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Title: **MODELLING THE 1992 CAP REFORM: DEGREE OF DECOUPLING AND FUTURE SCENARIOS**

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Abstract: We model CAP reform in order to measure the response of production and land allocation to compensatory payments. The application refers to a sample of farms in Italy. The model allows us an analysis of the degree of decoupling and a simulation of the impact of the “Agenda 2000” proposals.

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**MODELLING THE 1992 CAP REFORM:
DEGREE OF DECOUPLING AND FUTURE SCENARIOS**

Daniele Moro and Paolo Sckokai

Right after the 1992 reform of the Common Agricultural Policy (CAP) of the European Union (EU), research effort has been devoted to modelling the new policy instruments (Fraser, 1993; Froud and Roberts, 1993; Nardone and Lopez, 1994; Roberts et al., 1996; Rygnestad and Fraser, 1996, Oude Lansink and Peerlings, 1996; Guyomard et al., 1996). After the release of the “Agenda 2000” medium-term reform proposal of the CAP (European Commission, 1997), in order to judge future scenarios, policy makers need both a consistent ex-post evaluation of the 1992 reform package and a reliable simulation of the impact of their proposals.

The present paper attempts to provide some empirical results that could shed some light on these specific problems. In particular, our analysis considers as a starting point the issue of the level of “decoupling” of the 1992 reform; in fact, the new policy instruments have only partially reached the target. This is even more evident if one considers that in the so-called ‘professional producer’ scheme, although current production plays no role in determining the level of the compensatory payments, farmers receive crop-specific per-hectare aids, which heavily affect the land allocation decisions and, indirectly, the current level of production. The issue of decoupling must be analysed in a model that considers explicitly the land allocation mechanism: we have incorporated the main CAP reform tools in a standard production model (Diewert, 1982; Chambers, 1988), avoiding the limitations of some previous work (Oude Lansink and Peerlings, 1996; Guyomard et al., 1996), in the sense that the proposed modified profit function does not rely on any particular restriction on technology, such as nonjointness, and carries all the standard properties of any extended profit function. The computed elasticities become extremely useful to evaluate the effects of the MacSharry package and to simulate future scenarios.

In this paper, we apply the above methodology to a data-set from the Italian Farm Accounting Data Network (FADN) in the MacSharry transition period (1993-1995); we refer to a sample of farms located in the North of Italy, where production of cereals and oilseeds is particularly important. After a brief description of the theoretical framework, we apply the procedure by estimating a normalised quadratic modified profit function and we use the elasticity values to compute the degree of decoupling of the MacSharry plan and to simulate the impact of a policy change in line with the “Agenda 2000” package.

Theoretical framework

The specification of the profit function

Consider a multioutput technology in which a vector q of N variable netputs is involved in the production process in a given period of time (with the usual sign convention, positive for the n outputs and negative for the $(N-n)$ inputs); in the short run, this technology is assumed to be restricted by the presence of a vector s of fixed allocatable inputs and a vector z of other fixed inputs which are not allocatable. Given the corresponding netput price vector p , the standard short run profit function can be defined as:

$$(1) \quad \pi(p, s, z) \equiv \max_{q, s_1, \dots, s_n} \left\{ \sum_{i=1}^N p_i q_i : T(q, s_1, \dots, s_n, z) \geq 0; \sum_{i=1}^n s_i \leq s \right\}$$

where producers choose simultaneously both optimal netput levels and optimal allocations of the fixed input vector. While the specification in (1) is fairly general, for agricultural production land is the most typical element of the vector s , and technology is constrained by total land availability.

The 1992 CAP reform framework requires a modification of the above profit function: in fact, for some specific commodities (cereals, oilseeds and protein crops), EU producers receive a per-hectare aid based on their acreage declarations (the compensatory payments’ package). In our view, the most relevant case relates to the so called ‘professional producer scheme’, where payments are crop-specific and are tied to the obligation of setting aside a fixed percentage of the land allocated to program crops.

