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THE IMPACT ON INVESTMENT AND PRODUCTION OF DIFFERENT AGRICULTURAL POLICY INSTRUMENTS - PRINCIPAL FINDINGS

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Note by the Secretariat

This paper investigates the investment effects of agricultural support measures. It was drafted by Jesús Antón based on two econometric studies - "Modelling the impact of agricultural policies on farm investments under uncertainty: the case of the CAP arable crop regime" [AGR/CA/APM(2005)13/FINAL] and "Dynamic econometric models of Manitoba crop investment and production under risk aversion and uncertainty" [AGR/CA/APM(2005)14/FINAL]. The authors of these two papers are respectively, Paolo Sckokai from the Universitá Catolica di Piazenza, and Barry Coyle from the University of Manitoba.

This summary contains the principal findings and it aims to convey the policy-relevant conclusions of this work in a non-technical way. The paper was declassified on 27 April 2005 by the Working Party on Agricultural Policies and Markets of the Committee for Agriculture.

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Investment and decoupling

1. Agricultural support in OECD countries has evolved in recent decades away from market price support programmes towards mainly direct payments. The scale of this movement differs substantially for different commodities and for different countries (OECD, 2005). Some of these direct payments are intended to weaken the links between Government programmes and farmers' production decisions. Analysing the extent to which these linkages have been broken requires a complex and interrelated set of effects, through which support measures can condition production decisions, to be taken into account (OECD, 2001). The main and most direct effect of policy on production is due to the relative direct incentives created to produce some outputs or to use some inputs. Those are primarily the relative price effects of policy measures. A second type of effect relates to risk issues: some programmes have an effect on the variability of returns from farming or on the perception of risk attached to that variability. Finally, there are some effects that are due to dynamic dimensions of the policies or of farmer's decision making. These include mainly expectations effects (see [AGR/CA/APM(2005)11/FINAL]) and investment related effects. This latter topic is the specific focus of this paper.

2. All types of support measures are likely to have an impact on investment. This is particularly the case of the most coupled forms of support such as market price support. However, the dimension of the investment impacts may differ significantly across policy measures since they have different impacts on the farmer's decision environment. For instance, they have different impact on effective incentive prices and different income transfer efficiency. Under these circumstances the investment effects can be very different, requiring a specific empirical analysis.

3. The behaviour of demand for capital to be used in agriculture has some peculiarities that may be major determinants of investment decisions and deserve particular attention. The first one is that investment decisions often have strong dynamic constraints due to the fact that it may take time to adjust the level of capital and, once it is changed, the new capital may last for several periods and/or may be difficult to adjust in the short run. Additionally, investment may require resources that go beyond the returns from current production and depend on expected future returns and availability of funds. Finally, it has often been underlined by experts (Dixit and Pindyck, 1994) that investment decisions can be irreversible, at least to a certain extent. This irreversibility gives additional value to any information that can be obtained in order to take an investment decision and provides the rationale for the option value of waiting to obtain better information.

4. Under these circumstances it becomes evident that current investment decisions potentially have an impact on current and future production possibilities. That is, in general there are investment effects on production that have to be considered when analysing the linkages between support programmes and production. Furthermore, investment decisions are taken in an environment of uncertainty and asymmetric information. As a result market outcomes may depend not only on effective incentive prices, but also on other variables that can be used to complete unavailable information or to reduce the degree of uncertainty associated with production and returns. In this context, government programmes have the potential to

directly affect investment possibilities and/or the optimal investment decisions of farmers benefiting from these programmes. For instance, if a farmer is subject to a credit constraint, government programmes may relax this constraint. If farmers are risk averse (they dislike variable returns), policies affecting risk will have an additional impact on investment. The degree to which support programmes can affect investment depends not only on the design of the programme, but also on the functioning of markets and other institutional arrangements that are specific to each country or region.

5. In general, agricultural support programmes are expected to have the effect of increasing investment due either to their impact on effective incentive prices (higher returns from agriculture) or from their impact in relaxing capital and information constraints faced by farmers or in reducing uncertainty. Additionally, higher levels of investment and capital may expand production possibilities. However, differences in the investment effects of different programmes need to be studied empirically.

