Cross-subsidization and Exit Deterrence due to Infra-Marginal Support: Implications for Agricultural Policy Analysis

Harry de Gorter

David R. Just

and

Jaclyn D. Kropp*

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* Associate Professor, Assistant Professor and Graduate student, respectively, Department of Applied Economics & Management, Cornell University.

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In two recent high profile trade disputes brought before the WTO, higher prices for domestic sales, which were limited by a production quota, were found to "cross-subsidize" exports in the Canadian dairy and EU sugar sectors (WTO, 2002, 2004). Domestic sales were deemed to indirectly finance losses on all over quota production exported since world market prices were below average total cost of production. Until de Gorter, Just and Kropp (2007), there had been neither a formal definition of cross-subsidization nor an economic analysis of it in the literature. In addition to the trade distortion of extra-marginal output because of declining average costs, some farms would not produce the limited amount of output entitled to the support without it in the first place. This deters exit which generates an additional source of production distortion due to infra-marginal support. Furthermore, there are other farms that would be unprofitable producing only the limited amount but would find it profitable to produce a higher amount at the margin only because of the infra-marginal support.

The issues of cross-subsidies and exit deterrence center around infra-marginal support where farms receive higher revenue on only a limited amount of output.[1] This paper determines the conditions under which output distortions occur due to exit deterrence or extra-marginal output, or both simultaneously. The WTO cases were silent about the effects on decisions to exit and determined the distortion to be only the extra-marginal output, that is, output beyond the quota. Cases of both positive and negative profits at the limited output are analyzed, as well as when price is below either average total or variable costs of production. Two theoretical results

[1] Support can be consumer or taxpayer financed. Price discrimination combined with a production quota is an example of consumer financed infra-marginal support (as in the aforementioned WTO cases) where higher prices are received for only a limited amount of output (farmers are free to produce beyond that at market prices). But infra-marginal support can also occur with taxpayer financed subsidies on the same limited quantity.

are of particular importance. First, farms will never chose to produce only the limited amount unless required to. Distortions due to extra-marginal output can only occur with exit deterrence. Second, it is also possible that infra-marginal support is more output distorting than an equivalent fully coupled subsidy.

We present empirical evidence of the various sources of output distortion with cross-subsidization by evaluating infra-marginal subsidies for U.S. dairy farmers introduced in the 2002 Farm Bill's Milk Income Loss Contract Program. Results show that output distortions due to infra-marginal subsidies are significant and close to that of a fully coupled subsidy only in the short run. We show that production distortions due to exit deterrence are much higher than the extra-marginal output distortion analyzed by the WTO.

The results of this paper have broad implications for several literatures on agricultural policies, including that on the effect of decoupled payments on output distortion, the effect of farm programs on farm size and structure, and the political economy of farm policy. Our empirical results also have implications for potential trade disputes in the future and the controversy over which type of policy goes into what "box" in the WTO trade negotiations.

Both our theoretical and empirical results are in sharp contrast to the literature, highlighting the uniqueness of our theory compared to what has been derived on infra-marginal support to date. Although the two WTO cases being considered involved consumer financed transfers to exporters via a production quota, cross-subsidization can occur for importers as well, and can also result from taxpayer financed infra-marginal subsidies. Therefore, there are important policy implications of cross-subsidization, given the increase in a wide array of policy changes over time world-wide that has resulted in a greater share of infra-marginal support in agriculture.

This paper is organized as follows. The following section first summarizes the literature on decoupled and infra-marginal support. We then present a conceptual outline of the different scenarios under which cross-subsidization occurs. The fourth section presents the empirical results for infra-marginal subsidies in the U.S dairy sector. The final section explains the implications of our theoretical and empirical results for future trade negotiations and analyzing the effect of government policies on the structure of agriculture. The final section explains the implications of our theoretical and empirical results not only for future trade negotiations and potential disputes, but also for understanding the effect of infra-marginal support on farm structure, the political economy of farm policy and the economic efficiency of meeting policy goals like keeping small farms in business.

Background

The literature on the economics of cross-subsidization is non-existent except for Tangermann (1997), the only study cited in the WTO rulings. Tangermann (1997) explains:

> "Price support within quotas has the effect of covering…fixed costs…above-quota production can be sold even if the price received for it covers only marginal cost of production…at least some of above-quota production is effectively cross-subsidized".