Assuming that all producers participate in the above scheme, if $m < n$ is the number of crops covered by the new regime, a is the vector of the crop-specific per-hectare aids, b is the set-aside premium, c is the fixed set-aside percentage, s_t is total land availability, s is the vector of land allocations to program crops, s_y is the corresponding vector for non-program crops and s_x is land allocated to set-aside (thus $s_x = \sum_{i=1}^m s_i \frac{c}{1-c}$), we can rewrite the maximisation problem as follows:

$$(2) \quad \pi(p, s_t, z, r, c) \equiv \max_{q, s, s_y} \left\{ \sum_{i=1}^N p_i q_i + \sum_{i=1}^m r_i s_i : T(q, s, s_y, s_t, z) \geq 0; \quad \sum_{i=1}^m s_i \frac{1}{1-c} + \sum_{i=1}^{n-m} s_{y_i} \leq s_t \right\}$$

where we define $r_i \equiv a_i + b \frac{c}{1-c}$ and the binding constraint $s_x = \sum_{i=1}^m s_i \frac{c}{1-c}$ is substituted for in the maximisation problem.

As shown in Moro and Sckokai (1997), this profit function carries all the standard properties of any extended profit function: under standard regularity conditions, $\pi(p, s_b, z, r, c)$ is in fact nonincreasing in input prices and nondecreasing in output prices and compensatory payments, positively linearly homogeneous in (p, r) , convex and continuous in (p, r) . Moreover, if we assume that $\pi(p, s_b, z, r, c)$ is twice continuously differentiable, the most interesting empirical implication is the following:

$$(3) \quad \begin{aligned} q_i(p, s_t, z, r, c) &= \partial \pi(p, s_t, z, r, c) / \partial p_i & i = 1, \dots, N \\ s_i(p, s_t, z, r, c) &= \partial \pi(p, s_t, z, r, c) / \partial r_i & i = 1, \dots, m \end{aligned}$$

which allows us to define output supply, input demand and land allocation equations.

The empirical model

The results derived in the previous section allow us to specify a parametric form for both the netput supply/demand functions and the land allocation functions for crops involved in the new CAP regime.

We rely on the normalised quadratic profit function, originally proposed by Lau (1974).

Choosing p_N as the numeraire, let $\bar{p} \equiv p / p_N$ and $\bar{r} \equiv r / p_N$ be respectively the normalised price vector and the normalised per-hectare aid vector, and $v=(s_b, z, c)$ be the vector of all fixed resources. Then, the normalised quadratic profit function takes the following form:

$$(4) \quad \begin{aligned} \bar{\pi} = & \alpha_0 + \sum_{i=1}^{N-1} \alpha_i \bar{p}_i + \frac{1}{2} \sum_{i=1}^{N-1} \sum_{j=1}^{N-1} \alpha_{ij} \bar{p}_i \bar{p}_j + \sum_{i=1}^m \beta_i \bar{r}_i + \frac{1}{2} \sum_{i=1}^m \sum_{j=1}^m \beta_{ij} \bar{r}_i \bar{r}_j + \sum_{h=1}^l \gamma_h v_h + \frac{1}{2} \sum_{h=1}^l \sum_{k=1}^l \gamma_{hk} v_h v_k \\ & + \sum_{i=1}^{N-1} \sum_{j=1}^m \delta_{ij} \bar{p}_i \bar{r}_j + \sum_{j=1}^{N-1} \sum_{k=1}^l \phi_{jk} \bar{p}_j v_k + \sum_{j=1}^m \sum_{k=1}^l \varphi_{jk} \bar{r}_j v_k \end{aligned}$$

where $\bar{\pi} \equiv \pi / p_N$ is the normalised profit and α 's, β 's, γ 's, δ 's, ϕ 's and φ 's are parameters to be estimated. This profit function is linearly homogeneous by construction, while symmetry can be maintained by further imposing $\alpha_{ij} = \alpha_{ji}$, $\beta_{ij} = \beta_{ji}$ and $\gamma_{hk} = \gamma_{kh}$.