6. An empirical study using a static framework without any uncertainty, will only capture the incentive price effects on investment and would omit the main specificities of investment, making it difficult to estimate the incidence of different support programmes on investment properly. It is precisely the particularities that link investment to uncertainties and dynamics which make decisions on the use of capital (investment) different from decisions on the use of other inputs. Despite this, virtually no econometric estimation of investment in agriculture has been undertaken using a framework that incorporates dynamics and uncertainty. This is mainly because econometric estimations of investment behaviour under uncertainty and dynamics are very demanding in both data and methodological terms.

Two econometric studies on investment in the crop sector: data and methodological issues

7. The OECD has commissioned two econometric studies on the investment effects of agricultural support measures in the crop sector. These studies are innovative, opening up new areas of research in which to date, there is hardly any empirical evidence. These two papers are:

- The Italian study: "Modelling the impact of agricultural policies on farm investments under uncertainty: the case of the CAP arable crop regime" [AGR/CA/APM(2005)13/FINAL], by Paolo Sckokai.
- The Canadian study using data from the province of Manitoba: "Dynamic econometric models of Manitoba crop investment and production under risk aversion and uncertainty" [AGR/CA/APM(2005)14/FINAL], by Barry Coyle.

8. Both studies have a common theoretical framework to analyse investment decisions. Their structure accounts for some forms of uncertainty in a context where farmers are potentially risk averse. In both cases, the main source of uncertainty and variability of returns is price variability and the response to this variability is estimated from the data. Both models have also a dynamic structure that links current investment decisions to available information from the past and expectations concerning the future. These dynamic linkages and this uncertain environment are the specific characteristics of investment decisions.

9. Table 1 shows some differences between the two studies. Some modelling decisions in each study are imposed by data limitations, others reflect the reasoned choice of the authors. These differences make the studies complementary. The main difference is the source of data. The first study uses micro farm data for Italian crop producers from the FADN survey. The second study uses aggregate data for the whole province of Manitoba. Micro data have the advantage of being able to capture individual responses to risk variables through a large set of cross section observations. However, the lack of information on off-farm activities and the lack of variability in price uncertainty and payments levels across farms offset some of these advantages. Aggregate data can present serious aggregation difficulties, particularly for risk related variables, and usually suffers from a reduced number of time series observations. However, the study on

Manitoba is based on a long time series and has developed sophisticated aggregation methods. Each approach has its own merits and limitations.

10. The definition of investment as current expenditure on machinery and buildings or equipment for crop production is very similar in both studies. It excludes investment in land purchase. However, the meaning of this variable at the aggregate and at the individual level may not be the same, and there could also be differences in the statistical methodologies and definitions in Italy and Canada. The Italian case constructs and estimates a set of structural equations derived from a profit maximisation problem for the individual farmer. The Canadian study on Manitoba is mainly focused on reduced form models with distributed lags. The structural model approach is theoretically more consistent, but it has been argued that, when there is little a priori knowledge of the investment behaviour and data constraints, a reduced form approach can be an appropriate first estimation technique. The coverage of Government programmes differs between the studies, reflecting the policy reality in each country. The Italian study looks at market price support and area payments and directly estimates coefficients for these policy instruments, while the Canadian study on Manitoba looks at the impacts of a set of five policy programmes through their incidence on effective incentive prices and revenue variability.

Table 1. Some differences between the two studies on investment assuming uncertainty and dynamics

	Study on crops in Italy	Canadian Study on crops in Manitoba
Data	Micro farm data for more than 7 000 Italian crop producers 1993-99	Aggregate data for the province of Manitoba 1960-2002
Definition of Investment	Current expenditure on machinery and buildings for crop production	Current expenditure on machinery and equipment for crop production
Main Model	Structural model based on individual maximization of profits	Reduced form models with distributed lags
Government programmes	Price support and area payments	A set of different available programmes (GRIP, WGTA, NISA)
Estimation of impacts	Direct estimation of price and payments impacts and simulation of a policy shock	Simulation of programme impacts through their incidence on incentive prices and variability

The Italian study on the crops sector [AGR/CA/APM(2005)13/FINAL]

11. The main objective of this study is to estimate the importance of the dynamic investment effects of area payments using farm level data from the Italian FADN survey. It investigates the investment response by crop producers under the assumption that they are risk averse, and there is uncertainty concerning prices. A dynamic econometric model is estimated. Investment is defined as current expenditure on machinery and buildings for crop production. This paper uses the same data as OECD (2002), which studied risk related effects, and it makes estimations and simulations in a way that can be compared with the results obtained in that paper.

