Decoupling: a conceptual overview

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DÉCOUPLAGE : UNE VUE D'ENSEMBLE DU CONCEPT

Foreword

This is the final version of a study which was carried out under the 1999/2000 Programme of Work of the Committee for Agriculture. It develops a comprehensive framework to allow the notion of decoupling to be used in precise terms, incorporating not just static price effects on agricultural production and trade, but also effects arising via wealth and risk alleviation on the creation of expectations concerning governments' future behaviour.

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TABLE OF CONTENTS

Preamble

Agriculture Ministers adopted a set of shared goals in March 1998, stressing that these goals should be seen as an integrated and complementary whole. Among the shared goals is the further integration of the agro-food sector into the multilateral trading system. In pursuit of that goal, Ministers mandated the OECD to examine ongoing and new agricultural trade and trans-boundary policy issues and their impacts, and to provide analytical support, as appropriate, to the process of agricultural trade liberalisation.

In response, the Committee for Agriculture adopted (and the Trade Committee endorsed) a comprehensive programme of work on agricultural trade policy issues, to be carried out throughout the period 1999-2000 and continuing during the period 2001-2002. The programme of work was carefully designed to incorporate specific agricultural trade policy issues that are of major interest to Member countries of the OECD, but which may also concern non-OECD countries. A wide range of issues arising at the interface of trade and domestic policy is also covered, such as the trade implications of different kinds of agricultural support measures, food safety, food security, rural development and environmental protection policies.

On-going core activities of the Committee for Agriculture such as the annual monitoring of agricultural policies and medium term outlook exercises provide an essential backdrop to the specific trade programme of work, which is being implemented on two broad fronts.

One **major element**, characterised as evaluating and strengthening trade liberalisation, aims to assist policy makers and negotiators as they enter the next round of multilateral trade negotiations on agriculture by:

— assessing in-depth the effects of the URAA on trade, on agricultural policy and on protection levels

— identifying possible impacts on trade and markets of different scenarios for further trade liberalisation

— analysing the effect of trade policy instruments such as export credits or export taxes and restrictions that have not, to date, been disciplined and the trade impacts of food aid and STEs.

The **second major** element of the agricultural trade policy work programme deals with a wide range of issues that arise increasingly at the interface of trade and domestic policy. The following issues will be examined:

— Production and trade impacts of different agricultural policy measures ranging from market price support to different kinds of direct payments and including agri-environmental measures.

(continued)

— The concept of multifunctionality and in particular relationships between policies intended to ensure an adequate supply of agriculture's non-food outputs (such as possible contributions to environmental benefits and rural development) and existing or future international commitments with respect to trade.

— Policies that contribute to improving environmental performance in ways that are consistent with agricultural trade liberalisation.

— The implications of trade liberalisation for food security in OECD and selected non-OECD countries.

— Trade aspects of domestic policies in the area of food safety and quality with respect to topical issues such as biotechnology and animal welfare.

— Trade or trans-boundary aspects of competition policy with respect to geographical labels and state trading.

Reflecting the wide range of issues, different methodologies are employed in the implementation of the agricultural trade work programme — analytical, model-based tools are used alongside statistical and descriptive approaches while some issues receive a conceptual treatment. Choice of methodology is determined by data availability and by the nature and complexity of the issues being examined, leading to either quantitative or qualitative results. In a later phase, work will be undertaken to synthesise the main conclusions and policy implications for each of the main elements of the programme.

This paper presents a conceptual analysis of "decoupling" and has been undertaken under the heading of Agricultural Trade and Transboundary Issues (Issues arising at the interface of domestic and trade policy) of the Committee for Agriculture's Programme of Work for 1999-2000. It is closely related to many other aspects of the overall work programme, including monitoring and evaluation, PEM, multifunctionality and minimally trade distorting agri-environmental measures.

EXECUTIVE SUMMARY

In order to improve understanding of the concept of decoupling by economists, policy makers and agricultural trade negotiators, all of whom use it in their deliberations but often with different meanings, a technical exploration of its meaning is proposed. The approach taken is conceptual or theoretical and it seeks to improve awareness of the different ways in which agricultural policies affect production and trade. In other words, the extent to which a measure affects production and trade is put forward as the measure of decoupling — not the way in which the measure is implemented. This allows for a wide range of effects to be taken into account, not only those that directly change relative prices of inputs and outputs.

Decoupling has become one of the key issues in agricultural policy, both at the national and international levels. The need to minimise international trade distortions associated with support to the agricultural sector was a key element in the principles for agricultural policy reform adopted by OECD Ministers in 1987. This same issue dominated much of the debate leading to the adoption of the Uruguay Round Agreement on Agriculture in 1994. In the latter, policies deemed to have no or minimal effects on production and trade were exempted from all disciplines. As a result, policies so classified have been providing a growing and important share of total support to agriculture. The extent to which the exempted policies really are production and trade neutral has attracted increasing scrutiny, including in the context of the new WTO agricultural trade negotiations launched in March 2000.

Two distinct ways of defining decoupling are put forward. The less restrictive definition requires, for a policy measure to be deemed decoupled, that production (or trade) not differ from the level that would have occurred in the absence of that measure. Such measures are described as **Effectively Fully Decoupled**. A more restrictive definition requires not only that the equilibrium level of production (or trade) be the same as without the measure, but that also the quantity adjustment due to any outside shock should not be in any way altered. Such a measure would be **Fully Decoupled**.

There are several mechanisms through which policies affect production and trade. They are cumulative and can occur simultaneously in response to a given measure.

- **Static effects** occur whenever policies affect the incentive prices of agricultural inputs or outputs. Income effects when production decisions are constrained and the effects of quantitative restrictions are also static effects.
- If farmers are risk averse any measure that reduces risk or increases farm income will have effects on production and trade -these are dubbed **effects under uncertainty**.
- **Dynamic effects** occur because investment decisions taken in one period continue to affect production in later years or because farmers have expectations concerning government behaviour that influence their decision-making.

Consequently, it seems difficult to contend that any policy measure can be entirely production or trade neutral. However, little is known about the relative importance of these different mechanisms and much research remains to be done to estimate relative effects empirically.

DECOUPLING: A CONCEPTUAL OVERVIEW

1. Introduction

The term "decoupling" has been used widely both in academic literature and among agricultural policy makers during the past decade. At times, it denotes measures that do not affect relative prices of agricultural commodities or of the inputs used to produce them. For policy makers, and in particular for those involved in agricultural trade negotiations, decoupling often refers to the effects of a measure or set of measures; more specifically, a policy is decoupled if it has no or only very small effects on production and trade. The concept of "decoupling" as used by policy makers for policies having no or minimal impact on production and trade will provide the point of departure. By exploring the different mechanisms — price and non-price, static and dynamic — through which policies create production and trade effects, this analysis will attempt to give a more rigorous economic meaning to this term by going beyond the discussion of static relative price effects to include uncertainty and longer-term dynamic effects.

Although the term decoupling was not used, it was implicit in the 1987 OECD Ministerial Communiqué which committed OECD countries to a process of agricultural policy reform in which the "long term objective is to allow market signals to influence by way of a progressive and concerted reduction in agricultural support, as well as by all other appropriate means, the orientation of agricultural production". It was used, however, directly in the 1998 Communiqué of OECD Agricultural Ministers when, in agreeing to a set of operational criteria, they affirmed that "policy measures… should be… targeted to specific outcomes and as far as possible decoupled".

In the Uruguay Round Agreement on Agriculture (URAA), signatory countries agreed to reduce their domestic support as stated in Part IV of the Agreement. However, article 6.1. allows exceptions to this commitment for measures which conform to criteria defined in Annex II. These measures (the so-called "green box") are excluded from the Aggregate Measure of Support (AMS) and are required to have no, or at most minimal, trade-distorting effects

or effects on production. More specific criteria apply to a wide range of different policy measures described in that Annex.

