996). The main drawback is that the estimated

[5] At first glance, the hypothetical equilibrium price of ES seems very high as does the margin between the German and Spanish prices. We must emphasise that the equilibrium prices will never be observed in practice. As Table 11 shows, the estimated deviations from equilibrium, e.g. for ES-NL, lie between -0.43 and 0.73. Hence, observed prices might well have been 300€/head for example since 434€$\cdot e^{-0.3}$= 322€.

functions are not unique. They depend on the ordering of the variables and the chosen orthogonalization of shocks. Lee and Pesaran (1993) suggest an alternative measure. They propose considering time paths which track the effect of a system-wide shock to the cointegration relations. They call such system-wide impulse responses *persistence profiles*. Persistence profiles are defined as “the scaled difference between the conditional variances of the n-step and the (n-1)-step-ahead forecasts” (Pesaran and Shin, 1996).

------------------------------------- Table 11 about here -------------------------------------

Formally, scaled persistence profiles for multiple cointegration vectors are defined as:

$$h_Z(n) = GH_Z(n)G = G\hat{\beta}'\hat{B}_n\hat{\Omega}\hat{B}'_n\hat{\beta}G\,. \tag{5}$$

$H_z(n)$ denotes the unscaled persistence profile of an n-step-ahead forecast of a unit-shock to the multivariate system. It is calculated from estimated cointegration vector $\hat{\beta}$ where all deterministic terms restricted to the cointegration space (constant, trend and dummies) are not regarded. Hence, the profiles are independent of time. Furthermore, the recursive sum of the estimated parameter matrices $\hat{B}_n$ of the Wold representation of the multivariate process is considered. Lastly, the estimated variance-covariance matrix $\hat{\Omega}$ of the shocks of the World representation plays a role. The Wold representation is approximated by the corresponding VAR form of the estimated VECM. Hence, the $\hat{B}_n$ matrices in (5) are functions of $\hat{\Pi}$ and $\hat{\Gamma}_i, i = 1,2$. The matrix G denotes a suitable scaling matrix. The resulting time profiles are unique and independent of the ordering of the variables and the orthogonalization of shocks. They are functions of the forecast horizon *n,* and converge eventually to zero for cointegrated models; although the convergence can take a while (Garrat et al., 2006). Figure 2 displays the persistence profiles of the restricted VECM estimated above.

------------------------------------- Figure 2 about here -------------------------------------

The time paths of the three cointegration relationships are very similar. After overshooting in the first week after the system-wide shock, i.e. temporarily increased disequilibrium, the profiles converge rapidly to zero. Within four weeks, more than 50 percent of any shock is absorbed into each of the cointegration relationships. The French and the Spanish relationships although overshooting the most, show the steepest decline afterwards. After eight weeks, only 6 percent of the shock remains in the DE-NL and FR-NL relationships, respectively. In the ES-NL relationship, more than 98% of the shock is absorbed after eight weeks. This finding confirms the general picture of the close interrelationships of the four European calf markets studied.

6 CONCLUSIONS

Following the 2003 Fischler reforms of the EU's Common Agricultural Policy, decoupling of support payments from production was implemented differently by EU member states. In the cattle sector, German policy makers opted for the most liberal choice of full decoupling in January 2005 while Spain, France and the Netherlands initiated partial decoupling a year later. Decoupling reduces slaughter premia for cattle, which in turn, reduces the marginal value product of calves in beef production. Hence, such a policy can be expected to lead to decreasing prices for calves as the derived demand curve shifts downward. Since 2003 however, European cattle markets were not only subject to structural changes in the policy framework, but also to a major animal health crisis induced by the first outbreak of the Blue Tongue disease in Central Europe. In August 2007, a large scale outbreak occurred, resulting in strict restrictions on animal movements for some member states.