This provides a basis for our general theory, even though we will show that fixed costs are not necessary for cross subsidization to occur, prices can be below average variable costs of production and that all above-quota production is cross-subsidized for those farms that would not be in business without the infra-marginal subsidy. In addition to profits on high priced quota production financing losses in export markets, Tangermann (1997) includes the export subsidy effect of price discrimination and revenue pooling in his definition of cross-subsidization.[2]

[2] Canadian dairy policy also consisted of a revenue pooling scheme, which can be more trade distorting than a traditional taxpayer financed export subsidy (Sumner, 1996; Alston and Gray, 1998; Schluep and de Gorter, 2001). In this paper, distortions in consumption are ignored, as trade distortions are measured only vis-à-vis changes in production.

Our analysis contributes to the emerging literature on the production effects of decoupled programs. Some argue that the effects of decoupled programs in the United States have been negligible (see Burfisher and Hopkins (2003), and the background studies for that report). Many other studies find varying degrees of distortion, presenting several arguments as to how payments seemingly not tied to current production can still provide production incentives. These mechanisms include wealth effects that impact attitudes towards risk; decisions on leisure and savings; overcoming credit constraints or other input market imperfections; and farmer's expectations about future government decisions on agricultural policy (Abler and Blandford, 2005; OECD, 2005; Goodwin and Mishra 2006; McDonald et al., 2006; and Sckokai and Moro, 2006). Our paper adds to this literature by explaining how cross-subsidization is another mechanism by which production can be distorted.

The agricultural trade literature to date concludes that infra-marginal support does not distort production provided the level of the infra-marginal output receiving the higher per unit revenue is less than the level of output that would otherwise occur at free trade (Alston, 1992; Alston and Hurd, 1990; Blandford, de Gorter and Harvey, 1989; Borges and Thurman, 1994; Rucker, Thurman, and Sumner, 1995; and Sumner and Wolf, 1996). The conclusions of the literature are best summarized by Rucker and Thurman (1990):

> "An unusual feature of the peanut program is that there is little or no deadweight loss from allocative inefficiency: the quantity of peanuts produced under the program is the same as the quantity that would be produced in a free market".[3]

Infra-marginal support is deemed to have no effect on the level of output because it does not influence production decisions on the margin. However, we show how infra-marginal support

[3] Sicular (1988) comes to the same conclusion but recognizes in the case of Chinese agriculture that infra-marginal prices can indirectly affect production through their effects on income distribution that changes consumption and hence market prices. We ignore these second round effects in this paper.

cross-subsidizes lower priced output by deterring exit and by expanding output beyond the infra-marginal level receiving support.

The WTO panel rulings only addressed one aspect of cross-subsidization, or more specifically, the extra-marginal output and failed to analyze the output distortions due to exit deterrence. In addition to all of this, the WTO Panel only evaluated cases where prices were below average total costs of production, as variable costs were considered explicitly to be covered. We show that cross-subsidization can also occur if world prices are below the average variable costs of production. Although the two WTO cases being considered involved consumer financed transfers to exporters via a production quota, cross-subsidization can occur for importers as well, and can also result from taxpayer financed infra-marginal subsidies. This means cross-subsidization and ensuing trade distortions can arise from a wide array of policies; any policy in which producers receive a higher per unit revenue on a limited amount of production can potentially lead to cross-subsidization. Close examination of OECD data in table 1 shows an increase in infra-marginal support such as counter-cyclical payments, payment limits per farm, payments based on a limited amount of output or inputs (e.g. land or animal numbers), production quotas and historical entitlements. Governments are not only moving away from border to domestic support, the composition of domestic support itself has shifted from fully coupled towards that only partially tied to production.

Therefore, the dispute settlement panel rulings on domestic production quotas with infra-marginal support open the door for an array of domestic support programs to be subject to the same WTO disciplines. Domestic support is currently classified under the WTO Agreement on Agriculture as falling into three "boxes." *Amber Box* policies are those deemed to be the most trade-distorting and hence subject to disciplines. All other boxes are exempt from reductions.