In fact, the term decoupled in the URAA text is applied to only one specific policy category, namely "decoupled income support". However, decoupling is clearly embodied in the idea of having "no, or at most minimal, trade-distorting effects or effects on production". Since trade has to be equal to the difference between production and consumption,[1] a completely decoupled policy should not affect either production or consumption decisions. This is why "decoupling" of agricultural support policies is an issue for third countries and has become an issue in multilateral negotiations. Theoretically, a completely decoupled policy should have no trade spill-overs across country borders (although there are few, if any, policies that in practice have absolutely no effects on production or trade). Policies that are not completely decoupled have trade spill-overs across countries; they create concern in one country about another country's policy.

The issue of decoupling has at least three relevant dimensions:

- A theoretical dimension consisting of understanding the ways in which agricultural policies potentially affect production and trade.

- An empirical dimension related to measuring the size of the production and trade effects of different policies. Most empirical studies focus only on part of the theoretical production and trade effects of policies.

- A regulatory dimension aimed at defining "best practice" in the design of the most decoupled policies or policy packages.

Much effort has already been expended in exploring these dimensions both directly and indirectly in OECD and elsewhere. The recent reclassification of measures of the Producer Support Estimate (PSE) according to implementation criteria reflects a need for more information about how policies are implemented as a prerequisite for analysis of their production and trade effects. The PEM pilot project goes further and investigates the empirical dimension by attempting to quantify the production, consumption and trade effects of a range of measures specified through a series of relative price effects arising from changes in components of the PSE (OECD, 1999*a*). A considerable body of work aimed at the regulatory or "best practice" dimension has also been undertaken. This includes the study on direct payments (OECD, 1994) which, in addition to defining general criteria for direct payments that would have minimum production and trade impacts, it also explored best practice for the

design of payments aimed at specific purposes. These were (a) improving environmental performance, (b) providing minimum income support (c) offsetting price and income variability and (d) promoting structural adjustment. In addition, several projects currently underway in the context of the 1999-2000 Programme of Work are clearly relevant to the general question of decoupling. In the agri-environmental area, one study looks specifically at criteria for minimally trade distorting measures. In the work on multifunctionality, the policy implications of the joint production relationships, when they exist, are analysed (OECD, 2001*a*). Further analysis of the notion of decoupling is clearly important in the context of the annual monitoring and evaluation exercise which evaluates developments in support and in domestic and trade policies against benchmarks — notably market orientation and targeting — arising from the various Ministerial principles for agricultural policy reform.

To date, however, the broader theoretical dimension has been neglected. The present objective therefore falls under the first bullet above and seeks to strengthen and complement other research efforts already underway. As agricultural policies have become more complex, there has been some movement away from measures affecting relative prices of outputs (i.e. in PSE terms, away from market price support). As a result, it has become important to clarify decoupling by identifying all potential sources of production and trade effects induced by agricultural policies.

This analysis of decoupling focuses on the production impacts of policy instruments or policy packages. The purpose is not to analyse welfare implications.[2] There are several potential sources of efficiency losses or gains associated with agricultural policy packages, including losses which occur when inefficient production is maintained, transaction costs of implementing policy, costs associated with raising taxes[3] and potential benefits from externalities.[4] We focus our attention on the production and trade impacts of policies and not on the associated welfare impacts. These are interesting issues that are dealt with in other work underway in OECD, but which are far beyond the scope of this paper. More generally, this paper does not investigate general economic distortions. Its purpose is to look at policy measures only from the angle of their agricultural production and trade effects.

To analyse the concept of decoupling correctly, policies already in place should be borne in mind. Despite the reforms of agricultural policies undertaken by some countries, 68% of the Producer Support Estimate in OECD countries in 1999 was in the form of market price support (OECD, 2000*b*), down from 78% in 1986-88. The percentage PSE in the OECD as a whole was 40% (OECD, 2000*b*). Despite large differences among Member countries, these

data suggest that world agricultural markets are significantly distorted by policy measures. Therefore, the impact of any policy change should be analysed in a context which recognises that the status quo is already highly influenced by existing policies.

This paper is organised as follows. An appropriate definition of decoupling is examined in section 2. The production and trade effects of policies in a static world with certainty are studied in section 3 and in section 4, the focus is placed on the production and trade impacts of policies in the presence of risk. In section 5, the dynamic effects on production and trade are considered. The relative price effects on production and trade studied in a static framework in section 3, remain when risk or dynamic effects are introduced into the analysis. That is, these channels of impact are cumulative and not alternative.

2. A definition of decoupling

Even if the general meaning of the term "decoupling" seems clear and well accepted, there are several difficulties in arriving at an operational definition. Several concepts summarised in Box 1 are introduced below

The policy package matters

A set of tightly coupled measures operating together as a single package could have a zero net effect on equilibrium prices and quantities, even if the individual measures have a significant impact on production decisions. This is the case of a coupled payment, the production effect of which is offset by a quantity restriction. The payment alone would have a significant effect on production and the quantity restriction would also have such an effect. However, the package — assuming there is enough information available — could be designed to have zero or even negative production effects. A similar situation occurs when the same measure covers several products; the measure applied to a single commodity could have much larger production effects than if applied to a broad group of agricultural products due to the existence of substitution effects in production.

We will assume that any test for "decoupling" can and should be applied to different kinds of policy packages: those including specific measures for a single product and those including a bundle of different measures applied to several products. However, any assertion on "decoupling" applied to a measure or a package of measures requires a detailed analysis of all the

elements included. Abstract statements on general types of measures should be interpreted cautiously.

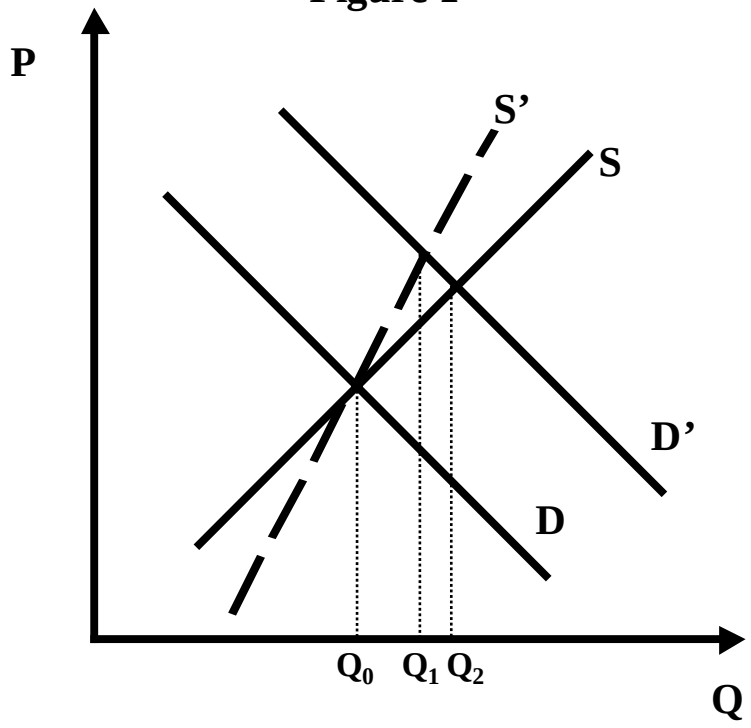
Decoupling: a concept focused on equilibrium or a concept focused on adjustment?

