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Non-trade Concerns and Domestic/International Policy Choice
by
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Abstract

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In recent years increased emphasis has been placed on a range of "non-trade" concerns and their implications for the move towards freer trade. We review the basis of several of these concerns, focusing particularly on multifunctionality. The simple view of a fixed proportions relationship between agricultural production and non-commodity outputs, such as landscape amenities, is shown to be untenable. Nevertheless, policies to internalize the effects of multiple externalities and public goods must be selected jointly to account for any interrelationships among them, and/or the market goods from agricultural production. We argue that this requires a shift away from traditional agricultural policies with their commodity orientation, towards a new policy paradigm that has a natural resource focus. We also suggest that this will require a shift in the location of where policy is formed and implemented from the center to the community level. We believe that this change in policy focus would be consistent with the move to freer trade, although some expansion would be needed in the range of policies that are considered permissible under the green box category of the WTO Agreement on Agriculture. We argue that major non-trade concerns can be satisfied in a way that is not inconsistent with freer trade, and that freer trade would not undermine important domestic objectives.

Non-trade Concerns and Domestic/International Policy Choice

David Blandford and Richard N. Boisvert[1]

Non-trade concerns have traditionally figured prominently in agricultural trade policy and in international negotiations to reduce trade barriers. For more than forty years after the conclusion of the General Agreement on Tariffs and Trade in 1947, the dominance of domestic agricultural policy objectives limited progress on liberalizing agricultural trade. Countries with high levels of domestic agricultural support pointed to a range of traditional domestic policy goals that might be undermined if trade barriers were lowered. In the Uruguay Round of GATT negotiations, launched in 1986, it was recognized that domestic agricultural policies had to be addressed, both to assure countries that domestic objectives could still be pursued, and to impose international discipline on how countries could go about this. The Agreement on Agriculture (AoA), signed in 1994, is noteworthy in that it contains provisions on both trade measures and domestic support, explicitly acknowledging the critical linkage between domestic agricultural policies and trade policies.

In recent years, the range of non-trade concerns has broadened. The list now appears to include food security, food safety and quality, animal welfare and rural development, in addition to the collection of attributes that are encapsulated in the term "multifunctionality". While the latter concept appears to have various interpretations, the major intent is to characterize agricultural production as a multi-output activity in which there are both commodity and non-commodity outputs. In addition to food, fiber and agricultural raw materials, these multiple outputs may include environmental effects, landscape amenities and cultural heritage (aspects of how land is used) that yield "social' benefits not traded in organized markets. Such non-market outputs have no price because an individual's enjoyment (consumption) of the good does not reduce the quantity available to others, and it is not possible to prevent someone consuming the good once it is made available.[2]

In addition to concerns associated with land use, certain other non-trade concerns may also have public good attributes, in particular animal welfare. However, for the most part, the remaining non-trade concerns appear to relate to whether freer trade undermines the ability of a country to guarantee a sufficient supply of domestically produced food or to maintain a level of agricultural activity that promotes the economic and social development of rural areas. Such concerns are qualitatively different from public good issues since they do not involve missing markets. Instead they relate directly to the efficiency with which existing markets function, and the acceptability of market outcomes. Public good issues are far more complex since they involve the possibility of market failure. The linkage between the two sets of non-trade concerns (public good and other) is that both may be affected by the impact of freer trade on domestic agricultural production. In this paper, we pay particular attention to the multifunctionality issue, since in our view, this raises the greatest challenge for the traditional multilateral approach to trade policy.

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[1] An earlier version of this paper was presented at the European Association of Agricultural Economists seminar on "International agricultural trade: old and new challenges", Helsinki (Finland), August 17-18, 2001.

[2] These characteristics of public goods are non-rivalry and non-exclusivity. Unlike public goods, positive and negative externalities are divisible and depletable, but are also unpriced.

We also argue that this issue places in question, the whole foundation of traditional domestic agricultural policies.

The debate on how to reconcile multifunctionality with freer trade divides along two relatively distinct lines. Some argue that without appropriate domestic policies, free trade will jeopardize public good benefits. Others believe that such policies are designed to be nothing more than trade distortions in disguise. It is easy to predict where the battle lines have been drawn. High cost producers with high levels of domestic support see the continued provision of subsidies to agriculture as the way to secure multifunctional public benefits. Low cost producers argue that such subsidies, particularly when provided through commodity programs, are neither optimal nor desirable for ensuring desired levels of public benefits. The positions of the two sides are clearly polarized.

In this paper, we argue that attempts to resolve the impasse within the traditional domestic/international trade policy paradigm are likely doomed to failure. The issues surrounding multifunctionality are simply too complex in their global, country-specific, regional, and local dimensions. We argue for a fundamental rethinking of the way in which domestic policies are formed and the approaches used to achieve desired outcomes. We argue that a new domestic policy paradigm for agriculture, which focuses on the sector's importance as a user of land and other highly valued natural and environmental resources, is long overdue.

To accomplish our purpose, we review briefly current multilateral trade policy and how it relates to the debate over non-trade issues. We make some brief comments on the relationship of this framework to food security, food safety and quality, animal welfare and rural development. We then delve in greater depth into the "multifunctionality" issue, not so much to resolve the debate over definitions, but to illustrate its varied dimensions and the futility of attempts to address them within the context of the single, simplistic policy instruments that characterize most current agricultural policies. We use this discussion to argue for a new policy paradigm and provide some concrete suggestions of where and how to focus future policy initiatives. We discuss the relationship between such initiatives and international obligations. We close by offering our conclusions, emphasizing the reasons why our new paradigm may be the only way to resolve the current policy impasse surrounding multifunctionality.

International Trade Policy and Non-trade Concerns
The coming into force of the General Agreement on Tariffs and Trade on January 1, 1948 provided the underpinning for the multilateral approach to trade issues that has characterized the period since the end of the Second World War. The preamble to the treaty identified its aims as:

> raising standards of living, ensuring full employment and a large and steadily growing volume of real income and effective demand, developing the full use of the resources of the world and expanding the production and exchange of goods through reciprocal mutually advantageous arrangements directed to the substantial reduction of tariffs and other barriers to trade and to the elimination of discriminatory treatment in international commerce (General Agreement on Tariffs and Trade 1986, p.1).

In pursuit of these objectives, eight rounds of trade negotiations have been completed, the latest being the Uruguay Round (1986-1994). Further negotiations on agriculture are currently

underway as part of the Agreement on Agriculture (AoA) that resulted from that round. The major aim of all the GATT/WTO negotiations has been the reduction of barriers to international trade on a non-discriminatory (most favored nation) basis.

The GATT included a limited set of general exceptions to the terms of the treaty (Article XX). These exceptions included measures to protect public morals; human, animal or plant life or health; patents, trademarks and copyrights; and the protection of national treasures of artistic, historic or archaeological value. However, these were not specifically identified as "non-trade" concerns.

The AoA, by contrast, includes an explicit reference to such concerns in its preamble:

> commitments under the reform program should be made in an equitable way among all Members, having regard to non-trade concerns, including food security and the need to protect the environment.

The AoA also makes reference to the special needs of least-developed and net food-importing countries, noting that:

> Developed country members shall take such action as is provided for within the framework of the decision on measures concerning the possible negative effects of the reform program on least-developed and net food-importing developing countries (Article 16).

It has been accepted in the GATT/WTO negotiations that countries at different stages of development should be allowed some flexibility in meeting domestic objectives; poorer countries, in particular, should not be held to the same standards as richer countries.

The reform commitments in the AoA relate to market access (reduction in bound tariffs and agreed import levels); limitations on export subsidies; and reductions in certain forms of domestic support. Article 13 of the AoA provides an exemption from the disciplines of the Agreement for domestic support measures that have no or minimal trade-distorting effects, or effects on production. These so-called "green-box" categories of support are summarized in Table 1.

Many of the permitted green-box measures relate to non-trade concerns. Thus, for example, public stockholding and domestic food aid relate to food security objectives; decoupled income support, income insurance and safety nets, and disaster payments relate to equity and, indirectly, to rural development aims. Other measures that relate specifically to rural development are investment aids and regional assistance. Payments for environmental purposes are also permitted.