In this paper, we empirically explore how these external forces impacted the degree of long-run price transmission between four major European calf markets. We analyze interdependencies of calf markets by using weekly price data of young male calves of Germany, France, the Netherlands and Spain from 2003 to 2009. A recently developed range unit-root test, which is, among other features, robust to structural breaks, and a multivariate vector error correction model are used for this end. We conceptually differentiate between the notions of market integration and price transmission. The former term is seen as a dichotomous measure while and the latter concept is a gradual measure of both a long- and a short-run dimension. We find strong evidence for the existence of three cointegration relationships among the four prices. Thus, the markets are regarded as integrated. Most of the estimated coefficients are of plausible sign and magnitude. Price transmission in the long run is found to be complete in two of the three relationships. Long-run price transmission was significantly impacted by decoupling policies. The outbreak of the Blue Tongue disease played a significant role in the Spanish-Dutch long-run relationship. Price transmission in the short-run price is found to be fast.

The estimation results are illustrated by two counterfactual scenarios which demonstrate the price depressing effects of decoupling in comparison with hypothetical scenarios of more conservative liberalization strategies. Both scenarios show that the policy choices of decoupling indeed lowered the expected equilibrium prices in all national markets studied.

Dynamic analysis of the analyzed system confirms the general picture of the multivariate estimation. We compute persistence profiles, which show the reaction path to absorb a system wide shock along time for each of the long equilibriums. The estimated time paths underpin the findings of tightly interrelated prices of the spatially separated markets. Within a period of less than four weeks, more than half of any shock is absorbed into the system of markets. We conclude that the four calf markets studied are closely interconnected and find strong evidence that they belong to a common European market.

The policy implications of our results are twofold. First, the strong connectedness between the analyzed calf markets provides an interesting case against member state specific policy reforms in an internal market. The decision of the European agricultural ministers to allow for deviations from the general decoupling proposal which the European Commission had initially tabled leads to price – and therefore quantity effects – in the European Single Market. The additional cost caused by such member state specific policy changes should be carefully weighed against the perceived necessity of concessions for national interests in the negotiations of the Agricultural Council. Second, the strong price impact of Blue Tongue restrictions indicates that the consequences of trade restrictions due to Bue Tongue spilled over to all markets in the EU. The massive shifts in trade flows in the aftermath of the occurence of the disease emphasize that such Europe-wide pests require coordinated European action, as was established soon after the first recorded outbreaks. From our point of view, the importance of such pests for price determination also makes a strong case for mandatory vaccination, as this measure can successfully curb the number of new outbreaks.

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Table 1: Policy variables quantifying the degree of decoupling

Year	2005	2006	2007	2008	2009
pol_{DE}	100	100	100	100	100
pol_{FR}	7	77	78	78	77
pol_{NL}	2	24	24	24	25

Source: European Commission (2009b) and authors' calculations.

Note: The small actual policy variables in January 2005 of 7.5 percent in France and Spain and 1.6 percent in the Netherlands were due to the slightly lower animal numbers which received payments.

Table 2: Prices (€/ head) before and after the peak number of reported Blue Tongue cases

	Before August 2007		After August 2007	
	Mean	Standard deviation	Mean	Standard deviation
DE	241	30	207	12
ES	223	21	152	14
FR	255	34	208	16
NL	167	40	127	18

Source: European Commission (2009a).

Table 3: Results of the FB-RUR test

Series	DE	ES	FR	NL
FB-RUR statistic	1.947	2.433	2.839	1.379***

Source: Authors' calculations.

Note: The critical values for the 5% and 1% significance level are 1.866 and 1.582, respectively. Three asterisks denote significance at the 1% level.

Table 4: Results of the Saikkonen-Lütkepohl cointegration test

H_0	rank(Π) ≤ 0	rank(Π) ≤ 1	rank(Π) ≤ 2	rank(Π) ≤ 3
Test statistic	81.55	35.97	14.26	0.71
P-value	<0.001	0.001	0.022	0.455

Source: Authors’ calculations.

Table 5: Results of the structural break Gregory-Hansen test

ADF* statistic	95% Critical value	Observation	Year	Week
-5.29	-5.28	224	2007	35

Source: Authors’ calculations.

Table 6: P-values of misspecification tests

Series	LM-test	Jarque-Bera test	ARCH-LM test	Multivariate ARCH-LM test
DE		0.4500	0.9440	
ES		0.0008	0.2403	
FR		0.1896	0.4319	
NL		0.1005	0.9868	
Multivariate test	0.1676			0.3935

Source: Authors’ calculations.