The extract taken from the 1987 Ministerial Communiqué focuses on allowing market forces to determine equilibrium prices and quantities. Policies should not distort decision making by producers (or consumers) and markets should adjust as if there were no policy in place. This restrictive concept of decoupling corresponds to the definition of a Fully Decoupled package given by Cahill (1997). Under this definition, the demand and supply functions remain unchanged when a package of policy measures is introduced. There is no change in equilibrium prices and quantities, and there is no difference in the response of the market to any exogenous shock arising on the demand or the supply side.

However, the definition of decoupling implicit in Annex II of the URAA is not so restrictive. The general requirement is that there should be no, or at most minimal, effects on trade and production. This concept is in line with the definition of an Effectively Fully Decoupled package given by Cahill (1997): a package that "results in production that, for any product, does not exceed the level that would exist without it". This means that the introduction of the package would not increase the level of production. Production decisions by farmers could be affected by the package, but in a way that does not result in larger production. Following the introduction of an Effectively Fully Decoupled package of policy measures the response of supply to an external shock could be different.

A policy package with a zero net effect on production, that is Effectively Fully Decoupled, is very unlikely to be Fully Decoupled in the restrictive sense. This means that the package could have a zero net effect on equilibrium prices and quantities, but result in significantly different responses to exogenous shocks. This situation is represented in Figure 1. Starting from demand function D, supply function S and equilibrium quantity Q_0, a policy package changing the supply curve to S' would have no effect on production. However, a demand shock that moves the demand schedule to D' will lead to an equilibrium quantity Q_1 which differs from the quantity Q_2 that would have been produced if the policy was not in place. In this example, the policy measure reduces the degree of adjustment to shocks on the supply side.

Figure 1



An example in an open economy of this kind of supply responsiveness effect is an administered price fixed exactly at the world level, with the government ready to erect border measures to maintain this price. The introduction of such an administered price would have zero effect on production and trade. However, any shock in the world market would not be transmitted to producers. In this restrictive sense, zero market price support does not mean full decoupling of price support measures.

Whenever the term "effective" is attached to the term "decoupling", it refers to the less restrictive equilibrium concept of decoupling. Whenever "decoupling" is not qualified as "effective", it refers to the more restrictive adjustment concept. With these very specific meanings, both concepts can be applied to policy measures and packages.

Symmetric or asymmetric definitions of decoupling

The definition of Effective Full Decoupling by Cahill (1997) is an example of an asymmetric definition of the concept. Decoupling is defined with respect to policies that do not increase production. Under this definition, an additional payment linked to production would be coupled, while reductions

would be decoupled even under the assumption that the effects are symmetric. Measures having a negative effect on production or trade will not be considered as decoupled. Most policy measures can be provided in larger or smaller amounts. Increasing the amount of one measure may have a positive effect on production while reducing it may have a negative effect on production. To avoid this problem, it seems better to consider the possibility of being coupled/decoupled in both directions: positive and negative effects on production and trade.

This criterion does not exclude the possibility of a policy change having asymmetric production and trade effects depending on the direction of the change. This is especially true under quantity restrictions that are binding or could become binding.

Degree of decoupling versus full decoupling

Given the obvious difficulty in imagining a fully decoupled agricultural policy, it seems more operational to define a degree of decoupling than to define a fully decoupled policy. Defining a degree of decoupling requires two references for comparison. These are easier to define under the least restrictive "equilibrium" concept: effective full decoupling and effective full coupling. The degree of decoupling would be a measure of the production and trade effects of a package relative to those of an effectively fully coupled policy. The definition of a "maximum" or a "total" level of coupling is more arbitrary. An increase in the effective price received by the producer is generally assumed to be the reference for full coupling [Cahill (1997) and Moro and Sckokai (1998)]. Moro and Sckokai compare the effects on production of a direct payment package with the effects of a producer price increase which *ex ante* matches the increase in revenue generated by the payment. That is:[5]

$$\Delta P * Y_0 = Payment \Rightarrow \Delta P = Payment / Y_0$$

This means that the package should be compared to an increase in market price support, both having the same *ex ante* effect on the total Producer Support Estimate (PSE). These terms of comparison are used in this paper; i.e. we compare policy packages having the same *ex ante* impact on total PSE. The Degree of Decoupling (DD) is defined as one minus the ratio of the production effect of the package over the production effect of the equivalent (in PSE terms) price increase[6]:

$$DD_i = 1 - \frac{\Delta Q_i(Package)}{\Delta Q_i(\Delta P)}$$

The DD indicator would normally have a value between zero and one. However, DD could be greater than one, meaning that the policy package has a negative effect on production. This could be the case for a policy package including a binding quantitative restriction, for which a high degree of effective decoupling would be associated with a low degree of decoupling in the restrictive adjustment meaning. It could also be the case that DD is negative in the sense that the package has a production impact larger than that of an equivalent change in market price support.

If the package covers several commodities, the increase in prices to be considered should cover the same set of commodities. In any case, the degree of decoupling would be calculated for each product. That is, a single package could have different degrees of decoupling for different commodities.

All the empirical studies on decoupling focus on the less restrictive concept defined in terms of equilibrium quantities (effective decoupling). This is because the estimation of the degree of decoupling is more difficult if applied to the restrictive concept. In fact, some of the potential production effects of policies described below arise with respect to policies and contexts for which it is difficult to define a fully coupled reference. This is the case for the effects resulting from farmers producing under binding constraints, including quantitative restrictions, and, to a certain extent, the production effects under risk.

The degree of decoupling of a policy measure could differ depending on the size or level of the change proposed. The degree of the farmer's response could change with his position on the supply curve. There could also be a different response in the long run compared to the short run. This is a general empirical issue that should be dealt with in each case.

Focusing on decoupling from production

Most of the theoretical and empirical studies on decoupling focus on the production side only. It is clear that if consumer prices are affected by a policy, it will be coupled to trade on the consumption side as well. We will introduce the specific consumption and trade dimensions of decoupling in the static framework, even if some dynamic and risk issues could also be raised. We concentrate most of our analysis on the production impacts of policy.

Policy measures may affect two kinds of adjustment:

– the individual farmer's decision on the quantity produced, and

– his entry/exit decisions.

Both are reflected in the aggregate supply curve. Some farmers may be taken over by more efficient farmers. Any payment with a requirement to plant or to remain in agriculture could prevent the entry/exit of some land that would otherwise have been taken over by other farmers, become idle or have been used for other non-agricultural activities (farms which, in the absence of the payment, would have made losses). Even if the payment itself is fully decoupled, the package may not be, at least in the restrictive sense; after an external shock, some land that would otherwise have left agriculture may remain in the sector.

Box 1. Glossary of terms

Decoupling is a general concept taken from the policy debate. This concept is inspired by the general criterion established in Annex II of the URAA (the green box) and it applies to policies having no impacts on trade and production. More precise concepts of decoupling such as full decoupling, effective full decoupling and degree of decoupling can also be used.

Full Decoupling is a formal concept taken from Cahill (1997). A policy is fully decoupled if it "does not influence production decisions of farmers receiving payments, and if it permits free market determination of prices". That is, full decoupling is a very restrictive concept that requires no change in the way farmers and consumers take decisions. It is a concept centred on the adjustment process and not only on equilibrium values. After the introduction of a fully decoupled policy, both the shape and the position of the supply and demand curves should not be changed.

Effective Full Decoupling is a formal concept also introduced by Cahill (1997). A policy is effectively fully decoupled if it results in a level of production and trade equal to what would have occurred if the policy were not in place. This concept is centred on the equilibrium quantities. The shape of the supply or demand curves could be changed by an effectively fully decoupled policy, even if the equilibrium production and consumption are not changed.

Degree of decoupling (DD) is an index to measure effective full coupling independently from the units used to measure production. If the DD index value is one, this means that the policy is effectively fully decoupled; that is, it has a zero effect on production and/or trade. If the DD is zero, this means production and /or trade effects of the policy are equal to those of a PSE-equivalent increase in effective output prices. DD could also be higher than 1 (negative production effects) or negative (production impact higher than for an equivalent PSE change in the form of market price support).