The Agreement on Technical Barriers to Trade that resulted from the Uruguay negotiations also contains provisions relating to non-trade concerns. Thus Article 2 specifies that:

> Members shall ensure that technical regulations are not prepared, adopted or applied with a view to or with the effect of creating unnecessary obstacles to international trade. For this purpose, technical regulations shall not be more trade-restrictive than necessary to fulfill a legitimate

objective, taking account of the risks non-fulfillment would create. Such legitimate objectives are, *inter alia:* national security requirements; the prevention of deceptive practices; protection of human health or safety, animal or plant life or health, or the environment. In assessing such risks, relevant elements of consideration are, *inter alia:* available scientific and technical information, related processing technology or intended end-uses of products.

A central issue, therefore, is the extent to which existing international agreements permit countries to satisfy their non-trade concerns, and whether further reductions in tariffs, export subsidies and domestic support would undermine that ability. In order to examine these issues, we offer some comments on a range of non-trade concerns.

Food Security

The most recent and exhaustive international policy statement on food security and its relationship to international trade is contained in the Plan of Action for the Food and Agriculture Organization's (FAO) World Food Summit, held in Rome in 1996. The plan defines food security as:

> when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (paragraph 1).

The plan notes that many factors can affect the achievement of this goal. These factors include: poverty; civil strife; natural disasters; climate related ecological changes; environmental degradation; and inadequate access to the means of production (land, water, inputs, improved seeds and plants, appropriate technologies and farm credit). Trade is identified as a key element in achieving food security by promoting the effective utilization of resources and economic growth and by reducing the effects of production and consumption fluctuations, and the burden of stockholding. In addition to supporting the implementation of the Uruguay Round Agreement, the plan calls for a range of trade-related measures to achieve food security. These include: improvements in domestic marketing and transportation infrastructure; financial assistance to improve productivity and infrastructure, and to help developing countries meet food safety and sanitary requirements; measures to safeguard the ability of importing developing countries, particularly the poorest, to purchase supplies on reasonable terms and conditions; action by exporters to ensure reliability of supply, including refraining from using export restrictions; a reduction in export subsidies and responsible administration of export-related trade policies; and the promotion of national and regional food security policies and programs, particularly for food staples.

The plan stresses the importance of refraining from unilateral measures that are not in accordance with WTO obligations, in order to realize the benefits of trade for food security, and the importance of implementing the commitments to least-developed and net food-importing developing countries contained in the Uruguay Round Agreement.[3]

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[3] The Uruguay Round agreements embody provisions for "special and differential treatment" for developing countries. A special Decision sets out objectives with regard to the provision of food aid, the provision of basic foodstuffs in full grant form and aid for agricultural development. It also refers to the possibility of assistance from the International Monetary Fund and the World Bank for the short-term financing of commercial food imports. The Committee of Agriculture, set up under the Agreement on Agriculture, monitors the follow-up to the Decision.

This view of food security essentially focuses on measures that are supportive of, or complementary to, freer trade. To the extent that developing countries need to make investments that enable them to improve productive efficiency, government subsidies for investment and agricultural input subsidies for low-income or resource-poor producers are specifically exempted in the AoA. The main issues for developing countries are whether developed countries will actually deliver on their commitments to help developing countries adjust to an environment of freer trade, and whether food exporters will meet the commitment to be reliable suppliers. These issues are on the agenda for the current round of agricultural negotiations.

Some major food importing developed countries also stress food security as a concern. Rich countries do not have to worry about their ability to afford food purchases, although this may be an issue for certain disadvantaged groups of consumers in these countries. Beyond the question of reliability of supply from exporters, the key international issue seems to be whether rich countries should be allowed to subsidize domestic production in order to maintain a certain level of self-sufficiency, and, if so, how such subsidies should be provided.

Food Safety and Quality
Concerns over food safety and quality relate to whether freer trade will increase risks to human, animal or plant life and health, or will undermine food quality. The former of these concerns is currently handled by the Sanitary and Phytosanitary (SPS) Agreement that resulted from the Uruguay Round.

The SPS agreement allows countries to use sanitary and phytosanitary measures to protect human and animal or plant life and health, providing that these measures are based on scientific principles and do not arbitrarily or unjustifiably discriminate among trading partners. It calls for the recognition of equivalent measures in other countries and international harmonization of standards. The Agreement calls for risk assessment based on scientific evidence and potential economic impact.

The treatment of food quality, beyond the question of food that poses a health risk, is rather less clear in current agreements, primarily because quality is a more subjective issue than safety. The Technical Barriers to Trade (TBT) Agreement covers technical standards, including packaging, marking and labeling. It requires that imported products be accorded treatment no less favorable than that for like products of national origin, and that technical regulations should not be an unnecessary obstacle to trade. It identifies some legitimate objectives for the use of standards and for the application of available scientific and technical information in determining these standards. The Agreement calls for special treatment for developing countries and technical assistance to help them meet standards set by importing countries.

In some countries, quality and safety issues that are not, or only weakly, supported by scientific evidence have been associated with food imports – the use of growth hormones in meat production and genetically modified food ingredients fall under this category. If consumers are concerned about these attributes, labeling can be used as a means to inform them about the characteristics of the goods on offer.[4] It is also likely that food retailers will respond to consumer

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[4] Labeling is not a simple issue, however. In particular, there are important questions about what should be put on labels, and whether labeling should be mandatory or voluntary.

concerns in sourcing supplies. The use of import restrictions based upon largely subjective assessments by government officials of what constitutes an acceptable product is unlikely to contribute to consumer choice or to harmonious trading relationships.

Animal Welfare

Animal welfare has become an increasingly important issue in Europe. Legislation has been introduced at both EU and member state levels, and a number of private animal welfare schemes have been created (Blandford et al., 2002). Animal welfare is an issue that may involve a public good dimension. The way in which farmers treat animals may not affect the quality of animal products in an objective sense (although some might argue the opposite), but it may affect the well-being of both consumers and non-consumers because it offends their moral or ethical values (Blandford and Fulponi, 1999). In this sense, the act of production generates a negative output (moral or ethical dissatisfaction) in addition to the commodity (meat or eggs, for example).

As in the case of food quality, there would seem to be little justification for restricting trade based upon animal welfare concerns. To the extent that higher welfare standards impose additional costs on domestic producers, there may be a case for compensatory payments or investment aids to allow them to offset those costs. There is also a case for the voluntary labeling of products that conform to higher animal welfare standards than the norm (e.g., "free range" eggs).

Rural Development

The non-trade concern over rural development rests on the assumption that agriculture is an important part of the rural economy. In this case, a reduction in output due to the inability to compete internationally might cause a contraction in economic activity in rural areas, and possibly social disruption.

In most developed countries, agriculture accounts for a relatively small part of the economy and total domestic employment. In the European Union and the United States, for example, the sector contributes less than 2 percent of national income and 4 percent of national employment (Blandford, 2000). If we expand our definition of the sector to include activities from input supply through to retailing, agriculture is associated with a much larger proportion of income and employment.[5] In the United States, for example, the expanded sector contributed roughly 12 percent of national income and 17 percent of total employment in 1999 (Edmondson, 2001). Much of this economic activity and employment is generated outside rural areas. In the United States, 73 percent of the total employment generated by agriculture and agriculturally related industries was in urban areas in 1997; two thirds of the total employment was in wholesale and retail trade (Majchrowicz, 2001). OECD studies relating to the early 1990s, suggest that the contribution of the agricultural sector as a whole, including upstream and downstream industries, rarely exceeds 20 percent of total employment in regions that are identified as "predominantly rural" in industrial countries. Furthermore, as demonstrated by the growing proportion of farm

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[5] An expanded definition of the domestic agricultural sector inflates its importance, but the interpretation of the income and employment numbers must be treated with care. Any industry whose output is used in retail food products could lay claim to portions of the employment associated with food sales. Furthermore, in meeting consumer demands for food, it may not matter whether the agricultural commodity component is produced domestically or is imported.

household income that is derived from off-farm sources in industrial countries, it is farmers who are increasingly reliant upon other parts of the rural economy for their well being, rather than the reverse (Blandford, 1996).