Using the derivative property in (3), output supply and input demand equations can be written as:

$$(5) \quad q_i = \alpha_i + \sum_{j=1}^{N-1} \alpha_{ij} \bar{p}_j + \sum_{j=1}^m \delta_{ij} \bar{r}_j + \sum_{k=1}^l \phi_{ik} v_k \quad i = 1, \dots, N-1$$

while the land allocation equations for the CAP program crops take the form:

$$(6) \quad s_i = \beta_i + \sum_{j=1}^m \beta_{ij} \bar{r}_j + \sum_{j=1}^{N-1} \delta_{ij} \bar{p}_j + \sum_{k=1}^l \varphi_{ik} v_k \quad i = 1, \dots, m$$

The implied parametric form of the numeraire equation (output supply/input demand for netput N) can be retrieved by the normalised profit function in (4).

The degree of decoupling

To assess the degree of decoupling of the 1992 CAP reform, the above methodology provides elasticity values of both production and planting area with respect to changes in prices and compensatory payments. In a recent paper (Cahill, 1997), there is an attempt to evaluate the rate of decoupling provided by the CAP reform at the EU level. Results in that paper suggest that for some crops (wheat, rapeseed and soybeans) compensatory payments are indeed effectively fully decoupled.

We try a similar exercise with our estimated model; as in Cahill (1997) we take into account that the CAP reform is a package of measures and that there are cross-crop substitution effects: the definition of product supplies in our framework allows us to derive readily the rate of change in production by differentiation with respect to prices and compensatory payments:

$$(7) \quad \frac{dq_i}{q_i} = \sum_{j=1}^N \varepsilon_{ij} \frac{dp_j}{p_j} + \sum_{h=1}^m \eta_{ih} \frac{dr_h}{r_h} \quad i = 1, \dots, N \quad h = 1, \dots, m$$

where ε_{ij} and η_{ih} represent respectively the price elasticity and the payment elasticity of supply.

We define full coupling as the case in which $\frac{dq_i}{q_i} = 0$ after a price change, that is the compensation

scheme fully restore the price change (i.e. the case of a deficiency payments), and full decoupling as the case in which the change in production only corresponds to that under a price change, that is

$$\frac{dq_i}{q_i} = \sum_{j=1}^N \varepsilon_{ij} \frac{dp_j}{p_j}. \text{ Partial decoupling lies normally between the two extremes, although in principle it is}$$

possible for the change in production of some crop to overshoot that due only to the price change.

We define the rate of decoupling as:

$$(8) \quad DR = 1 + \frac{\sum_{h=1}^m \eta_{ih} \frac{dr_h}{r_h}}{\sum_{j=1}^N \varepsilon_{ij} \frac{dp_j}{p_j}}$$

that takes value of 0 in the case of full coupling and value of 1 in the case of effective full decoupling.

In order to evaluate ex-post the degree of decoupling of the CAP reform, we may compute DR for a plausible range of values for dp_j/p_j and dr_h/r_h . Furthermore, we can also reasonably relate the percentage change in prices to the percentage change in compensatory payments: as a matter of fact, the spirit of the reform was to fix compensatory payments to give full revenue compensation for the price cut. We may therefore take $dp_i \bar{y}_i = -dr_i$, where \bar{y}_i is the historical yield used for computations in the

reform package. In percentage terms this means that $\frac{dr_i}{r_i} = -\frac{dp_i}{p_i} \frac{p_i \bar{y}_i}{r_i}$. We have then considered a possible range of percentage changes in prices (10%, 20% and 30%) of the reform crops in our model (maize, other cereals, oilseeds), while keeping the price of other crops and inputs constant.

The impact of the “Agenda 2000”

A further appealing exercise is to evaluate the impact of the “Agenda 2000” package. The proposed reform in the crop sector (cereals, oilseeds, and protein crops) can be summarised in few points: a) reduction in the intervention price for cereals; b) introduction of a non crop-specific area payment based on historical cereals yields, to compensate for the foreseen reduction in prices; c) compulsory set-aside at the 0%, and voluntary set-aside admissible; d) silage cereals excluded from the regime.

We can include the relevant modifications in our model and try to evaluate how production would respond to changes in prices and compensatory amounts; computations are made over a restricted range of possible values.