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Risk aversion is a characteristic of individual preferences when decisions are taken in an environment with some uncertainty. An individual is risk averse if he prefers a sure income rather than a lottery with the same expected value. Absolute risk aversion is usually assumed to decrease with income (DARA assumption), meaning that if the individual becomes richer, he will be more willing to take risks.

3. Decoupling in a deterministic and static world (no time, no risk)

Assume for the purposes of this section that we live in a world in which there is no risk or uncertainty affecting farmers' decision making. This provides a good benchmark to understand some important channels through which policies can affect production and trade. The effects included in this section can be fully understood in a certain and static world, but they can also operate in dynamic and uncertain frameworks.

Production effects through relative prices

There are agricultural policies that directly affect the incentive prices faced by farmers. This is obviously the case for measures generating market price support or payments based on output: they create a gap between domestic market prices and world prices, or between producer prices and consumer prices. Input subsidies have the same kind of price gap effect in the agricultural inputs markets. Per hectare payments create a gap between the supply price for the use of land and the demand price. This is true even when land prices are shadow prices and not market prices.

When measuring the degree of decoupling, we can obtain very different results depending on the nature of the ***whole package*** considered. If there are changes in prices of commodities that are substitutes through production or through input use, the degree of decoupling will be different if we consider the measures for a single commodity or the whole package. The degree of decoupling will be affected because:

- payments for other commodities may affect the allocation of land and other inputs across agricultural commodities, and the production impact of the package;
- the reference to "full coupling" for a package should take into account the change in the whole set of prices, which have cross effects on supply.

Therefore, the meaning of the index as an absolute measure to compare across countries is not clear. The measure is not robust for different definitions of the nature and limits of the whole package. For instance, a measure which involves moving from a coupled to a decoupled payment for only one product would create additional production in the other products competing for inputs such as land. This situation would create a significant production effect for a commodity that was not supported by the original measure.[7]

Box 2. Attempts to define "decoupled policies"

The idea of polices not affecting marginal prices faced by producers lead to the proposal to establish ***Production Entitlement Guarantees*** (PEGs) (D.R. Harvey, 1989). The idea is to limit the volume of production eligible for support issuing these tradable, Government-financed PEGs. The maximum supported quantity should be less than what would be produced at the world price. However, changing world and domestic market conditions could result in the payments becoming relevant at the margin, thus making the PEG proposal difficult to manage.

Attempts were made in the early 1990s to define policy instruments which redistributed income to farmers without affecting the allocation of resources. That is, ***lump sum transfers***. A publication on direct income payments by the OECD (1994) states that the general characteristics of direct income payments should be:

- "That they are directly financed by taxpayers.
- The size of the direct income payment should either be fixed or, if related to an agricultural production variable, be outside the farmers control.
- The size of the direct income payment should not be determined by the volume of current or future production of specific agricultural commodities or the level of specific inputs used".

The first avoids the existence of consumption effects, the second prevents the farmer from being able to affect the payment by production decisions and the third specifically rules out the use of measures that raise prices above international levels. The same kind of general characteristics are found in paragraph 1 of Annex 2 of URAA. The Green box general criteria also include the requirement of having no or at most minimal trade distorting effects or effects on production, which in principle covers other non price effects of policies also analysed in this paper. However, the more specific criteria to be applied to Decoupled Income Support in the Green Box concentrate only on the price effects mentioned in this section and on no production being required (paragraph 6 in Annex 2 of the URAA).

Box 3. Measuring the degree of decoupling

All policies affecting relative prices of inputs or outputs have a direct effect (or incidence) on farmers' decisions and they undoubtedly affect resource allocation in agricultural production and elsewhere. There are some ***theoretical studies*** that focus on these effects on production and consumption. Gohin, Guyomard and De Mouel (1999) develop a partial equilibrium two-product three-inputs model with the total amount of land fixed and to be allocated between the two sectors. They study the impact of payments based on each kind of input and output. They conclude that only payments based on fixed product-specific inputs are fully decoupled. However, these authors do not say which factors could be completely fixed in production of a specific product. Payments based on the use of land are coupled to the extent they affect the allocation of land. The degree of decoupling depends on the characteristics of the whole policy package affecting all the alternative products and the specific elasticity values in each country.

Under the ***Policy Evaluation Matrix*** pilot project, the OECD (1999*a*), in a stylised one-product two-inputs model, studies the ranking of the effects on production of different kinds of payments. At least three kind of payments are considered: payments based on output, and payments based on two kinds of inputs, one with a more elastic supply than the other. The study shows that the effects on production of payments based on the most rigid input are smaller than those induced by payments based on output, and both are smaller that those induced by payments based on the most elastic input. This result is consistent with Gohin *et al*. (1999).

It is also this context of relative price effects that is the focus of most of the ***empirical studies*** carried out to measure degrees of decoupling. There are some studies devoted to the European Union's Common Agricultural Policy (CAP). Cahill (1997) explores the concept of decoupling and defines a rate of decoupling consistent with our definition above. Using an empirical model of the behaviour of area and yields calibrated on 1991/92, he obtains rates of decoupling of CAP area payments in his unrestricted model between 0.5 for sunflower and 1 for wheat[8].

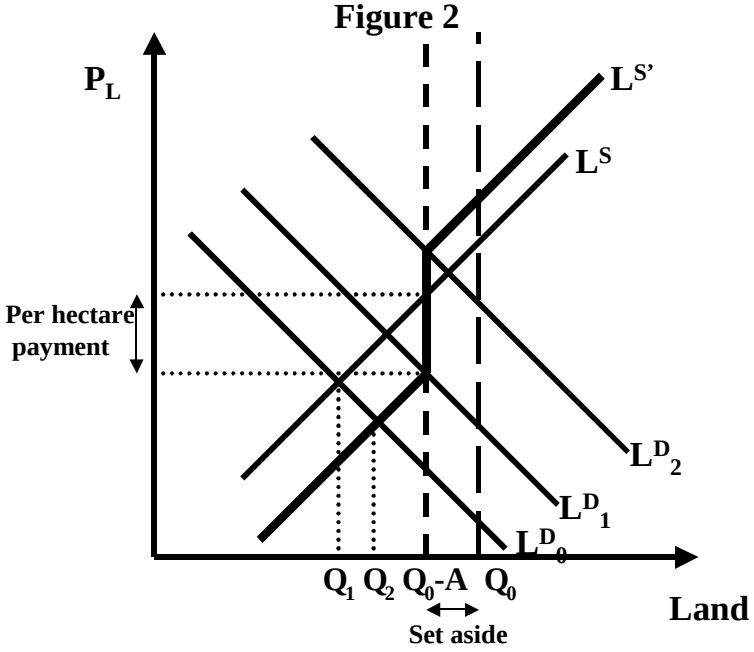
The product coverage of a support program has a significant impact on the production effects. Programs covering a wide variety of agricultural commodities tend to have smaller effects on the allocation of resources at least within the agricultural sector. For instance, area payments which are equal across all possible uses of agricultural land (total land being fixed) would have a zero production effect if there is perfect land substitutability between outputs (for instance, a linear land constraint). However, some additional land could enter into agricultural production if total land is not fixed and some reallocation of resources across commodities would occur if joint production is characterised by imperfect cost substitutability[9].

Finally, the degree of decoupling of a measure could be different for increases than for reductions in support (***asymmetric degree of decoupling***). This is true even when we consider only the relative price effects of policies in the case of a policy package that involves a quantitative limit on land, an input or the volume of production benefiting from the payment. If the constraint is binding a reduction in support could lead to a fall in production whereas additional payments will generate no additional impact on equilibrium production. However, this kind of package will reduce the production adjustment caused by exogenous shocks. Let us consider the case of an area payment granted to a maximum base area, with a set aside requirement. In Figure 2 we draw the implicit demand and supply function for the use of land for a single commodity.