Structural constraints, that limit the growth of the non-farm economy in rural areas, are a central issue in rural development. This is reflected in the difficulties that many rural populations are having in taking advantage of new technologies, particularly the Internet, and the emergence of a "digital divide" between rural and urban areas (Leatherman, 2000). It is for such reasons, that some commentators have suggested that the commodity-focus of current agricultural policies should be replaced by a rural focus (Castle, 2001).

There *are* rural areas that are heavily reliant on agriculture. This is particularly true in developing countries, where the proportion of the population employed in agriculture and the sector's contribution to employment is usually much higher than in developed countries. In developing countries, a reduction in agricultural output resulting from freer trade could have a significant impact on regional economies. As in the case of food security, the primary issue seems to be whether countries should be allowed to subsidize domestic production in order to maintain a certain level of agricultural output, and, if so, how such subsidies should be provided.

Multifunctionality
As stated above, by elevating the multifunctional non-commodity outputs from agriculture to a place of prominence, we recognize the social values of agriculture that are not traded in organized markets. To comprehend the significance of this view for domestic and international policy, we must devise a way to "level the playing field" in order to compare policies affecting the production of non-commodity outputs with those affecting commodity outputs, even though it is difficult to value non-commodity outputs or to determine how inputs are combined in their production. We need not agree on every non-commodity output to include in a definition of multifunctionality. We must agree, however, not to list only those with social benefits; there are non-commodity outputs that impose social costs. It also matters little whether these social benefits or costs derive from an externality or the public good nature of the non-commodity outputs.

We are assisted in our task by characterizing multifunctionality as joint production – a situation in which two or more outputs are technically interdependent (Shumway et al., 1984).[6] Originally, the definition of joint production focused only on commodity outputs – the classic definition refers to things that cannot be produced separately, but are joined by common origin or non-allocable input (e.g. wool and mutton from sheep, wheat and straw, or soybean meal and oil). There are two other important, but quite distinct conditions, that give rise to inter-linkages between products: when there are technical interdependencies in the production process; or when outputs compete for an (allocable) input that is fixed at the firm level.

A broader notion of joint production, where outputs occur in other than fixed proportions, was introduced by Baumol et al. (1988) to show that under free entry and exit multi-product firms will exist only if joint production is less expensive than is separate production.

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[6] This discussion draws heavily on two technical annexes prepared by Boisvert (2001) as part of an OECD report entitled *Multifunctionality: Towards an Analytical Framework*.

Recent attention has focused on the implications of this broader concept of joint production for estimating complete systems of agricultural supply and demand equations for commodity inputs and outputs (Shumway et al., 1984; Leathers, 1991). If production is joint, the nature of supply response or input demand to changes in relative prices is different than for non-joint production. There are cross-price effects among both inputs and outputs. For commodity outputs, private markets still function, and joint production is neither necessary nor sufficient for public intervention. The situation is different when non-commodity outputs are considered explicitly; it is the nature of this intervention that is at the heart of our policy discussion.

A Formal Definition

Since joint production encompasses all production situations in which two or more outputs or products are technically interdependent, joint production of outputs, Y_j ($j = 1, \ldots, m$), and inputs, X_i ($i = 1, \ldots, n$) can be described by an implicit transformation function:

$$F(Y_1, \ldots, Y_m; X_1, \ldots, X_n) = 0$$

to which the restrictions *implying non-joint* production do not apply. The most commonly quoted conditions are due to Lau (1972, p. 287):

> **CONDITION 1** The production function is non-joint in inputs if there exist individual production functions f_i such that $Y_i = f_i(X_{i1}, \ldots, X_{im})$ and $X_j = \sum_m X_{ij}$ imply $F(Y_1, \ldots, Y_m; X_1, \ldots, X_n) = 0$.

> **CONDITION 2** The production function is said to be non-joint in outputs if there exist individual input requirement functions, G_j such that $X_j = G_j(Y_{1j}, \ldots, Y_{mj})$ and $Y_i = \sum_n Y_{ij}$ imply $F(Y_i, \ldots, Y_m; X_i, \ldots, X_n) = 0$.

These are the mathematical conditions that apply when there are no technical economies or diseconomies, because of the production of the multiple outputs (1) or the use of multiple inputs (2). Although perhaps somewhat counterintuitive:

> ➢ If production is *non-joint* in *inputs*, we can define a *separate* production function for each of the products.
> ➢ If production is *non-joint* in *outputs*, there are *separate* input requirement functions.

It is clear from these propositions that "*jointness" in outputs* is pervasive in agriculture; most input demands are affected by the prices of other inputs. The case of "jointness" in inputs – where outputs are economically interdependent because of cross-price effects in supply – however, is more relevant for our purposes.[7]

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[7]A necessary and sufficient condition for technology to be non-joint in inputs is for the profit function to be additively separable in output prices Lau (1972, p. 288):

$\pi = \sum_m p_i F_i(r/p_i)$,

where F_i is the individual profit function for the *i*th output, p_i is the *i*th product price, and r is the vector of input prices. Thus, non-jointness in inputs is equivalent to:

$\partial^2 \pi / \partial p_i \partial p_j = \partial Y^*_i / \partial p_j = 0$ ($i \neq j$).

A Stylized Model of Joint Commodity and Non-commodity Outputs

In appendix I, we capture algebraically the critical aspects of joint production by using a relatively simple model. In this model, there are two commodity outputs and two non-commodity outputs – one positive environmental residual (for example, landscape) and one negative environmental externality (for example, pollution). Each commodity is produced with only two inputs, land and a purchased input.

The environmental residual is associated only with the purchased input used to produce commodity 1. Production of the residual increases exponentially with the application of the purchased input, but pollution declines if, *ceteris paribus*, production of good 1 becomes more land intensive. In this case, production of the environmental residual and good 1 is joint because they both require the non-allocable purchased input. There is no way to isolate the separate contribution of the purchased input to good 1 and the residual. Interestingly, the purchased input in this case is allocable between the two market commodities.

Landscape amenities increase with the amount of land in agricultural production, but at a decreasing rate. Land is an allocable input with respect to the two commodities, but it is non-allocable between both commodities and the production of landscape amenities. Thus, when the amenities are considered explicitly, production is joint as well. As commodity output expands, the additional inputs needed in production contribute jointly to an expansion in the non-commodity output, but not in the same proportion. This is the essence of jointness in inputs.

As output 1 expands along the profit maximizing expansion path, the environmental residual increases proportionately more. The two goods are *technical complements*, but because the environment deteriorates with production of the residual, good 1 and the environment are *technically competitive*. As either commodity output expands, the supply of the amenity increases less than proportionally to the commodity output. They are also *technical complements*.

This discussion establishes technical interdependence between joint commodity and non-commodity output; the only evidence of any economic interdependence is through commodity prices. However, it is only through the economic interdependence of joint outputs that we find the common ground on which to compare policies related to commodity as well as non-commodity outputs.

In words, the supply of an agricultural good is affected by changes in its own price, but not by prices of other goods. These products are *economically independent*. There are three cases:

- If $\partial Y_i^* / \partial p_j < 0$, then Y_i and Y_j are *economically competing*;
- If $\partial Y_i^* / \partial p_j = 0$, then Y_i and Y_j are *economically independent*; and
- If $\partial Y_i^* / \partial p_j > 0$, then Y_i and Y_j are *economically complementary*.

Leathers (1991), on the other hand, relates the notion of joint production to cost and profit by appealing to the notion of economies of scope, which can be defined in a somewhat simplified manner for our purposes. For any group of outputs, $Y_1,\ldots, Y_m$, there are economies of scope if:

$$C(Y_1) + C(Y_2) + C(Y_3) + \ldots + C(Y_m) > C(Y_1,\ldots,Y_m),$$

the cost of producing the m products jointly, $C(Y_1,\ldots,Y_m)$, is less than the cost of producing the products separately.

A Policy Interpretation

We effect our policy interpretation simply by accounting for the social values or costs of the non-commodity outputs explicitly in farmers' decisions. In so doing, the various commodity and non-commodity joint products, technically interrelated for one or more reasons, are revealed to be *economically interdependent*.[8] Further, by viewing subsidies or taxes on these non-commodity outputs as their "prices", we can compare direct policy intervention to affect the levels of these non-commodity outputs with the indirect effects that come through traditional agricultural commodity policy.