Table 7: Cointegration relationships of the restricted VECM

	NL	Constant	Trend	pol_{DE}	pol_{FR}	pol_{NL}	d_{AUG07}
DE	1.173	-0.932	0.002	-0.0007	-	-0.006	-
	(0.055)	(0.307)	(<0.001)	(<0.001)		(0.003)	
ES	1.000	0.349	0.002	-0.0022	-0.009	0.023	-0.135
	(-)	(0.082)	(<0.001)	(<0.001)	(0.004)	(0.013)	(0.037)
FR	1.000	0.116	>-0.001	-	-0.013	0.039	0.014
	(-)	(0.124)	(<0.001)		(0.004)	(0.013)	(0.036)

Source: Authors' calculations.

Note: The prices in the first column are a function of the variables in the remaining columns with the reported coefficients. Standard errors are given below in parentheses.

Table 8: Adjustment coefficients of the restricted VECM

Cointegration relationship	DE-NL	ES-NL	FR-NL
DE	-0.077 [8.7]	-	0.062 [10.8]
	(0.018)		(0.019)
ES	0.062 [10.8]	-0.101 [6.5]	-
	(0.017)	(0.020)	
FR	0.102 [6.5]	-	-0.128 [5.1]
	(0.021)		(0.021)
NL	-	0.134 [4.8]	-
		(0.027)	

Source: Authors' calculations.

Note: Standard errors in parentheses. The square brackets contain the correpsonding half-lives as a more intuitive measure of the speeds of adjustment. They are defined as the number of weeks needed to correct c.p. 50% of any disequilibrium.

Table 9: Scenario I - Fully coupled policies on January 1, 2005

	Country	DE	FR	ES	NL
	Observed price (€/head)	200	246	196	145
Actual policy	Policy variable	100	7.5	7.5	1.6
	Equilibrium price (A)	151	156	198	-
Scenario I	Policy variable	0	0	0	0
	Equilibrium price (B)	163	162	254	-
	Ratio (B) to (A)	1.08	1.04	1.28	-

Source: Authors' calculations.

Table 10: Scenario II - Most protective policy choice by January 1, 2007

	Country	DE	FR	ES	NL
	Observed price (€/head)	235	254	206	143
Actual policy	Policy variable	100	78	78	24
	Equilibrium price (C)	164	144	227	-
Scenario II	Policy variable	25	25	25	25
	Equilibrium price (D)	171	304	434	-
	Ratio (D) to (C)	1.04	2.12	1.91	-

Source: Authors' calculations.

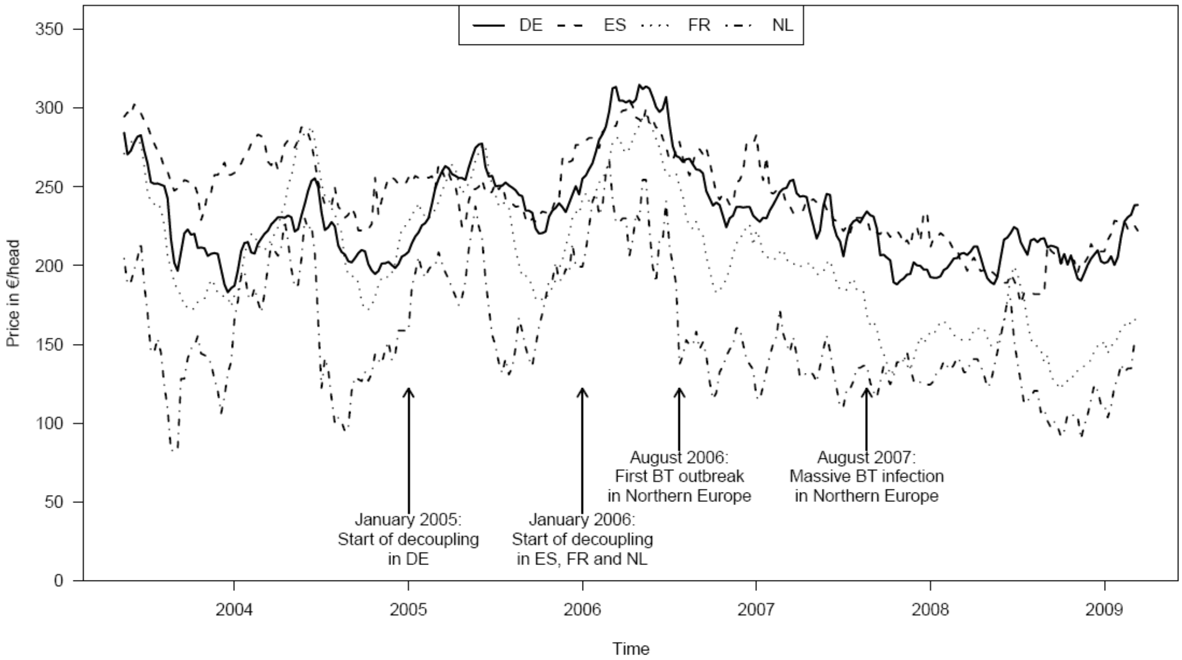
Table 11: Descriptive statistics of the estimated error correction terms