The original supply function L^S is modified to the thicker linked function $L^{S'}$ when a package of per hectare payments with a compulsory set aside of A hectares over a base area Q_0 is introduced. We can consider three cases:

- If the implicit demand for land use curve is L^D_0, the package will increase the amount of land in production from Q_1 to Q_2. In fact, the set aside provision is not binding and does not affect the allocation of land. A marginal increase in the per hectare payment will have positive production effects, but a marginal increase in the compulsory set aside will have no effect on production.
- If the implicit demand for land use is L^D_1, the package will have similar land allocation and production effects. However, land use would arrive to the point at which the set aside constraint becomes binding. Therefore, a marginal increase in the per hectare payment will have no effect on production, while any increase in the compulsory set aside will directly affect land use.
- If the implicit demand for land use is L^D_2, the introduction of the package will reduce the amount of land allocated to this commodity, but only part of the total set aside imposed will result in reduced land use. A marginal increase in the payment per hectare will now be production neutral (effective full decoupling), but an increase in compulsory set aside will reduce the number of hectares used for production of the commodity in question.

Figure 2



This example shows the importance of the definition of the package (only an area payment, only set aside, or both simultaneously) for the purpose of measuring the degree of decoupling. It also shows how the production effect of policy changes can be asymmetric. In reality, few policies would generate a completely rigid section of the supply curve. There would, however, be a range in which the supply curve becomes almost completely inelastic.

Income effects when production decisions are taken under constraints

It is often assumed that the relative price effects are all production effects that can be foreseen in a static, deterministic world. This would be true in a world with non-increasing returns to scale and perfect markets with no agent being quantity constrained.[10] Under ***increasing returns to scale***, the best a firm may do is to equalise average cost and average revenue. Any payment with a requirement to plant will increase average revenue and may affect total production (Rude, 1999*a*).

The existence of market imperfections and constrained agents could mean that even lump sum income transfers with no requirement to farm have an impact on production decisions by farmers. Rude (1999) focuses on a farmer facing debt constraints (section 5); Gohin *et al.* (1999) also mention the effect on the farmer's labour supply to the farm.

Benjamin (1992) uses the ***farm household model*** to explain farmers' production decisions and concludes that if labour markets were perfect, production decisions would be separable from consumption decisions, so that lump sum income transfers would have no production effect. However, if the labour market is imperfect (there is a binding constraint on off-farm employment, some rationing on the labour demand side, or if there is a wage gap between off-farm and on-farm returns), production and consumption (and labour supply) decisions will be made simultaneously. In this case, lump sum payments will affect production decisions by farmers. OECD (1999*b*) finds that under the standard preference assumptions, lump sum income transfers will have a negative effect on labour supply and production.

To what extent is this Farm Household model with imperfect labour markets more appropriate than the neo-classical model to analyse production decisions? From the point of view of the aggregate production effects in most OECD countries, we could expect that labour market imperfections would have a limited impact. However, this is an empirical question and the important issue is that a production effect could arise from additional income transfers to farmers whenever these labour market imperfections exist.

Production effects of policies designed to control the use of inputs and to control output

Some policies are designed to control output or input use and are conditional on a quantity restriction. Figure 2 shows an example. A policy package of this kind may have a small or even a negative impact on production and trade even if both its components, taken individually, directly affect prices and factor use. Sometimes the quantity constraint is meant to offset the incidence on production and trade of other payments and measures. There are also environmental measures that aim to constrain the use of certain inputs accompanied by an incentive payment.

In either case, if the constraint on input use or output is not binding, the production impact of the constraint by itself is zero. If the constraint becomes binding, there will be an immediate effect on production decisions, normally leading to a reduction in production and/or to a reduced production responsiveness. It is very unlikely that these measures or packages are fully decoupled in the restrictive sense; that is, they will generally affect adjustment to shocks. These policies could have a high degree of effective decoupling, but a low degree of decoupling in the restrictive sense.

Decoupling from trade

This section has focused so far only on the production effects of policies in a certain and static world. However, this kind of simple world would also have ***consumption***. Relative price changes clearly affect consumption decisions. Whenever the policy measure has the effect of changing the marginal price faced by consumers, it will have an effect on consumption and trade. This effect is cumulative with the effect on production so that an increase in the domestic market price (market price support) will have the effect of increasing net exports by an amount equal to the increase in production plus the reduction in consumption. A payment based on output (deficiency payment) that does not affect the consumer price will, on the contrary, affect trade only to the extent that production is changed.

There are some policy measures oriented to affect consumer decisions. These measures are captured by the Consumer Support Estimate (CSE). If they create an incentive to consume agricultural products, they will have an effect on trade, thereby reducing net exports. The dimension of the consumption effect relative to the production effect is an empirical question and will depend both on the kind of measure and the country involved.

In the case of a small country that cannot significantly affect ***world prices***, this would be the end of the story. Any policy change affecting a big country's trade will have an impact on all other countries' production and trade. In general, the effect of coupled policies will be an increase in the net trade of the country, a reduction in other countries' exports and a fall in world prices. A set of secondary effects could arise from the change in world prices provoked by the policy change.

The change in world prices may not be transmitted to domestic producers. This would require a set of border measures that prevent ***price transmission***. In this case, the secondary effects do not occur. Of even greater relevance, the country in question will not respond to world price changes. The production and consumption adjustments required world-wide after a change in world prices must occur only in third countries. These kind of border measures isolating national prices from world market prices may have little effect on current production, but they can substantially reduce world trade responsiveness to world price and oblige additional production and consumption adjustment elsewhere. It is, nevertheless, difficult to measure a degree of "decoupling" for border measures affecting supply responsiveness. Once again, these measures could have a high degree of effective decoupling but a low degree of decoupling in the restrictive sense.

The existence of ***market power*** in upstream or downstream domestic markets, and/or in the world market could change the production effects of different policy measures. This is once again an empirical question that should be taken into account for an appropriate estimation of the trade effects of policy changes.

4. Decoupling in an uncertain world

In the real world, all farmers — like other economic agents — have to bear some degree of uncertainty in their decision making processes. This uncertainty may affect prices or any other variable affecting final production, such as weather conditions. The behaviour of individuals under uncertainty is usually described as their degree of risk aversion (Box 1). In this context, agricultural policies may generate specific impacts, especially when policies target risk-related objectives.

Insurance and wealth effects of policies

Recently there has been interest in the literature on production effects of agricultural policies under uncertainty. Hennessy (1998) developed a comprehensive ***neo-classical framework*** for the analysis of agricultural income support policies under uncertainty, following the general results of Sandmo (1971). Hennessy assumes a competitive firm maximising the expected utility of profits. These profits are a function of three variables: a farmer's decision variable, an uncertain variable and an index of the magnitude of policy support. We will assume for simplification that these variables are, respectively, the quantity produced Q, the price $\tilde{P}$ and the budget expenditure on policy measure B, with the price being the only source of uncertainty.[11] That is, the price is not known when the decision is taken, but farmers can decide the exact level of production and they know the exact determinants of the payment g. Profits are defined as market revenue minus total costs of producing Q plus the government payment g.

Hennessy finds two kinds of effects under uncertainty that would not arise in a certain world. Both require that the farmer be risk averse. A risk neutral farmer will not respond in these ways. These effects under risk are additional to the effects under certainty mentioned in section 4 and are defined as:

- *Wealth effect*. The government payment affects the total wealth of the farmer and this change in wealth can affect the farmers'

attitude to risk (risk aversion). The way in which wealth affects risk aversion depends on assumptions concerning the utility function[12]. Hennessy shows that if absolute risk aversion is reduced by the wealth effect (DARA assumption), farmers will be willing to assume more risk and therefore will produce more.