Despite the stylized nature of our model, the considerable range of technical interdependencies translates into a similar range of economic interdependencies. The two commodity outputs are *economically competitive*, while both the amenities and environmental residuals are *economic complements* with commodity output 1. The environmental residual is *economically independent* of the second commodity output, while there is an *economically complementary* relationship between amenities and commodity 2. The two non-commodity outputs are also *economic complement*s. To reflect the fact that pollution increases with the level of the residual, the tax is really a negative price. Thus, the cross effects are negative, rather than positive, for these "complements". Since environmental quality improves as the quantity of the residual falls, good 1 and the environment are *economically competitive.*

Not surprisingly, if we set the subsidy on amenities and the tax on pollution at their marginal social values in our model, we obtain the welfare maximizing Pigouvian outcome for internalizing the external benefits and costs of the non-commodity outputs (Spulber, 1985). Further, the solution aligns with Tinbergen's (1952) time-honored policy principle: we need at least as many policy instruments as there are policy objectives.

It follows immediately that an equivalent commodity output subsidy to achieve this Pigouvian outcome is possible only if there are no negative externalities jointly produced and any positive externalities are produced in proportion only to that particular commodity. Despite its simplicity, the model underscores another conclusion. Unless all multifunctional attributes occur in fixed proportions, it is not sufficient to focus only on the most pervasive externality, or combine all external values into a single index or "net" measure (Ollikainen, 1999), especially if the index includes items contributing to widely different social objectives.

In the political debate on multifunctionality, an implicit assumption often seems to be made that the multifunctional attributes of agriculture <u>are</u> supplied in fixed proportions with commodity outputs. By extension, a reduction in commodity output resulting from freer trade would lower social welfare once the value of the non-commodity outputs are taken into account. The discussion above demonstrates that the existence of such a fixed proportional relationship is extremely unlikely and consequently that this simplistic policy interpretation is likely to be flawed. What is more likely is a situation in which the public good attributes associated with agriculture can be supplied through a range of input combinations and outputs and at a range of relative prices. Of equal significance, to the extent that the public good attributes are primarily

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[8] Some might be complements with one another; others might be competitive; and still others might exhibit a complementary range as well as a competitive range.

associated with land use, they may not even be strictly linked to agricultural activities, and consequently ensuring their supply may not be linked exclusively to agricultural policy.

A New Policy Paradigm for Domestic Agriculture
If one accepts the concept of a multifunctional agriculture, theoretical analysis points towards the rethinking of domestic policy. While the application of the results must be tempered by reality, we are able to identify the essential features of a new policy paradigm.

A basic requirement in rethinking policy is acceptance of the changing status of agriculture in industrial economies. The income elasticity of demand for food and agricultural commodities in wealthy countries is very low. Agriculture is only a minor contributor to economic activity and employment. In contrast to commodities, the demand for the non-commodity outputs of agriculture appears high. As incomes and wealth increase, people place a far higher value on amenities, environmental quality (or the lack thereof), and other multifunctional outputs. Agriculture's importance is that it is a major potential supplier of such outputs.

Traditional agricultural policies, with their focus on price and income support and on commodity production, have only loosely, if at all, contributed to achieving environmental goals and satisfying public preferences for the non-commodity attributes of agriculture. Sometimes non-commodity aims have been grafted onto traditional commodity policies, where these were consistent with other aims. A case in point is the Conservation Reserve Program in the United States, which has had as much to do with income support and controlling the costs of government price support programs, as any strictly conservation aims.[9]

If multifunctionality is a key aspect of agriculture, it is no longer sufficient to have national governments set price supports for agricultural commodities, hoping for acceptable levels of jointly produced non-commodity outputs. Nor is it sufficient to ignore negative outputs or to have their effects mitigated through supplementary payments that encourage "good practices", or through regulation. With agriculture as the major user of land and other natural resources, we are long overdue for an approach to policy that recognizes explicitly the industry's critical role in the supply of highly valued non-commodity outputs.

In designing such a policy, it is important to reject once and for all the idea that commodity policy can effectively address income problems in agriculture. As economic scale in agriculture has increased, we have witnessed a continuous shift in the distribution of agricultural program payments in favor of large producers. In the United States, for example, 47 percent of the payments under government programs in 1998 went to the 8 percent of farms that had more than $250,000 in sales. The households who operated these farms had average incomes that were 2-4 times those of the average U.S. household (Hoppe, 2001). One can hardly expect programs that rely on commodity-based payments to address low incomes of small or limited resource producers. In order to do this, we would need a set of targeted policies that are not linked to production to provide an income safety net for poorer producers (Gundersen, et al., 2000). This

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[9] Similarly, traditional agricultural policies have only loosely or haphazardly related to rural development objectives, although such objectives have often been used as a justification for such policies.

would allow other policies to target the ability of farmers, regardless of the size of their operations, to deliver diverse non-commodity outputs of increasing social significance.

Some Essential Features of the New Policy Focus
In order to realize the desired supply of non-commodity outputs, even a policy with a largely rural focus would not go far enough. Many countries face growing pressures on their natural resource base (land, water and air). The future policy agenda for agriculture is likely to be driven by such pressures. The interaction between rural, urban and suburban economies and populations is critical in shaping how natural resources in rural areas are used. A classic example is the phenomenon of urban sprawl. Growth management has been a major issue in Europe since the end of the Second World War. Major urban areas in the United States have wrestled with the issue for at least the past three decades, and the issue is of growing concern in smaller population centers. The management of natural resources involves the well being of the population as a whole, regardless of location. The urban/rural distinction is increasingly blurred in addressing this set of policy issues.

The new policies must, however, bring into much sharper focus the spatial diversity of various non-commodity outputs, be they site-specific, local, area-specific, regional, or nationally differentiated. Some areas are less vulnerable to erosion; others are better suited for wildlife habitat, promoting bio-diversity, or the provision of ecological services. The demand for amenities may be stronger around urban areas. It would also be rare indeed that one technology or production technique would also dominate others in all social value dimensions.

To accommodate this diversity, the new policy agenda requires devolution in policymaking from higher to lower levels of government.[10] Because of the geographical specificity of many resource use issues, the reorientation of the policy agenda towards resource management will tend to shift the focus of policymaking and implementation to the local or community level. We already see this trend in Europe and the United States. In the European Union it is reflected in the debate over the "renationalization" of policy – the devolution of policymaking authority from Brussels to national capitals or regions.[11]

It is notable that in both Europe and the United States many of the growing number of environmental policies and programs that involve agriculture or farmland retention are legislated and administered at sub-national levels. In the United States, the first legislation to promote farmland retention was passed in New York in 1971. In the intervening years, the other 49 states have followed suit. Many localities have policies to provide open space or control the quality of the environment. In many instances state and local regulations that provide safe drinking water or relate to environmental quality are more stringent than their national counterparts.

While local considerations may dominate the majority of issues in open space, environmental quality, and other natural resource management, some transcend local boundaries. These issues

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[10] Gundersen et al. (2001) have made this argument for U.S. agricultural policy. They argue that the role of the Federal government should be limited to food safety, environmental issues that involve several states (e.g., watershed quality), and international trade issues.
[11] In a recent report prepared for the European Commission, a group of experts argued for the decentralization of policymaking oriented to agriculture in the Union, primarily to deal with the diversity of natural resource policy needs in rural areas (Buckwell, 1997).

range from those that demand regional treatment, for example, watershed protection, to trans-border issues, such as global warming, that require involvement at the highest levels of government. Higher levels of government involvement may also be required for the protection of natural resources that have particularly high existence values, such as areas of outstanding natural beauty or national parks, primarily to spread the financial burden of maintaining and protecting existing uses. Higher levels of government will also have an important role to play in the financing of policy, particularly where public goods are involved.

In the new policy paradigm, the traditional focus on commodity outputs through a standard set of commodity policy instruments, largely implemented at the national and supra-national levels, is broadened. For policy to be effective, we have already argued that implementation may be required at the local, regional or national level. To accommodate the variety in the non-commodities themselves, a whole different list of policy instruments is also called for. We already know some instruments to put on the list, but there is clearly room for further additions.