Changes in compensatory amounts are linked by the provision that the final payment is non crop-specific: thus, given a percentage change, for example, in $r_{other\ cereals}$ we have that:

$$(9) \quad \frac{dr_{mais}}{r_{mais}} = \left(1 + \frac{dr_{other\ cereals}}{r_{other\ cereals}} \right) \frac{r_{other\ cereals}}{r_{maize}} - 1 \quad \text{and} \quad \frac{dr_{oilseeds}}{r_{oilseeds}} = \left(1 + \frac{dr_{other\ cereals}}{r_{other\ cereals}} \right) \frac{r_{other\ cereals}}{r_{oilseeds}} - 1$$

In this context, it seems plausible to evaluate the impact of the “Agenda 2000” for a cut of 10% and 20% in prices and an increase of 10% and 20% in the compensatory payment for other cereals; prices of other crops and inputs are held constant.

Data

The data-set employed in this paper has been obtained from a sample of farms in the North of Italy during the MacSharry transition period (1993-1995); these farms belong to the FADN class “Field Crops”. Information from the FADN data-base is highly detailed, both on the output and on the input side, such that the data-set has been integrated only for the series of regional input prices, which are from the Italian Official Statistics (ISTAT), and for the CAP reform variables (regionalised compensatory payments, set-aside percentage). Aggregating farms over the regions considered in the MacSharry regionalisation plan for Italy, the final data-set includes 62 observations for the three years (1993-95).

We have considered four output categories (maize, other cereals, oilseeds, other field crops) with their respective land allocations, where the first three represent those crops for which the CAP reform guarantees different levels of the per-hectare aids. We have also considered three variable inputs (seeds and chemicals, hired labour, other inputs) and four fixed inputs (capital, total land, family labour, set-aside percentage).

Results and discussion

Estimation

Equations (5) e (6) define, for our specific application, a system of 9 simultaneous equations, estimated using a maximum likelihood estimator (Davidson and MacKinnon, 1993). Moreover, given the different variance of our observations, we need to account for heteroskedasticity. The model has been estimated with convexity imposed by means of the Cholesky reparameterization; to reach convergence, a semi-flexible version of the model was estimated, adopting the technique proposed by Diewert and Wales (1988).

Due to space reason, we do not report parameter estimates; although the estimated model fits the data quite well (the R^2 coefficients range from 0.739 to 0.982), some coefficients are not significant.

In Table 1 we report elasticities at the mean point of the sample. Although imposing convexity under the "semi-flexible" Cholesky factorisation implies restrictions on substitutability, the magnitude of both own-price and cross-price elasticities turns out to be quite reasonable. All outputs show inelastic supply, except for maize. The demands for variable inputs turn out to be inelastic as well, except for the aggregate "other inputs", whose demand is particularly elastic. Cross-price elasticities among outputs determine mainly substitutability relationships. Cross-price elasticities among inputs also determine substitutability relationships, even though the elasticity values are quite low.

The main results are those which relate to elasticities involving the CAP compensatory payments and the land allocation functions. The first observation relates to the nature of the aids r_i , which are linear combinations of the crop-specific per-hectare aids, the set-aside payment and the set-aside percentage; this clearly implies that even a change in the set-aside premium, or in the set-aside percentage, does affect land allocation decisions and supply levels. The supply of maize, other cereals and oilseeds is inelastic with respect to their own compensatory payments, but the positive response to the aids implies a possible incentive to production, and shows once again that the CAP reform tools are not fully decoupled. Cross-elasticities with respect to compensatory payments are normally negative, although quite low.

Similar considerations arise from the analysis of the elasticities of land allocations. First, they are strongly responsive to prices of their respective crops; moreover, they are positively influenced by the aids. It is somehow interesting to note that land allocation elasticities with respect to compensatory payments are higher than the corresponding supply elasticities, thus showing that the direct effect of the CAP payments is typically on land allocations, which also implies lower yields and more extensive techniques. Input demands show also some interesting behavioural relationships, with respect to output prices and aids. In general we observe very low elasticity values, especially for seeds and chemicals, and this may again justify the hypothesis that CAP reform tools tend to disincentive intensive agricultural practices.