- *Insurance Effect*. The government scheme may affect the degree of risk faced by the farmer. This would be true whenever the payment function g also depends on the source of uncertainty, that is, the price. The idea is that a policy reducing the risk faced by the farmer will have a positive effect on production. It can be proved that a government scheme that increases payments when prices fall and reduces payments when prices rise will increase production if there is partial income compensation for the price movements.

Therefore, under price uncertainty and for a farmer with DARA or CARA preferences, the net effect on production of a government program g(B) will be positive in the following cases:

- *Lump sum payments*. The payment g(B) does not depend on P or Q. In this case, there may be a wealth effect but no insurance effect.
- *Production coupled payments*. That is, the payment g(B) increases with Q ($\partial g/\partial Q > 0$). In this case we have two effects: a wealth effect, and a relative price effect.
- *Payments partially offsetting price fluctuations* (price stabilisation programmes). That is, the payment g(B) decreases with P ($\partial g/\partial P < 0$). In this case, we have both wealth and insurance effects.

Hennessy's analytical results do not allow the relative magnitude of the effects of these three general types of programmes to be determined. This ranking would depend on the details of each program defined by the specific form of the function g(B). However, he makes the general statement that programs which are coupled under certainty "often have a bigger impact on decisions than similar but decoupled programs". Simulations for corn producers in Iowa estimate weak production effects for lump sum payments.[13]

There is another part of the literature based on the work by Newbery and Stiglitz (1981). This model allows labour supply decisions by the farmer to affect production decisions. It is a risk version of the farm household model

(OECD, 1999*b*) mentioned in section 3, in the case where there are ***labour market imperfections*** represented by a wage gap between on-farm and off-farm returns. Under these assumptions, and with leisure as a normal good, lump sum payments and price stabilisation programs have a negative production effect. This result is analogous to the result under certainty (see above). Quiggin (1991) finds the explanation for these opposite production effects in the labour market assumptions. The Newbery-Stiglitz model assumes farmers cannot separate production and consumption (and labour supply) decisions. Which is the most appropriate model is an empirical question, but there is no doubt that payments that are fully decoupled under certainty will have production effects under uncertainty.

Insurance effect of border measures

Border measures isolating domestic market prices from world market prices (no price transmission) could have production effects in a world with uncertainty and risk averse farmers. The effect of these measures has at least two dimensions:

- they reduce the price risk faced by domestic producers. This will create an insurance effect that could increase production; and
- they reduce the degree of adjustment in domestic markets, increasing world price variability and forcing greater adjustment in other countries. In other words, there could be a negative insurance effect on other countries' production.

The net effect under the neo-classical model will be an increase in production and net trade in the country with the border measures, and a reduction in production and net trade in other countries.

5. Decoupling in a dynamic world

In the real world, farmers also need to take the impact of current decisions on future decisions and profits into account. Assume that farmers make an inter-temporal choice involving current and future profits.[14] If there is no link between the present and the past, the results are the same as for a single period profit maximisation. Several interesting effects occur, however, when some inter-temporal links are introduced into this decision problem.

Investment decisions

Capital goods can be used at least partially in future production years. In our optimisation problem this means that production is a function of several inputs including the current level of capital, which depends on past decisions on investment. The farmer must decide each year how much to produce and invest in his farm, taking into account that any additional capital will affect both current and future production.

If ***capital markets are perfectly competitive***, the production and investment decisions are independent of consumption decisions. The level of investment will be decided on the basis of the internal rate of return of the investment on the farm compared to market interest rates. Farmers will adjust their pattern of consumption/investment decisions across time, using capital markets to borrow or lend freely. It is obvious that any kind of statically coupled payment will have the effect of pushing investment and future capital to higher levels. Therefore, statically coupled payments have an effect that carries over into future years. As a result, the production adjustment to a cut in these coupled programmes will be gradual [see ABARE (1999)]. Capital for which alternative uses cannot be found will remain in agricultural production even if coupled support policies have been removed. If capital markets are perfect, however, statically fully decoupled payments will not affect investment decisions. That is, they will also be fully decoupled in a dynamic sense.

If we have ***imperfect capital markets*** all kinds of agricultural programmes affecting farmers' income will affect investment decisions. These market imperfections include the existence of a significant gap between borrowing and lending rates and/or the presence of binding debt constraints for the farmer willing to invest (Rude, 1999*b*). Under these circumstances, farmers' decisions concerning agricultural production and household consumption cannot be separated and policies increasing income can loosen the constraints imposed by these market imperfections. Any kind of income support — even if statically fully decoupled — will be partially reinvested in agriculture, generating additional production in years to come. That is, with imperfect capital markets, no agricultural policy affecting farmer's income will be fully decoupled in a dynamic sense.

Expectations about future policies

Some policies may have dynamic elements incorporated into their design so that farmers' decisions one year may affect government payments the following year. In our optimisation problem, this means that the payment g_t

depends on past production Q_{t-1}. This is an important concern for the green box in the URAA. So-called decoupled income support requires that the payments not be based on output, prices or factors used in any year after a fixed base year. The fact that the base year is fixed is highly relevant for the degree of decoupling. The specific criteria imposed for these payments in the URAA take into account these kinds of dynamic effects.

However, policies are changed every few years or adjusted in specific years in response to external events. Farmers will observe these policy adjustments carefully and will try to guess the criteria being used by government. The way governments design, decide or adjust agricultural policies might affect expectations of benefits from future policy changes. For example, the decision to introduce area payments calculated by reference to a base year area and yield could create an expectation that, some time in the future, the policy will adjust and that current land use and yields could be the basis for the change. This might be a logical assumption given observed government behaviour.

It could also be the case that although payments were designed to have no production effect in the year in which they were granted, *ad hoc* decisions for a specific year may have a high correlation with price or quantity variables. There is no reason to assume that farmers do not take this information on government behaviour into account. If they extrapolate past government behaviour, the payment will have at least a wealth and an insurance effect. The existence of other effects will depend on the nature of the correlation observed. These effects would arise even if the payments were decided after farmers had made their production decisions (Young and Westcott, 2000). That is, a policy that has a high degree of decoupling theoretically could be implemented in a way that creates expectations of payments somehow coupled to current production. This "expectations" effect requires the existence of some uncertainty about future policies.

The issue of expectations of future agricultural policies becomes more relevant when we consider the effects of a whole complex package of policy measures evolving over time. The fact that programmes benefiting farmers are replaced by new programmes which also benefit farmers confirms the impression that one needs to be a farmer in order to benefit. The pay-off for continuing to farm may be uncertain but has a positive expected value. Farmers may perceive that the probability of receiving future payments depends on present production. As shown in the example presented in Annex 1, the expected payments from future programmes may affect farmers' decisions. The relevant issue for this "expectation effect" is that farmers believe that current production may have a positive effect on the probability of and/or the amount of

payments received in the future. The fact that this is not written or stated anywhere does not exclude this effect. If this is the case, farmers will produce more than if the programme was not in place and they will probably adjust less to external price shocks.

In this context, the production and trade effects of a broad, complex policy package could be different than the sum of the effects of the individual measures included. This would be the case when farmers change the way they respond to policy changes once the package is in place. The main mechanism that could explain this change of behaviour is related to the expectations effect. We could have different degrees of decoupling for a single measure when a complex package is in place compared to the same measure where there is no initial policy.