Within the new policy paradigm, programs would be administered primarily at the local or regional level. Farmers would become part of a broader class of "land and natural resource managers", toward whom policies would be aimed. They would be remunerated for their contributions to the range of positive non-commodity outputs or penalized for negative outputs. Short of being able to quantify some non-commodity outputs such as landscape amenities or identify the source of production as in the case of non-point source pollution, so that the Pigouvian policies can be applied directly, payments would have to be tied to resource use.[12] Thus, for example, if land were to be kept as open space, a payment based on land would be made with no commodity production conditions attached, except where use involved negative outputs (e.g., pollution). Resource owners would be able to choose how to use the land, within the conditions attached to the payment (e.g., land could not be diverted to a housing development or shopping center, but could be used for agriculture, as a golf course, parkland, or woodland providing that public access were maintained). In the new policy paradigm, commodity policy instruments would only be used where the production of a particular commodity resulted in a high social benefit (e.g., paying for the planting of trees because of their contribution as a carbon sink). In that case, payments could be linked to establishment (investment) costs, use of desirable inputs, or directly to the desirable output.

In highly urbanized areas, where there is intense competition for land from all sectors, annual payments may only serve to delay conversion of land to other high intensive uses for a short time (Peterson and Boisvert, 2000). Thus, there are instances in the United States where local governments have purchased or transferred development rights. This is also the principal purpose of some not-for-profit land trusts that operate in both Europe and the United States.

If the major benefits that we are attempting to realize in non-urban areas relate to how land is used, it would be desirable to tie annual payments directly to land. This would result in a substantially different distribution of payments than under current programs. Data for the United

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[12] In discussing a similar case, Peterson et al. (1999) caution that if land is subsidized and the polluting input is taxed, an optimal subsidy on agricultural land does not equal the net value of land amenities. Thus, results from non-market valuation surveys or other techniques to elicit amenity values may not be appropriate for setting the farmland subsidy, even if the values are "corrected" to account for the value of pollution generated per acre.

States illustrate the potential impact of a simple policy based on land ownership (Table 2). This table shows the distribution of payments under current farm programs in 1998 for eight classes of farms identified by the U.S. Department of Agriculture's Economic Research Service. As may be seen from the table, average gross cash income ranged from roughly $7,000 for limited resource farms to $977,000 for very large family farms. Average government payments under existing programs ranged from $722 for limited resource farms to $29,971 for very large farms. Since not all farms in each group are eligible for, or elect to receive payments, actual payments per farm ranged from $3,610 for limited resource to $51,585 for very large farms.

If, instead of the commodity programs used in 1998, a simple uniform per acre payment to landowners had been made (total expenditure constant), the resulting payment distribution would have been very different. Average payments per farm would range from $436 for limited resource farms to $13,240 for non-family farms. However, since a large proportion of the land farmed in the United States is rented from non-farmers, 42 percent of the total payments would go to those non-farmers. We are not suggesting that all land used in agriculture has the same social value and that a uniform payment to land would be appropriate, but it is clear that land-based payments would involve a radically different payment structure.

It has long been known that the transfers provided by commodity policies are eventually capitalized into land values (Floyd, 1965). Barnard et al. (2002) estimate that roughly 20 percent of the value of U.S. cropland used in the production of supported commodities in 2000 was attributable to commodity program payments. Analysis of the impact of U.S. commodity programs suggests that landowners capture the benefits of payments rapidly by adjusting farmland rental rates (Ryan et al., 2001). If the social benefit that we are trying to achieve is directly related to keeping land in agricultural use, it would seem preferable to pay the owners of that land directly for such services, rather than indirectly through commodity programs, particularly since some of these programs encourage the intensification of production. In this way, payments could be targeted directly to the desired outcome and production distortions could be reduced.

Diversity in Policy Instruments

Payments based on land may be a relatively efficient means of keeping land in agriculture and thus realizing the benefits of the non-commodity outputs of that usage for other situations. Some degree of conditionality could be attached to such payments to ensure that the land is managed appropriately. To the extent that this imposes additional costs, these will be reflected in a lower net payment to land owners or in the rental rates charged to land operators. Payment rates could be adjusted accordingly to reflect these additional costs.

In other cases, we may want to borrow policy prescriptions from other venues in order to tie the payment as close as possible to specific non-commodity outputs. If specific amenities and cultural heritage are, for example, tied closely to certain types of small-scale animal agriculture, then payments should be conditioned on maintenance of the farming system in much the same way incentives are provided to restore buildings of historical significance. If paid commensurate with the their social value, these farms may benefit more than through modest increases in commodity support and continue to coexist with larger scale operations (see appendix II).

The current rethinking of the eligibility rules for the CRP in the United States can be interpreted in terms of the joint production relationship. If payments are to capture the net public and private benefits of moving land out of agricultural production and into sound conservation practices, then by Leathers (1991) characterization, one has successfully severed the joint relationship between commodity production and the production of conservation and other environmental benefits. It is now more profitable, or less costly, to produce them separately.

In other cases, the net benefits may not be sufficient to sever the joint production relationship altogether. Thus, the optimal level of water quality might be sought through a tax on the inputs, or through incentives to adopt voluntarily environmentally friendly production practices (e.g., Wu and Babcock, 1995 and 1996; Peterson and Boisvert, 2000). To deal specifically with the problem of not being able to trace the source of groundwater pollution, Segerson (1988) describes an economic incentive scheme in the presence of this uncertainty, and monitoring that eliminates free-rider problems.

Some Other Issues

Any redirection of this magnitude in the focus of policy is certainly not without its costs. They are likely to be substantial, but the diversity of the multifunctional outputs whose levels must be sustained or enhanced is also substantial. Put differently, the policy goals implicit in this new policy focus differ markedly from those underpinning traditional agricultural policy. It is impossible to predict the budgetary cost of substantial implementation. We simply do not know whether taxpayers will be willing to pay for these outputs. Further, while it may be possible to provide some of the funding centrally, the budgetary burden would likely be less concentrated at the national level. It will be difficult to allocate the costs to the appropriate existing administrative agencies.

It is relatively certain that administrative costs would rise. In the United States, for example, the need for local policy involvement might reverse the trend in consolidation of county agricultural services. In this new policy arena, however, there would be incentive for coordination with other local efforts to deliver similar services. We also know that only selected pieces of the knowledge base required to design appropriate policies currently exist (Boisvert, 2001). Antle and Wagenet (1996), for example, argue persuasively for the need for collaboration across the full spectrum of biological, physical, and social sciences in setting research priorities and addressing the impacts of agricultural technology. The public now demands greater accountability for public objectives and the assessment of tradeoffs among economic, environmental, and health outcomes associated with agricultural technology. These same tradeoffs are at the heart of assessing the contribution of a multifunctional agriculture to a broad spectrum of social priorities.

We also know that the initial cost of a change in policy direction is likely to be registered more in political terms than in program costs. The debate surrounding the current U.S. farm bill is clearly moving legislation in the direction of targeting payments based on contributions to conservation and environmental stewardship. With pressures to constrain total expenditures, there is concern about the redistribution of program benefits away from the most productive agricultural regions toward those with a comparative advantage in valued non-commodity

outputs.[13] If the redistribution proves substantial, the legislators with the courage to embrace this new approach may be victims of the political fallout.

Implications for International Obligations

As has been indicated above, a key issue is the degree to which domestic policy objectives that fall under the heading of non-trade concerns would be undermined by freer agricultural trade. By extension, if the pursuit of domestic objectives requires some form of government support, what form should that take and can it be reconciled with international obligations?

Currently, four major types of exemption from reductions in domestic support are permitted in the AoA. These are: (1) the so-called blue-box payments (payments made under production limiting programs; exempt from reduction until 2003); (2) green-box payments that are judged to be minimally production or trade-distorting; (3) payments that are sufficiently small that they fall under a *de minimis* provision; and (4) special exemptions for payments made by developing countries. Trade-distorting payments (those that fall in the amber box) are subject to reduction.