12. The model develops a consistent decision making framework for the farmer. The farmer's objective is to maximise his well-being from farming, both currently and in the future. His well-being is affected both by expected returns and by the risk associated with those returns. The estimated model reveals if the farmer is indeed risk averse under the assumption of constant relative risk aversion. The form of the estimated equations is derived from optimal control theory. The estimation requires a two stage procedure. A first stage estimation of a probability (probit) model for investment tackles the problem that a large number of farms in the sample do not engage in any investment during the period. The estimated

equations in the second stage provide estimates for all the relevant elasticities of production, land and investment with respect to prices, payments and price variability. The estimated equations are then used to simulate a reduction in intervention prices that is partially compensated by a payment per hectare. Following the methodology defined in OECD (2001), the impacts of this simulation are decomposed into four components: relative price effects, relative payment effects, insurance effects and wealth effects.

The Canadian study: Manitoba crops sector [AGR/CA/APM(2005)14/FINAL]

13. The province of Manitoba is selected as an example of Canadian prairie crop production, and investment is defined as current expenditure on machinery and equipment for Manitoba crops (except potatoes) production (data is not specific for each commodity). Econometric results are used to simulate impacts of agricultural programmes on crop investment. Investment is explained in terms of price effects, wealth effects, and insurance effects. The major price variables are an aggregate index of expected output prices for the six major crops and an aggregate index of price variances and covariances for these crops. A standard index approach is used to aggregate expected prices. An index approach to aggregation of price uncertainty is developed and shown to be critical to this study. Initial wealth is approximated as the value of cropland and buildings (value of machinery and equipment and of farm debts are much smaller and approximately cancel out). The insurance effect of farm programmes is measured by the covariance between government payments and market prices for crops. Econometric models use annual Manitoba data for 1960-2002.

14. Two alternative approaches to dynamic models of investment under risk aversion are explored: autoregressive distributed lag (ADL) models and Euler equation models. The study concludes that, given the current lack of knowledge of true structural models for dynamics, less emphasis should be placed on results for Euler equation models than for ADL models. Nevertheless the simplified structure of Euler equation models facilitates testing of certain hypotheses of interest. Investment does not appear to be limited by financial constraints, and option value may have a negative impact on current investment. The latter conjecture is consistent with the modern theory of investment emphasising the evolution of information over time and irreversibility of decisions, although the estimated elasticity is quite small.

15. The estimated models measure the impacts of expected prices, price variances, wealth and insurance effects on investment. By specifying the effects of government programmes on these variables, an estimate of the effect of these programmes on investment may be obtained. A critical assumption here is that similar expectation and response processes apply to these programme effects as in the aggregate. This approach is applied to several Canadian agricultural support programmes in the province of Manitoba. An alternative approach is to include programme specific variables directly in the econometric models, and so estimate programme impacts on investment and output directly. However this approach is inappropriate for countercyclical programmes.

Main results

16. The results of the econometric estimations in the two studies have to be framed in the context of their respective data sources (micro versus aggregate) and the limitations attached to these data. The main limitation of the micro data in the Italian study is the lack of information about off-farm activities and the limited variability exhibited by some variables. The main limitation of the data on Manitoba is the aggregate measurement of investment and variability in the crops sector. The econometric equations that are estimated in both studies are very ambitious and they may go beyond the information that is available from the data. However these studies are a pioneering effort to make consistent estimations of investment effects of agricultural programmes. Their results have to be interpreted with caution as first attempts to obtain consistent empirical evidence on the investment effects of Government programmes. Even if an

extrapolation to general results on investment would not be appropriate without further empirical evidence, the results are valuable as such.

Main results from the Italian study

17. The estimations in the Italian study confirm that farmers in the sample are risk averse. Furthermore, the insurance effects associated with reduction in risk dominate the simulated impacts on investments and production. These risks related effects are associated with the changes in intervention prices: a reduction in intervention prices expands the potential variability of prices. On the other hand, area payments are modelled as fixed payments that have no impact on variability.