Any further assertion in this area of expectations would require additional assumptions about the way farmers generate their expectations about policy. There are no developments in this direction in the literature. Some arguments on the advantages and disadvantages of discretionary policy versus fixed rules and on the impacts of different assumptions about how expectations are generated (adaptive versus rational expectations) could be adapted from the literature on monetary policy.

Dynamic decoupling from trade

It seems unlikely that the dynamic dimension has a very significant impact on consumption decisions. However, all measures affecting ***stockholding*** will have a dynamic impact on trade. Policies can create incentives for stock holding or just imply a government decision to engage in public stockholding. These policies are dynamic in nature since they operate by keeping part of current production to be sold in some year in the future. Very often they have an immediate effect on trade and therefore are, in general, coupled to trade. Some policies not directly related to stockholding may, nonetheless, have an indirect effect on stockholding decisions. Such situations usually combine both dynamic and uncertainty elements. For instance, price support measures can create expectations of future prices that some stockholder may be willing to profit from. In principle, all stock holding effects on trade should cancel each other across the years so that, on average, stockholding effects on trade are zero.

Conclusions

Most of the literature on decoupling has focussed on the static relative price effects of agricultural support. There is a large variety of additional mechanisms through which policies can affect production and trade, especially when markets work imperfectly. By including risk and dynamic effects this allows us to cover a large number of them. The specific characteristics of each policy package must be taken into account to have a complete picture of these possible mechanisms.

The concept of "effective decoupling" (policies that have no effects on equilibrium production and trade) seems more operative than the restrictive concept based on adjustment (no effects on the degree of responsiveness to shocks). It allows a definition of the degree of decoupling which, despite conceptual limitations, is applicable to a wide range of policies and frameworks. The concept of the degree of decoupling is a first attempt to measure the trade impacts of different measures. However, the restrictive concept of "full decoupling" based on the impacts of policy on the adjustment process can capture a very significant dynamic dimension of agricultural policies. The concepts are complementary and can be used to analyse policies.

An attempt to rank trade impacts of alternative policies can be useful for policy makers and trade negotiators. Given the difficulties in covering all types of mechanisms, efforts made to estimate effects for a single mechanism — for example, relative prices — are valuable. An important challenge, however, is to rank the different mechanisms by their relative potential to affect production and trade. Empirical evidence on the ranking of mechanisms will be difficult to obtain, especially when countries have a complex set of agricultural support measures in place. There seems to be some evidence that static relative price effects on equilibrium levels of production and trade are greater than the effects associated with risk. It is difficult to assess the importance of the dynamic effects, especially those related to expectations. It seems reasonable to postulate that the static relative price effects are more significant for assessing the effective degree of decoupling and that the effects associated with risk and dynamics are more likely to be significant for assessing the degree of responsiveness with respect to external shocks and market signals (full decoupling in the restrictive sense). All policy packages containing quantitative constraints may have significant implications for this second dynamic concept.

The mechanisms by which policies can affect production and trade could be grouped as:

- *Static effects*. Whenever policies affect the incentive prices of an agricultural output or input, there is a static production and trade effect. However, policies affecting only farm income — and not affecting prices — may also have static effects on production whenever markets work imperfectly or farmers make decisions under binding constraints. Market price support sustained by border measures can have an effect on production responsiveness in addition to the relative price effect. In this case, even a zero level of price support does not mean that the measure is decoupled in the restrictive sense.

- *Effects under uncertainty*. If farmers are risk averse, all policies reducing risk and/or increasing farm income may have additional effects on production and trade.

- *Dynamic effects*. Investments made in a supported framework affect production decisions in the following years. In addition, if there is uncertainty about future agricultural policies, present policies and Government decisions may affect farmers' expectations of future policies and through these channels may affect current production decisions. Complex policy packages could easily affect farmers' expectations and the responsiveness of farmers to market shocks and policy changes.

Annex 2 contains a diagrammatic representation of the main mechanisms described above. All these static, dynamic and risk mechanisms are cumulative and can occur simultaneously in response to a single measure. Under this broad framework of analysis, it seems difficult to design a policy measure not having some production or trade effects .

NOTES

1. Policies affecting stockholding decisions would also have an effect on trade and world prices. These effects are dealt with in section 5. Since most agricultural policies are oriented towards producers, most studies on decoupling focus on production. For this reason, the definitions mentioned below concentrate on production effects of policies.

2. See OECD (2000*c*) for some discussion of these welfare issues in the framework of agri-environmental policy measures

3. It is rare that any government can raise taxes without affecting the allocation of resources. This issue is dealt with in some studies, such as Parry (1997), which usually assume that raising taxes has a constant marginal opportunity cost. Moschini and Sckokai (1994) find that it is very unlikely that these losses would be larger than the welfare gains from decoupling. However, it is difficult to find a direct link between tax distortions and agricultural production and trade.

4. Externalities in agriculture are studied in other work underway in OECD. For instance, see OECD (2001*a*) and OECD (2000d).

5. P is the price of the commodity and Y_0 is the initial volume of production.

6. We could introduce a similar definition of the degree of decoupling with respect to trade.

7. This production impact could have substantially different welfare implications depending on the initial support pattern. It would lead to a better resource allocation if the production affected was not supported, but it could generate inefficiencies if production increases for highly coupled supported commodities.

8. Moro and Sckokai (1998) define a similar rate of decoupling and use a four outputs and three inputs empirical model to estimate the rates of decoupling of the same area payments with 1993-95 data. Using a dual approach to estimate profit functions, they obtain rates of decoupling for these payments of 0.5 for oilseed, 0.6 for maize and 1 for other cereals. These estimates refer to the case of identical percentage change in prices for the three commodities. Other empirical studies try to measure the "supply response effects" of policy measure, without using the concept of decoupling. Guyomard *et al* (1996) and Lin and Washington (1997) provide two examples. The empirical studies

illustrate two important issues in measuring degrees of decoupling in this context:

- The difficulty of interpreting the rate of decoupling when we have negative coupling, or whenever the calculated rate falls outside the interval [0,1].
- The importance of defining a complete package, especially when there are strong effects across commodities.

9. See Rude (1999) for a discussion of this point.

10. An economic agent is quantity constrained in a market if he is willing to buy or sell more than he effectively does at the equilibrium price.

11. In this formulation only $\tilde{P}$ is a stochastic variable. The farmer decision problem is maximising the expected utility of profits and which could be written as:

$$\underset{Q}{Max}\ E\left[U\left(\tilde{P}*Q-C(Q)+g(B)\right)\right]$$

The corresponding equivalent problem under certainty is:

$$\underset{Q}{Max}\ P*Q-C(Q)+g(B)$$

where none of the variables are stochastic.

12 . It is very common to assume constant relative risk aversion, which implies Decreasing Absolute Risk Aversion (DARA). However, Constant Absolute Risk Aversion (CARA) assumptions can also be found in the literature.

13 . M. Burfisher *et al.* (2000) also estimate very modest production effects through the risk mechanism. They simulate increases in expenditure in the main North American direct payments programmes: PROCAMPO in Mexico, PFC in the United States and NISA in Canada. They use a CGE model with an *ad hoc* representation of risk aversion as a risk premium.