If significant reductions were to be agreed in amber box payments, and in tariffs and export subsidies, the ability of countries to pursue domestic objectives by maintaining domestic market prices for agricultural commodities above border prices would be substantially reduced. Such policies, which tax consumers in order to subsidize agricultural production, have been the mainstay of agricultural policies in industrial countries, and the desire to protect such policies could be a major reason why some countries are arguing strongly for the consideration of non-trade concerns in the current negotiations. If such arguments are ineffective, incentives to maintain output would have to be provided through other means – in particular, through measures that reduce input costs (input subsidies) or subsidize output directly (output subsidies).

From the perspective of reducing distortions in trade volumes and prices, the switch to these alternative policy measures has much to recommend it. Since input or output subsidies affect supply directly, rather than indirectly through market prices, distortions in consumption are reduced (Blandford, 2001).[14] The problem is that under current international law, these measures would not necessarily be exempt from reductions. In particular, it is likely that output price supports would be classified as amber box measures, since they would not have a minimal effect on production and trade. Where there are non-priced outputs, such as the public good components of multifunctional agriculture, and these are linked directly to production, the minimal effect requirement creates a serious problem, since output support is necessary to correct the distortion that results from incomplete markets. In this sense, there is a clear conflict between the domestic objective of correcting a market distortion and current international law, which equates policy measures that increase output with trade distortions.

We would argue that when agriculture produces positive externalities or public goods that are not priced in the market, the issue should not be viewed as one of providing "subsidies" to

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[13] In addition to changing the distribution of payments across types of farm (in particular, reducing the amount that goes to large farms), the geographic distribution would change from the Midwest, where much of the commodity output and commodity support is concentrated, to other parts of the United States.

[14] To the extent that consumption is highly price inelastic and does not respond to changes in price, for example, for certain "basic" commodities in industrial countries, these distortions may not be large.

producers, but rather of providing the remuneration necessary to bring forth a socially optimal supply. The term "subsidy" has often been interpreted in a pejorative context in the past and used as a proxy for "distortion". The term "producer subsidy equivalent", popularized by the OECD, is an example of such terminology. The newer term used by the OECD – "producer support estimate" – while an improvement, does not capture the concept that we are proposing. It does not reflect the fact that certain payments are not forms of support, but rather payment for services rendered. Neither the term "subsidy" nor "support" reflects the fact that a payment is being made (remuneration provided) for an unpriced output that has social value.

It is our belief that terminology is important. If the logic of payment for services were to be applied, some of the traditional stigmas felt by farmers, such as that associated with being paid not to use land for agricultural purposes, might be removed. If such payments were associated with the aim of generating positive outputs, e.g., creation of wildlife habitat, farmers might not view them with such disfavor. The problem is that farmers have often been expected to supply non-commodity outputs without being paid for them, e.g., access to footpaths in the United Kingdom. With respect to that particular example, it is curious that we do not consider it unusual in most countries to use public money for the maintenance of rights of way for vehicles; but do not consider paying for the maintenance of rights of way for pedestrians.

The use of payments, tied directly to land, rather than to commodity production should be more acceptable internationally, even if they are unlikely to be totally production or trade neutral. To the extent that the income of farm operators is increased by such payments, they may choose to invest more in production activities and this will affect output. However, a given level of expenditure on a land-based payment is likely to have a smaller impact on the production and trade of a particular commodity, than the same expenditure on a commodity-based payment.

In summary, therefore, how would this new policy paradigm relate to international obligations and international trade? The shift away from commodity policy would be consistent with the move towards freer trade through the WTO. The use of payments linked to land use and resulting multiple outputs, rather than to commodity production, would eliminate the need for price supports and the trade barriers that make these possible. The use of input and output subsidies would affect production, but this would be a small price to pay for eliminating major sources of distortion in international trade. In order to safeguard the interests of other countries, the criteria to be used for resource based payments, or for input/output subsidies could be elaborated and included in an expanded green box category. It might also be desirable to replace the current requirement for notification of such payments to the WTO, by a formal review requirement for proposed policies and programs (Blandford, 2001). This is not without precedent in current international law – the current WTO agreement on subsidies and countervailing measures contains such a procedure for certain types of subsidies.

Conclusions

While a major function of agriculture is to supply the world with food and fiber, it is increasingly recognized that non-commodity outputs, ranging from effects on food safety, to the numerous effects of agriculture on the environment, to soil and land conservation, to landscape and cultural amenities, and implications for bio-diversity are of major importance.

As agricultural producers have increasingly embraced new technologies, the food and fiber output of western economies has expanded dramatically, and the structure of the industry has been changed forever. Agriculture, by most conventional measures, is now of minor importance in the overall economies of most rich countries, and in many of their rural areas. In stark contrast, agriculture's role in terms of the use of land and other natural resources has never been more critical. The competition for these resources from other sectors of the economy has intensified dramatically. Further, since the income elasticity of demand for the non-commodity outputs from agriculture is high, the value of non-commodity outputs from agriculture, many of which are linked importantly to land and other natural resources, is on the rise.

In the absence of organized markets for many of the non-commodity outputs from agriculture, their effects, be they intended or unintended, are often ignored in production decisions of agricultural producers. Without policy intervention to internalize the value to society of non-commodity outputs such as landscape amenities or costs imposed on others, such as the adverse effects on the environment, their levels may be far from socially optimal. To date, domestic policies in many countries aimed at the various externalities and public goods associated with agriculture are typically legislated and administered independently; most economic models examine externalities in isolation, implicitly assuming other externalities are fixed or are unimportant.

If the interrelationships among the externalities and public goods are ignored, "compartmentalized" government programs aimed at each independently may work at cross-purposes. Policies to internalize the effects of multiple externalities and public goods must be selected jointly to account for any interrelationships among them, and/or the market goods from agricultural production. We have argued that this requires a shift away from traditional agricultural policies with their commodity orientation, towards a new policy paradigm that has a natural resource focus. We also believe that this will require a shift in the location of where policy is formed and implemented from the center to the community level. We believe that this change in policy focus would be consistent with the move to freer trade, although some expansion would be needed in the range of policies that are considered permissible under the green box category of the AoA. Major non-trade concerns can be satisfied in a way that is not inconsistent with freer trade, and freer trade would not undermine important domestic objectives.

Appendix I
Joint Production in Four Outputs: Two Agricultural Commodities and Positive and Negative Externalities

To characterize the stylized farm situation discussed above, we begin by defining the following variables.[15] Let Y_1 = agricultural output 1; Y_2 = agricultural output 2; a = amount of landscape amenities; e = amount of environmental residual; L_1 = land input for agricultural output 1; L_2 = land input for agricultural output 2; Z_1 = purchased input in the production of output 1; Z_2 = purchased input in the production of output 2; P_1 = market price of output 1; P_2 = market price of output 2; P_L = land price; P_Z = price of purchased input; T_e = tax on the environmental residual; and S_a = subsidy on the landscape amenity.

Further, the commodity outputs and the two non-commodity outputs a and e are functions of input use:

(1a) $Y_1 = L_1^{.6} Z_1^{.2}$
(2a) $Y_2 = L_2^{.4} Z_2^{.3}$
(3a) $a = L^{.5}$; and
(4a) $e = Z_1^{2}/L_1$,
where $L = L_1 + L_2$.

Commodity output production functions are assumed Cobb-Douglas because of their widespread use in empirical production economics (e.g. Heady and Dillon, 1961) and in stylized aggregate policy analyses (e.g. Peterson et al.; 1999; Floyd, 1965; Gardner, 1987). In so doing, we also begin the analysis with functions that are separable in both outputs and inputs; by adding complexity to the model, we study the causes of jointness explicitly.

We must also specify production functions for the two non-commodity outputs. Amenities, a, increase with land used to produce both commodities, but again at a decreasing rate. For a given amount of land allocated to output 1, the production of the environmental residual, e, increases with Z_1 and at an increasing rate. For a given Z_1, the environmental residual decreases as the amount of land increases. For example, e might be the leaching of nitrates in the groundwater from the application of chemical fertilizer. Clearly, as one applies more fertilizer to a fixed amount of land, leaching would increase, as would output. However, if a fixed amount of fertilizer were applied to more land, output would rise, but leaching would fall because the fertilizer intensity of production would fall.