Blue Box policies are potentially trade-distorting, but are considered less trade distorting than Amber Box policies as they include supply restrictions. *Green Box* payments are those subsidies that are not related to current output and are therefore considered minimally trade-distorting. Annex 2 of the Agreement on Agriculture states the basis for exemption from the reduction commitments:

> "Domestic support measures for which exemption from the reduction commitments is claimed shall meet the fundamental requirement that they have no, or at most minimal, trade-distorting effects or effects on production."

Currently, many infra-marginal support programs are classified as either Blue or Green Box and therefore are exempt from reduction since they are believed to have little effect on output.[4]

The July 2004 Agriculture Framework, upon which the (now suspended) Doha negotiations are based, articulates the basis for continued negotiations of full modalities in agriculture and has stipulated that the Blue Box criteria be redefined and expanded, while Green Box definitions will be reviewed and clarified. Along with this tighter scrutiny, the implications of the two WTO panel rulings on EU sugar and Canadian dairy policies could cause some significant adjustments in Green Box criteria and policies that constitute minimally trade distorting policies. This paper provides additional criteria for clarifying such policy designations. The results are particularly important, given that the WTO legal system has already ruled on one aspect of cross-subsidization that is now formalized and extended in the analysis to follow.

How Infra-marginal Support Causes Production Distortions

We show that, under an infra-marginal subsidy, producers select one of three distinct production levels: no output (0), the base level of production (B), or the free market level (Q*). We assume that the farm must produce each unit for which it receives the subsidy. In addition,

[4] The July 2004 Framework Agreement proposed an overall trade distorting cap which includes the Blue Box so indirectly Blue Box payments will not be fully exempt.

the maximal level of output entitled to the payment (B) is not binding; meaning that there is no penalty for over-production. Any production in excess of the base is simply sold at the prevailing market price. In situations where infra-marginal payments influence production, we delineate two different cases: positive or negative profits for production at the base (B) level of production. Each case has two sub-cases: the market price is above or below the average variable cost of production at the expanded level of output Q*.

However, not all farms are influenced by the infra-marginal payment and hence to do not fall into one of these four classifications. Some profitable farms remain in the industry at Q* regardless of the infra-marginal payment. Conversely, some potential farms remain out of the market even in the presence of support. In addition, some farms have a cost structure such that when marginal cost is equated with the infra-marginal price (T) the resulting quantity is less than the base amount. These farms will produce strictly less than the base amount and will not engage in cross-subsidization of any kind. Therefore, the following analysis only considers farms with costs such that the marginal cost at the base is strictly below the infra-marginal price and thus corresponds to one of the four case classifications defined in this section.

We assume that all farms covering their variable costs remain in the market in the short run, while farms not meeting their variable costs will not produce. Thus, in the short run farms will produce if rents are non-negative. Furthermore, farms covering their total costs will remain in the market in the long run, while farms not covering their total costs will exit. Farms engage in production in the long run if profits are non-negative. Total costs consist of variable costs plus fixed costs. We define fixed costs as costs that do not vary with the level of output which are pre-committed in the short run and avoidable in the long run (Wang and Yang, 2001). We draw a key distinction between fixed costs and sunk costs. Sunk costs are unavoidable, nonrecoverable costs, while fixed costs can be recovered or avoided by divesting in the long run. Examples of fixed costs which are recoverable and/or avoidable in the long run are mortgage payments, lease payments, overhead costs and property taxes. We allow for both exit deterrence and cross-subsidization in both the short run and long run.

Case 1: Positive Profits at the Base

Consider the case where the market price (P*) is greater than average variable cost of production AVC* but less than average total costs of production ATC* (figure 1). This means that in the absence of infra-marginal subsidies, this producer would produce at Q* in the short run, but not be in business in the long run. Given that the support price T is greater than average total costs at the base B (ATC_B), profits are positive at B and given by area *a* in figure 1. The producer will not exit the industry in the long run, since the infra-marginal payment acting alone will result in long run positive profits at the base. However, the farm has the potential to make additional profits by taking advantage of declining average costs (increasing returns to scale) if it equates marginal costs with P* and produces at Q*. Recall that P* must exceed the marginal cost of production at the base quantity for cross-subsidization to be observed, otherwise the producer would simply equate marginal cost with T and produce at a quantity less than B.