The Degree of Decoupling

In Table 2 we report the rate of decoupling (DR) for the three main crops (maize, other cereals, oilseeds) of the CAP reform, evaluated for a range of values of percentage changes in their prices (10%, 20% and 30%).

First of all, other cereals (mainly wheat) show a prevalence of negative signs (21 out of 27): it is an indication that the effect of a calibrated change in the compensatory scheme overshoots in absolute value the effect of a price change (i.e. if the price cut gives a decrease (increase) in production, the rise in the compensatory payment gives a larger increase (decrease) in production in absolute terms: thus, the reform package is skewed toward that crop). With one exception, maize shows values between 0 and 1, thus a partial rate of decoupling: Such behaviour, although prevalent, is less evident for other cereals and oilseeds. Furthermore the degree of decoupling for maize and oilseeds decreases as its own price cut increases: the calibrated adjustment in the compensatory payment seems to favour its own production; other cereals do not show such a regularity.

Furthermore, it may be possible that for some program crops the package will provide effective full decoupling (i.e. $DR=1$), with a proper combinations of price changes; of course this is not the same as saying that the package is effectively fully decoupled *per se*. Results also confirm that the compensatory payments package is not fully coupled either: values in the table entries are largely different from zero. Indeed, we may also have, for the same reasoning, full coupling of the scheme.

The simulation of the “Agenda 2000”

The impact of the “Agenda 2000” is summarised in Table 3. Our simple simulation shows that maize would be negatively affected by the reform in Italy. However, the negative effect on the supply of

maize tends to be quite sensitive to the price decrease of other program crops, which in some cases could even reverse this negative impact. On the contrary, the supply of maize is only slightly sensitive to a further increase in the non crop-specific per-hectare aid, because in Italy this would not imply an effective increase in the maize aid.

Other cereals (mainly wheat) would be largely favoured by the reform, and this positive effect tends to be quite sensitive both to the price decrease of other program crops and to the increase of the non crop-specific aid. Oilseeds supply would also be favoured by the “Agenda 2000” package, except in those cases where the oilseeds price decrease should be higher than the price decrease of other program crops; moreover, the oilseeds supply would also be quite sensitive to the increase of the non crop-specific aid. Finally, we would register a small reduction in other arable crops (outside the reform crops). It is interesting to note that we would experience quite a strong increase in land allocation to other cereals; however, the increase in planted area in percentage terms would always be higher than that of production, thus confirming that there is a tendency towards a more extensive production. The same is true for maize, where the supply reduction is normally higher than the reduction in planted area, while we have the opposite result for oilseeds.

Table 1: Elasticity Estimates at the Mean Point

	P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	r ₁	r ₂	r ₃
Maize (q ₁)	1.248	-0.072	-0.319	0.059	-0.163	-0.037	-0.683	0.203	-0.030	-0.205
Other cereals (q ₂)	-0.460	0.436	-0.167	-0.037	0.330	-0.202	0.144	-0.226	0.121	0.061
Oilseeds (q ₃)	-1.130	-0.092	0.505	0.088	-0.121	0.137	0.522	-0.142	0.053	0.181
Other field crops (q ₄)	0.190	-0.018	0.079	0.607	-0.093	0.098	-0.853	0.021	0.007	-0.038
Seeds and chemicals (q ₅)	0.510	-0.161	0.107	0.090	-0.756	0.010	0.255	0.065	0.082	-0.201
Hired labour (q ₆)	0.820	0.698	-0.852	-0.674	0.069	-0.762	0.629	-0.254	0.194	0.133
Other inputs (q ₇)	1.747	-0.014	-0.408	0.662	0.294	0.042	-2.489	0.291	-0.049	-0.077
Land allocated to maize (s ₁)	0.956	-0.166	-0.189	0.031	-0.098	0.054	-0.563	0.215	-0.071	-0.170
Land allocated to other cereals	-0.800	0.499	0.398	0.056	-0.692	-0.232	0.615	-0.399	0.549	0.005
Land allocated to oilseeds (s ₃)	-1.161	0.054	0.289	-0.067	0.364	-0.034	0.276	-0.204	0.001	0.483

Table 2: Degree of decoupling for different hypotheses about the percentage changes in prices