18. The estimated investment response is very much determined by the over-capitalisation of the farms in the Italian sample. The estimated capital adjustment rates show that the stock of buildings and machinery is being reduced to a lower long run equilibrium level at annual rates of -3.4% and -11.2%, respectively. Two types of supply elasticity are estimated. The short-term elasticity corresponds to the response when only a one year adjustment in capital is taken into account. The long-term elasticity includes all dynamic adjustment. The estimated values of these two elasticities are very similar. This implies a relatively weak linkage between dynamic decisions on investment in machinery and buildings, and production. This seems to be consistent with the reality of many crop farms in Italy that are former dairy farms with unused livestock specific capital. These farms are undergoing an important structural adjustment process that involves reducing capital stocks, which dilutes the observed dynamic investment effects of area payments on production.

19. All output prices and area payments have positive and statistically significant effects on production and land use. As would be expected, the variance (used to represent risk in the model) of each output price has a significant negative effect on own production and land use. The effects of prices, variance of prices and payments on investment are also statistically significant. Cross effects of prices, payments and covariance among different commodities tend to be large and significant.

20. The long term effects of a 5% reduction in intervention prices, 50% of which is offset by a compensating area payment, are simulated using the estimated equations. There is some overcompensation in this exercise: with already low intervention prices, the reduction in the intervention price is transmitted to the expected price by less than 50%. The measurement of the degree of compensation is very important in estimating the total and relative impacts of different support programmes. Investment is estimated to fall by 13.9% under this scenario. This total effect is mainly driven by insurance effects (-13.2%). Prices become more variable and this increased variability has a disincentive effect on investment. The fall in expected prices (price effects) results in a -0.1% change in investment, while the compensation through area payments leads to a 0.3% increase in investment. Wealth effects are virtually zero. The impacts of area payments on investment are, therefore, larger than the impacts of support to expected prices when only the direct relative price effect is taken into account. However, market price support has a much larger total impact on investment than area payments due to the risk effects associated with the intervention price mechanism that is used to support prices.

21. The simulated impacts on production are positive for maize, durum wheat and oilseeds, and negative for other cereals. The index of total crop output is reduced by -0.8%. The changes in price variability associated with lower intervention prices as reflected in the prices variance-covariance matrix is the main driving force of these impacts. As in OECD (2002) insurance effects associated with policy driven reductions (or increases) in risk are the most important estimated effects, and cross effects are relatively very large for both price and variance. The impacts on production of relative prices and relative payments are, as would be expected, of opposite sign, but the relative payment effect is larger due to over-

compensation. The production impacts associated with investment effects are very small: the biggest impact being a -0.3% reduction in production of maize.

Main results from the Canadian study on crops in Manitoba

22. Econometric results for ADL investment models in the study on Manitoba suggest that expected output prices, output price variance/covariance, wealth, and the covariance between government payments and market prices have statistically significant impacts on investment in the expected direction. Typical estimates of their respective long run elasticities (sum of lag coefficients) are +1.090, -0.052, +0.760, -0.074. These estimates seem plausible even if the elasticity of wealth is larger than anticipated. They confirm the hypothesis of risk averse behaviour. These estimated elasticities are used to simulate the impacts of the main Canadian support programmes for crops in Manitoba.

23. The Gross Revenue Insurance Programme (GRIP) of 1991-95 provided payments to producers linked to crop prices. GRIP serves as a good basis of comparison for other programmes, as it was a relatively standard price support programme, and its price effects are easily simulated. The average percentage change in price due to GRIP is +12.3%. In addition there are significant insurance effects. The average long run impacts on investment are calculated as +14.6% (price effect) and +7.3% (insurance effect), for a total of 21.9%.

24. The Western Grains Transportation Act (WGTA) provided western crop producers substantial support for transport of grain to ports for export. This programme was eliminated in 1995 and farmers received compensation in the form of "transition" payments over 1996-98. The econometric models are applied to simulate impacts of the WG transition ignoring secondary effects on prices (this would require a full general equilibrium model). It was anticipated that elimination of the WGTA would result in considerable shift from grains and oilseeds into livestock and subsequent research has documented a rapid increase in livestock production in Manitoba (Doan, Paddock and Dyer, 2005). The investment analysis reported here is only designed to look at the impacts of WGTA elimination on investment supporting grains and oilseeds production.