The technical interdependencies among all four outputs that give rise to joint production are described in the text. To demonstrate how to accommodate policy intervention for non-commodity outputs on an equal footing with commodity outputs, we must account for their social values or costs explicitly in farmers' decisions through a tax on environmental pollution and a subsidy for amenities. The farmer's profit maximizing problem is:

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[15] Several of the components of this model are similar to those in Peterson, et al. (1999).

(5a)   max $\boldsymbol{P}$ = $[P_1(L_1^{.6} Z_1^{.2}) - P_L L_1 - P_Z Z_1] + [P_2(L_2^{.4} Z_2^{.3}) - P_L L_2 - P_Z Z_2]$
L_1, Z_1, L_2, Z_2 $- T_e (Z_1^2/L_1) + S_a (L_1 + L_2)^{.5}$.

The first-order conditions for a maximum are:

(6a) $\partial\boldsymbol{P}/\partial L_1 = .6 P_1 L_1^{-.4} Z_1^{.2} - P_L + T_e (Z_1^2/L_1^{-2}) + .5 S_a (L_1 + L_2)^{-.5} = 0$;

(7a) $\partial\boldsymbol{P}/\partial Z_1 = .2 P_1 L_1^{.6} Z_1^{-.8} - P_Z - 2T_e (Z_1/L_1) = 0$;

(8a) $\partial\boldsymbol{P}/\partial L_2 = .4 P_2 L_2^{-.6} Z_2^{.3} - P_L + .5 S_a (L_1 + L_2)^{-.5} = 0$; and

(9a) $\partial\boldsymbol{P}/\partial Z_2 = .3 P_2 L_2^{.4} Z_2^{-.7} - P_Z = 0$.

As we shall see, when the value (be it private or social) of all four outputs is considered explicitly in the profit equation, this production is joint in inputs; all four outputs are *economically interdependent*. These joint economic relationships are derived in detail by Boisvert (2001). The essential features are summarized below, beginning with the case where only the commodity outputs are "priced".

Only Private Goods Valued. When both the tax and the subsidy are zero, the first-order conditions for profit maximization are the standard results. The values of the marginal products of each input used to produce the two commodities are equal to the input prices. Since only the inputs for commodity 1 are in the first two conditions, we can solve them simultaneously for optimal levels of L_1^* and Z_1^*. Similarly, we can solve the second two conditions for optimal levels of L_2^* and Z_2^*. Thus, because the production functions are Cobb-Douglas, we also know the indirect profit function is the sum of two separate indirect profit functions, one for each of the commodities. Further, it is separable in inputs, and the two products are *economically independent*. Because of their technical interdependence, the production of both non-commodity outputs is affected by commodity price changes, but there is no way to see an explicit economic relationship. By introducing the tax and subsidy one at a time, these relationships become transparent.

The Tax on the Environmental Residual, $S_a > 0$. In this case, we know that the production of commodity 1 is now more expensive, because of the implicit tax on the inputs that contribute to the environmental residual. Thus, as the tax increases, production of both commodity 1 and the environmental residual fall; the two outputs are *economic complements.*

Since *e* is written in equation (5a) in terms of its input equivalent, T_e, explicitly affects the costs, now non-linear in the input levels, of the purchased input and land used in producing good 1. This additional term reflects the social cost of each input's contribution to the environmental residual. As Z_1 increases, cost grows exponentially, production becomes more land intensive, and land's contribution to pollution reduction, *ceteris paribus*, is reflected in the fact that land costs rise only by the product of the marginal social cost of pollution times the reciprocal of land in good 1. These features of policies that tax or subsidize the externalities directly ensure their economic efficiency and set them apart from conventional taxes or subsidies on inputs or outputs (Thomas and Boisvert, 1995).

What is fascinating is the mechanism by which the outputs are reduced. The extra terms in (6a) and (7a) equal the tax on the residual multiplied by the marginal production of the residual associated with land or input Z in producing good 1. The tax on pollution mimics a land subsidy.

To restore the equality in (6a), land is allocated to commodity 1 beyond where its marginal value product equals its price. Similarly, (7a), the marginal product of Z_1 must rise (less is used), while the marginal product of L_1 must fall (land use increases). Production of the environmental residual, Z_1^2/L_1, also falls. The net result is to make good 1 more land intensive. For policy, we are reminded that as e increases, the environmental quality deteriorates; commodity 1 and environmental quality are e*conomically competitive.*

A Subsidy on Amenities $S_a > 0$. Here, the cost of land in each crop is subsidized. The rate of reduction in costs per acre actually increases with the land committed to agricultural production, but it does so at a decreasing rate. Since this is the rate at which land contributes to amenities, such a policy again would achieve the socially desirable level of amenities more efficiently than either direct input or output subsidies.

Both first-order conditions (6a) and (8a) have extra terms reflecting the subsidy on amenities multiplied by the contribution to amenities of an additional acre of land in farming. Reflecting the additional value of land to the farmer, land in both products increases beyond the point at which the marginal value product equals the price of land, and total amenities rise. Because the two inputs are complements in production of both crops, Z_1 and Z_2 must increase, leading to unambiguous increases in both commodity outputs. The landscape amenities are *economic complements* with both commodity outputs. Land is an allocable input between the two commodities but is non-allocable in its contribution to amenities.

Appendix II
Coexistence of Techniques of Production

In most countries' agricultural sectors, individual crop and livestock activities are produced using different technologies or production techniques. These techniques coexist because of regional differences in the quality of land and other natural resources, constraints facing individual farmers, and/or the natural gradual process by which farmers adopt new technology or production techniques. Further, because the production function for the commodity differs by technique, the joint production of the commodity output and the several non-commodity outputs differs as well.

To illustrate, we might think of milk production on small farms where cows are on pasture at least some of the time vs. large-scale confined dairy production where most feed is purchased. In the former case, landscape amenities could be substantial, while animal waste problem may be of relatively modest concern. On the large-scale, capital-intensive dairy operations, most feed is purchased, landscape amenities are minimal, and waste problems could be significant. Another example could be fruit production relying on substantial use of pesticides vs. production systems using integrated pest management (IPM) methods that substitute labor for capital and more frequent pesticide applications. In the latter case, problems of pesticide residues on food and health problems for the farm workers are reduced.

The effects of producing of non-commodity outputs through policy intervention will clearly differ by production technique. In some respects, the set of opportunities for policy intervention may actually be expanded.

Here, we demonstrate geometrically how the production of a single commodity can be possible using multiple production techniques. For simplicity, we assume that an original technique used in the production of an agricultural commodity uses two inputs, capital and labor.

Following McGuirk (1988), suppose that a new technique (2) is introduced, and it is more capital intensive than the original technique, but it is still characterized by constant returns to scale. Each technique can be represented by an input requirement set, $V_1(y_a^0)$, $V_2(y_a^0)$, as illustrated in Figure 1. Point H is the level of agricultural output before the new technique is introduced, and it is associated with a capital (including the land input)-labor ratio of k_a^0. After the introduction of technique 2, the effective agricultural technology set is the convex combinations of the two input requirement sets, enlarging the set to $V(y_a^0)$. The isoquant associated with $V(y_a^0)$ is identical with

that of technique 1 for capital-labor ratios less than or equal to $\tilde{k}_1$ and identical with that of

technique 2 for capital-labor ratios greater than or equal to $\tilde{k}_2$. For capital-labor ratios in-between, the isoquant is the line segment NT. The availability of technique 2 expands the number of feasible efficient production plans.

Once the second technique is introduced, given the capital-labor ratio k_a^0: $k_a^0 > \tilde{k}_1$, the efficient production plan is point A, rather than point H. At a capital-labor ratio consistent with point H, the marginal rate of technical substitution of labor for capital (MP_L/MP_K) is larger for technique 1 than for technique 2. Resources shift from the traditional technique into the modern technique,

reducing the optimal wage rental ratio, until the marginal rates of technical substitution of labor for capital are equalized between the two techniques.[16] This occurs at $\tilde{w}$, where the capital-labor ratio of technique 1 is $\tilde{k}_1$ and the capital-labor ratio of technique 2 is $\tilde{k}_2$. The assumptions on the technologies which imply that the isoquants of the individual technologies are strictly convex, also imply that for the isoquants drawn, coexistence occurs at a unique wage rental ratio, denoted here as $\tilde{w}$.