		Maize			Other Cereals			Oilseeds		
		$dp_3/p_3=-0.1$	$dp_3/p_3=-0.2$	$dp_3/p_3=-0.3$	$dp_3/p_3=-0.1$	$dp_3/p_3=-0.2$	$dp_3/p_3=-0.3$	$dp_3/p_3=-0.1$	$dp_3/p_3=-0.2$	$dp_3/p_3=-0.3$
$dp_1/p_1=-0.1$	$dp_2/p_2=-0.1$	0.323	0.324	0.330	-1.305	-0.050	0.407	0.684	0.835	0.466
	$dp_2/p_2=-0.2$	0.428	0.501	0.893	0.641	-0.955	3.438	1.006	1.646	-0.929
	$dp_2/p_2=-0.3$	0.554	0.742	2.536	0.095	-0.324	-1.148	1.262	2.080	-4.680
$dp_1/p_1=-0.2$	$dp_2/p_2=-0.1$	0.284	0.277	0.268	-1.263	-0.722	-0.365	0.526	0.490	0.411
	$dp_2/p_2=-0.2$	0.323	0.323	0.324	-3.395	-1.305	-0.486	0.668	0.684	0.719
	$dp_2/p_2=-0.3$	0.365	0.373	0.386	2.885	7.522	-1.546	0.797	0.855	0.971
$dp_1/p_1=-0.3$	$dp_2/p_2=-0.1$	0.274	0.269	0.262	-1.256	-0.910	-0.645	0.488	0.461	0.420
	$dp_2/p_2=-0.2$	0.365	0.373	0.386	-1.930	-1.272	-0.832	0.579	0.570	0.558
	$dp_2/p_2=-0.3$	0.323	0.323	0.323	-5.065	-2.412	-1.305	0.664	0.672	0.684

Table 3: The impact of the Agenda 2000 for different hypotheses about the percentage changes in prices and compensatory payments (percentage changes in supplies and land allocations)

dp_1/p_1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2
dp_2/p_2	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2
dp_3/p_3	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	-0.2	-0.2
dr_2/r_2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Maize	-0.031	-0.024	0.000	0.008	-0.156	-0.149	-0.124	-0.117	-0.034	-0.027	-0.003	0.005	-0.159	-0.152	-0.127	-0.120
Other cereals	0.060	0.016	0.077	0.033	0.106	0.062	0.123	0.079	0.072	0.028	0.089	0.045	0.118	0.074	0.135	0.091
Oilseeds	0.016	0.025	-0.034	-0.025	0.129	0.138	0.079	0.088	0.021	0.031	-0.029	-0.020	0.134	0.144	0.084	0.093
Other field crops	-0.009	-0.007	-0.017	-0.015	-0.028	-0.026	-0.036	-0.034	-0.008	-0.007	-0.016	-0.015	-0.027	-0.026	-0.035	-0.034
Seeds and chemicals.	0.056	0.072	0.045	0.061	0.005	0.021	-0.006	0.010	0.064	0.080	0.053	0.069	0.013	0.029	0.002	0.018
Hired labour	-0.051	-0.120	0.035	-0.035	-0.133	-0.202	-0.047	-0.117	-0.031	-0.101	0.054	-0.016	-0.113	-0.183	-0.028	-0.098
Other inputs	-0.175	-0.174	-0.134	-0.133	-0.350	-0.348	-0.309	-0.308	-0.180	-0.179	-0.139	-0.138	-0.355	-0.353	-0.314	-0.313
Land to maize	-0.033	-0.016	-0.014	0.003	-0.128	-0.112	-0.109	-0.093	-0.040	-0.023	-0.021	-0.004	-0.135	-0.119	-0.116	-0.100
Land to other cereals	0.153	0.103	0.113	0.063	0.233	0.183	0.193	0.143	0.207	0.158	0.168	0.118	0.287	0.238	0.248	0.198
Land to oilseeds	-0.129	-0.134	-0.158	-0.163	-0.013	-0.018	-0.042	-0.047	-0.129	-0.134	-0.158	-0.163	-0.013	-0.018	-0.041	-0.047

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