25. Elimination of WGTA led to an average decrease of 16.5% in crop prices over 1995-2002 and to a 10.9% average decrease in price for 1996. Transition payments were 3.4% of wealth in 1996 and 2.4% of wealth in 1997 (0.7% over 1995-2002). The average annual long run impacts on investment over 1995-2002 were calculated as -19.7% (price effect) and +0.6% (wealth effect), for a total effect of -19%. Since there is ambiguity in interpreting wealth effects in the econometric model, the model was re-estimated with transition payments treated as a separate wealth variable. This did not significantly change the results.

26. The Net Income Stabilization Account (NISA) programme of 1991-2002 was designed as a commodity neutral program to encourage farmers to increase savings in high income years for use in low income years, thus smoothing incomes over time. The difficulties in measuring impacts of NISA on total wealth and total withdrawals make it more difficult to measure the impacts of this programme. NISA fund balances and withdrawals from Fund 2 are used as upper bounds on these impacts. NISA fund balances averaged 12% of wealth over 1991-2002, and withdrawals from Fund 2 show a high negative covariance with market prices and revenues, indicating the potential for significant wealth and insurance effects. Price effects seem likely to be minor, but may be important for some participants. Attempts to estimate econometric models with separate NISA-specific variables (in order to calculate NISA effects directly) were inconclusive.

27. Simulation results based on the results of the econometric models (without separate NISA variables) and the above information show the average annual impact of NISA on investment over

1991-2002 to be +6.5% (wealth effect) and +5.8% (insurance effect), for a total of 12.3%. NISA may well increase investment, but these effects, which are taken to be the upper bound, are less pronounced than for programmes such as GRIP. NISA may have resulted in some switching of investment from crops to livestock not covered by earlier programs but this hypothesis was not evaluated.

Policy implications

28. Farmers are risk averse. The hypothesis of risk aversion is confirmed in both studies, which means that farmers are willing to pay to reduce risk involved in farming. This is consistent with previous findings and it has implications both for policy makers looking at farmers' welfare and for the measurement of economic impacts of agricultural programmes.

29. Investment effects of agricultural policies on machinery, buildings and equipment can be significant. The policy scenario in the Italian study leads to reduction in investment of 14%, and the GRIP programme in the Canadian study on Manitoba increases investment in machinery, buildings and equipment in the crops sector up to 22%. Investment can be a variable of interest in itself for policy makers. All programmes investigated in the two studies have a significant impact on investment and, therefore, can potentially have an impact of future production possibilities.

30. Insurance related effects are a main component of investment effects in both studies and of production effects in the Italian study. Risk related effects are much larger than relative price effects in the Italian example, where the main driving force of the results is the insurance effects associated with intervention prices. Insurance effects are of a magnitude that is comparable to relative price effects in most policy simulations in the Canadian study on Manitoba. Wealth effects tend to be rather marginal in most of the simulations in both studies. This confirms the need to use frameworks and models with uncertainty and dynamics in order to evaluate the impacts of policy measures.

31. The two studies allow some comparisons of the investment effects of different programmes to be made. Different programmes have very different composition of price and risk related effects on investment. Market price support through intervention prices in the Italian study has a much larger impact on investment than area payments. This is due exclusively to the reduction in the variability of prices generated by intervention prices and, therefore, to insurance effects. The NISA programme in the Canadian study on Manitoba is found to have a smaller impact on investment than the GRIP programme. This is due to the assumption of absence of price effects in the first of these two programmes. Finally, the transportation subsidy WGTA is estimated to have price effects on investment that are much larger than the wealth effects associated with transition payments. These results are consistent with the general presumption that more decoupled programmes tend to have larger wealth effects and smaller price effects, while insurance effects depend on counter-cyclical aspects of the policy design. Further implications of the different investment effects of stylised types of programmes would need more empirical evidence.

32. To summarise, the two studies show evidence of large impacts of support measures on investment decisions. However, no simple rule that would allow generalisation about which instruments have the largest investment effects can be found from the evidence presented here. The feed-back from investment into production effects was not investigated in the Canadian study. The results from the FADN sample from Italy show that the production effects associated with these investment impacts are smaller than the more direct effects through relative prices and payments, although the on-going shift from livestock to crop production complicates the interpretation of the observed effects.

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