	DE-NL	ES-NL	FR-NL
Minimum	-0.1419	-0.4334	-0.1317
Median	0.2490	-0.0029	0.2190
Maximum	1.1004	0.7324	0.7570

Source: Authors' calculations.

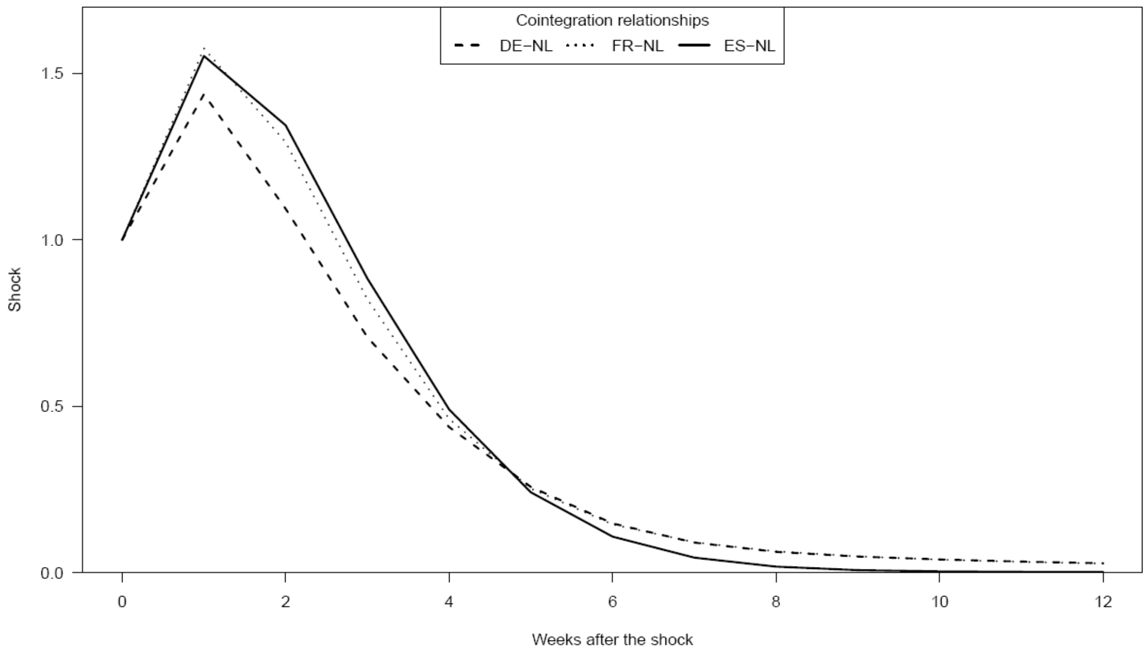
Note: For calculating the observed magnitudes of relative price deviations from equilibrium, the value of the exponential function of the estimated residuals has to be considered.

Figure 1: Weekly calf prices for Germany, France, the Netherlands and Spain



Source: European Commission (2009a) and authors.

Figure 2: Persistence profiles of the restricted model



Source: Authors' calculations.