14. The decision problem can be summarised as an intertemporal maximisation of the discounted sum of the stream of profits. For the simple case of only two periods and a discount rate of "d" the problem could be written as:

$$\underset{Q_t}{Max}\ \sum_{t=1}^{2}\left(\frac{1}{1+d}\right)^{t-1}*\left[P_t*Q_t-C(Q_t)+g_t(B_t)\right]$$

Annex 1

In the case of one output and two inputs, the optimisation problem for the farmer in all the sections above can be generalised with the following expression:

$$\underset{\substack{L_t, K_t, \\ t=1,...T}}{Max}\ E\left[U\left[\Sigma_{t=1}^{T}\left(\frac{1}{1+d}\right)^{t-1} * \left(\tilde{P}_t * Q_t - C_t + \tilde{g}_t(B_t)\right)\right]\right] \quad \text{s.t.} \quad Q_t = f(K_t, L_t)$$

where,

$E[.]$ denotes statistical expectation,

$U[.]$ is the utility function depending on the sum of the discounted net income stream,

$t = 1...T$ are the time periods representing the temporal horizon of the farmer,

$d \in (0,1)$ is the rate of discount applied by the farmer to future income,

$\tilde{P}_t$ is the price of the output, which is a stochastic variable,

$C_t = w_t * L_t + r_t * (K_t - \delta * K_{t-1})$ represents the total costs, L and K being input quantities (labour and land or capital) with prices w and r, and $\delta \in (0,1)$ being the inverse depreciation rate when K denotes capital,

$\tilde{g}_t(B_t) = \tilde{g}_t(B_t, Q_t, K_t, P_t, Q_{t-1})$ is the stochastic payment function which represents the policy scheme, where B is the amount of support and the other arguments potentially apply to different policy schemes,

$Q_t = f(K_t, L_t)$ is the production function.

In section 3, a static and deterministic model is considered. This case corresponds to P and g being non-stochastic and T=1. Some constraints or market imperfections are considered and should be added as additional constraints to the problem.

In section 4, we consider the existence of risk which can be represented by a stochastic output price. The nature of risk aversion is represented by the specific form of the utility function. The arguments included in the function g determine if the policy scheme is coupled to output, to input use, or to prices.

Section 5 deals with the farmer's decision making in a dynamic framework (T>1). To study the investment decisions K represents capital and δ>0. The expectation mechanism would be represented by a specific form of the stochastic function $\tilde{g}_t$. In the following example, the potential consequences of inter-temporal expectations of receiving a direct payment are examined[1]. An illustrative example is presented focussed on the farmer's production decisions, and the first order conditions are briefly analysed.

The farmer will maximise the expected sum of the discounted value of the stream of present and future profits. Two kinds of uncertain direct payments are included in profit: a lump sum transfer $\overline{Y}$ in each period with non-negative probability, and a payment per hectare $R * K_t$ (K_t being the land used in period t) with the same probability of being paid[2]. We assume that the perceived probability of payment depends on the level of production in the previous period $\rho(t) = \rho(f(L_{t-1}, K_{t-1}))$, with f being the production function with two factors considered: labour L and land K. In this example, we assume this is the only source of uncertainty for the farmer. In this specific case the policy payment function takes the form:

$$E[\tilde{g}_t] = \rho(t) * \left(\overline{Y} + R * K_t\right)$$

The farmer's production problem can be written as (when $T = \infty$):

$$\underset{L_t K_t}{Max} \sum_{t=1}^{\infty} \left(\frac{1}{1+d}\right)^{t-1} * \left[P_t * f(L_t, K_t) - w_t * L_t - \left(r_t - \rho(f(L_{t-1}, K_{t-1})) * R\right) * K_t + \rho(f(L_{t-1}, K_{t-1})) * \overline{Y}\right]$$

We obtain first order conditions for each period that can be written as:

$$\frac{w_t}{f_L^{'}(t)} = \frac{r_t - \rho(t) * R}{f_K^{'}(t)} = P_t + IPS(t) = P_t^*$$

where IPS stands for “implicit price support”:

$$IPS(t) = \frac{1}{1+d} * \rho'(t) * (R * K_{t+1} + \bar{Y}) .$$

These uncertain future direct payments have at least two different kinds of effects on production decisions:

- They reduce the cost of land used in production through the area payments. The amount of this reduction is $\rho(t) * R$. This is the standard relative price effect of area payments.

- They increase the relevant shadow price perceived by the farmer by an amount equal to IPS(t). This effect will exist for either the lump sum transfer or the area payment. It will create both an incentive to produce more and a reduction in the elasticity of supply[3]. This is specifically an expectation effect created by farmers who believe that the probability of receiving a payment in the future is attached to current production ($\rho' > 0$).

It would be more realistic to assume that there is a complete probability distribution of a direct payment associated with current production. The above is a simplified example of how farmers beliefs about future payments may affect current production decisions.

NOTES

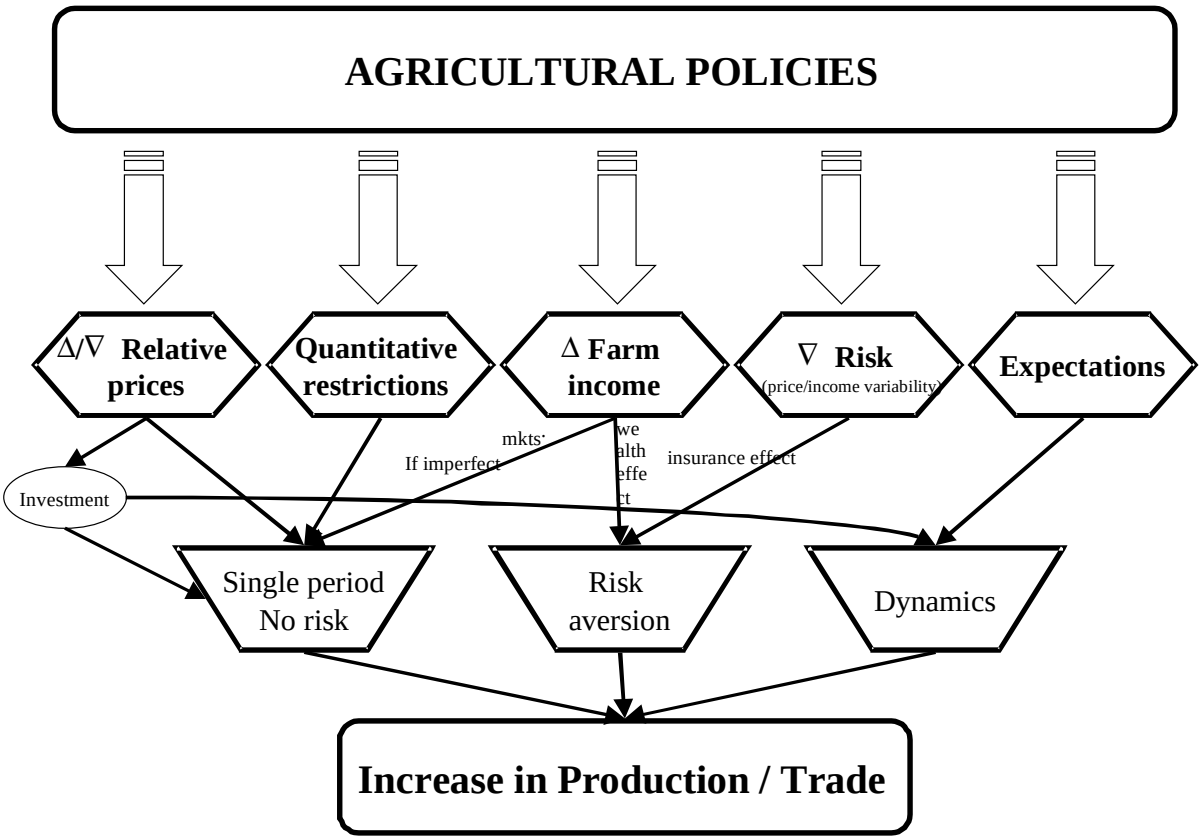
1. See Annex IV in OECD (1999*b*) for a similar development.

2. This is a binomial distribution: $g_t = \overline{Y} + R * K_t$ with probability ρ and $g_t = 0$ with probability (1-ρ).

3. This is true at least for the cases of isoelastic and linear supply functions.

Annex 2

Figure 1. Main "coupling" mechanisms.



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