When movement of resources between sectors is restricted, the availability of a new technique leads to an increase in agricultural production--with the new technique available in agriculture, point H is on a higher isoquant.

In this example, a combination of the two techniques is used, only because it has been assumed that $\tilde{k}_2$ ($\tilde{k}_2 > \tilde{k}_1$) is greater than the original capital labor ratio (k_a^0).

In the longer term, one would expect that capital and labor would move between the sectors and production would be concentrated in the new technique. On the other hand, the joint package of non-commodity outputs may be more "socially desirable" under the established technique. In this case, *direct* policy intervention to ensure the continuation of traditional methods (as in the dairy example) or to accelerate the adoption of a new methods (as in IPM) may be in the long term public interest.

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[16]This result is true only in the short-run, during which time it is assumed that capital and labor cannot move between sectors.

**Table 1. Summary of Main Forms of Allowable Domestic Support under the AoA**

Type of Measure	Main Criteria
General Services	Must not involve direct payments to producers or processors
Public stockholding	Volumes governed by legislated food security targets, financial transparency, purchase and sale at current market prices
Domestic food aid	Clearly defined eligibility criteria based on nutritional objectives, financial transparency, purchase and sale at current market prices
Decoupled income support	Clearly defined eligibility criteria for a fixed base period, payments not related to the volume of production, prices, or factors of production in any year after the base period, no requirement to produce to receive payments
Income insurance and income safety nets	Eligibility based on income loss >30% of average gross income for the previous three year period or three year average excluding high/low from a five year period, compensation less than 70% of the income loss, no linkage to production, prices or factors of production
Disaster payments	Production loss >30% of the average for the previous three year period or three year average excluding high/low from a five year period, only for loss of income, livestock, land and other production factors, no more than replacement cost and not linked to requirements for future production, if during a disaster no more than that required to alleviate further loss
Producer retire-ment schemes	Clearly defined eligibility criteria to facilitate retirement or switch to non-agricultural activities, conditional upon total and permanent retirement from marketable agricultural production
Resource retire-ment schemes	Clearly defined eligibility criteria to remove land or other resources from marketable agricultural production, land retirement for a minimum of three years, slaughter or definitive permanent disposal of livestock, no required alternative use for marketable agricultural production, payments not related to volume of production or other resources remaining in production
Investment aids	Clearly defined eligibility criteria to assist financial or physical restructuring for objectively demonstrated structural disadvantages, payments not based on production or prices in any year after a base period, provided for a fixed period of time, no mandate for future production (except no production), and limited to the amount to compensate for structural disadvantage
Environmental payments	Part of clearly defined environmental or conservation program linked to production methods or inputs, payment limited to extra costs or loss of income caused by compliance
Regional assistance	Limited to producers in objectively identified disadvantaged regions, payments not based on production in any year after a base period (other than to reduce production) or prices, available to all producers in eligible regions, limited to extra costs of loss of income related to undertaking agricultural production in the prescribed area

Table 2. Payments under Current U.S. Farm Programs and a Land-based Program, 1998

Farm Type	Number of farms	Average gross cash farm income	Share of current payments	Average payment per farm	Average payment for farms receiving payments	Operated land per farm	Owned land per farm	Share of payments based on land owned	Payment per farm
	Thousands	Dollars	Percent	Dollars	Dollars	Acres	Acres	Percent	Dollars
Limited resource	150	7,361	1	722	3,610	111	44	1	436
Retirement	291	12,255	5	1,566	5,573	180	189	6	1,873
Residential	834	13,780	9	993	4,190	148	102	9	1,011
Low sales	422	35,800	13	2,833	6,410	453	313	14	3,102
High sales	177	161,036	24	12,870	17,024	1,167	531	10	5,262
Large	92	348,769	24	24,539	32,203	1,747	661	6	6,551
Very large	61	977,037	20	29,971	51,585	1,971	878	6	8,701
Non-family	42	566,289	4	8,970	19,714	1,670	1.336	6	13,240
Non-operators								42	

Source: based upon data from USDA (ERS). Structural and Financial Characteristics of U.S. Farms: 2001 Family Farm Report, Agricultural Information Bulletin 768, Washington, D.C., May 2001.

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Figure 1. Coexistence of Two Production Techniques
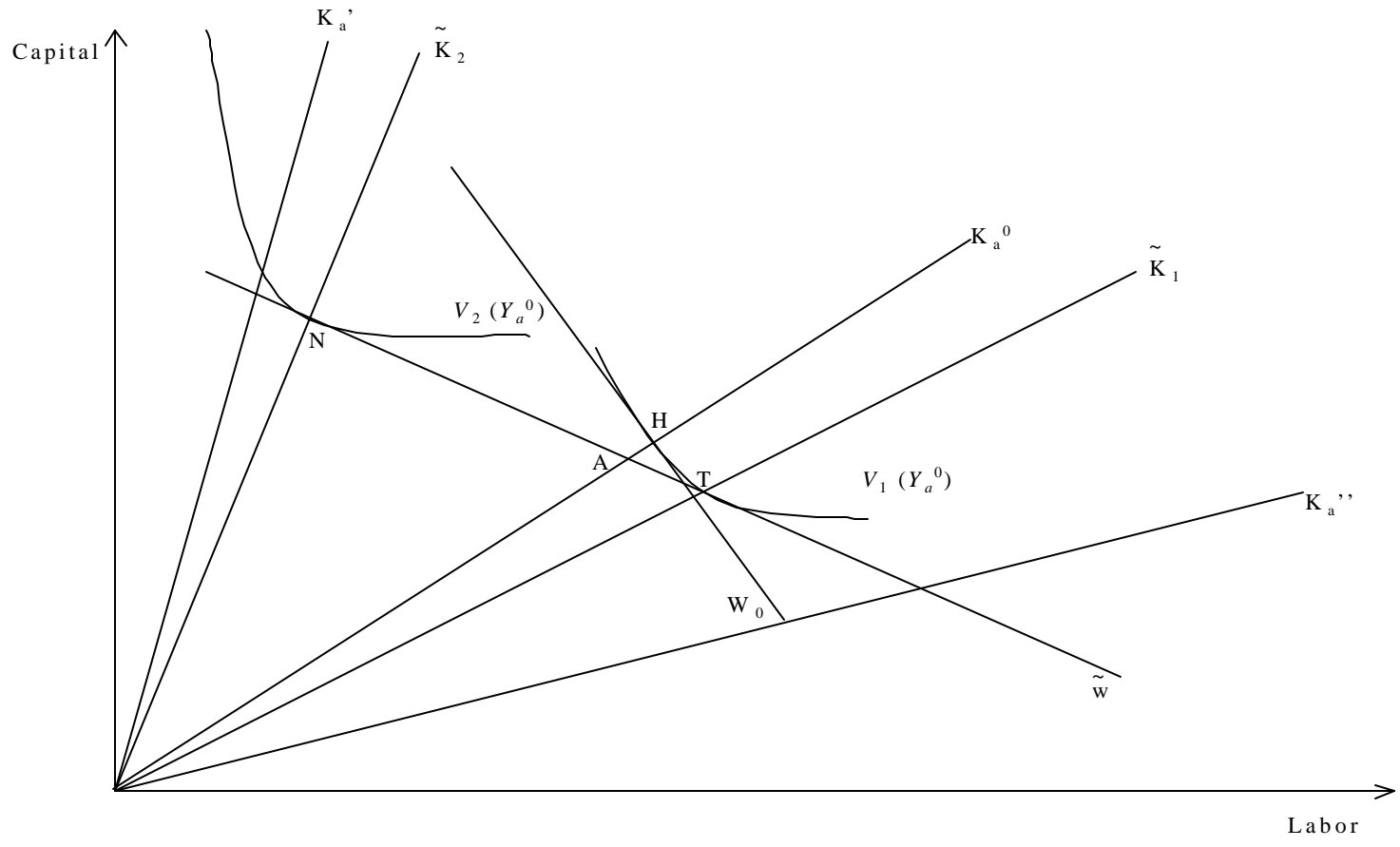
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