If area *b* is greater than area *d* in figure 1, then the farm will produce at Q* due to cross-subsidization. Area *b* represents the cost savings from increasing returns. Area *d* represents the additional costs associated with expanding output beyond the base that are not covered by P*. If the farm produces at Q*, then any output produced beyond B is sold below the average total cost of production. Cross-subsidization allows the farm to offset losses (sales below the cost of production) in the unregulated secondary market with additional profits obtained from increasing returns in regulated primary market. In this case, cross-subsidization is directly responsible for production occurring above the base amount and generating output and hence trade distortions.

It can be shown that area *b* is always strictly greater than area *d* in the case depicted in figure 1. Fixed costs at B are equal to area $(b + c + e)$, while fixed costs at Q* are equal to area $(c + d + e + f + g)$. Using the fact that fixed costs at B are equal to fixed costs at Q*, we obtain area b = area $(d + f + g)$. Hence, area *b* is strictly greater than area *d*. Consequently, in cases where T is greater than ATC_B and P* is greater than AVC*, cross-subsidization will always result in production at Q*.

In figure 2, P* is less than both AVC* and ATC*. In this case, the producer would not produce in either the long run or the short run in the absence of the infra-marginal payments. Once again, T is assumed to be greater than ATC_B, resulting in positive profits equal to area *a* if the farm produces at B. Hence, the infra-marginal payment deters industry exit again as in figure 1. Although P* is less than AVC*, it is still possible for cross-subsidization to occur in both the long and short run. If area *b* is greater than areas $(d + g)$ in figure 2, then cross-subsidization occurs. Area *b* can be interpreted as the cost savings due to increasing returns to scale, while areas *d* and *g* represent the loss in the secondary market. More specifically, area *d* is the portion of fixed cost not being covered while area *g* is the portion of variable cost not being met. Again, the infra-marginal payment allows the farm to remain in the industry when it would have otherwise exited, and cross-subsidization causes the farm to select a production level of Q* rather than B.

In cases where profits at B are strictly positive, the infra-marginal payment entices the farm to remain in the industry in both the short and long run. When profits at B are strictly positive, the mechanism that generates cross-subsidization is the same in both the short run and long run (the relevant areas being compared are the same). Therefore, we do not draw a distinction between the short run and long run analysis.

It should be noted that the infra-marginal payment acting alone without cross-subsidization leads to positive profits at the base quantity for some producers. Hence, the infra-marginal payment deters some producers from exiting the industry, even if the effects of cross-subsidies are ignored. In the case when profits at the base are positive, the infra-marginal payment deters industry exit while the cross-subsidies lead to an additional increase in output.

Case 2: Negative Profits at the Base

Profits need not be positive at the base level of production, B, for cross-subsidization to occur. It is entirely possible for a farm to receive negative profits at B, but positive profits/rents if production is increased to Q*. Under these circumstances, cross-subsidization deters industry exit. The key element is the farm's ability to take advantage of increasing returns to scale. It should be noted that in order for cross-subsidization to occur, T must be greater than ATC* -- otherwise the profits associated with sales in the primary market remain negative.

For example, the case shown in figure 3 has T less than ATC_B, generating a loss of area b_1 if production remains at B. In the absence of the infra-marginal payment the farm would produce at Q* in the short run and exit the market in the long run. This results because P* is greater than AVC* but less than ATC*. Although profits are negative at B, cross-subsidization could lead to positive profits and a production level of Q* in both the short and long run.

In the short run the farm incurs fixed costs regardless of the chosen production level. Therefore, the farm will select a production point that either minimizes losses or maximizes profits in the short run. In figure 3, the short run losses associated with production at B are equal to area b_1, while the short run losses associated with production at Q* are equal to areas $(d - b_2)$.

Area d represents the increased costs of the expanded output not covered by P*, while area b_2 represents the realized cost savings due to increasing returns generated by expanding output beyond the base and moving down the average cost curve. It should be noted that area $(b_1 + b_2)$ is the total savings resulting from increasing returns, but area b_1 is not a realized savings for the farm; it merely avoids losses equal to area b_1 by expanding production to Q*. If the farm chooses to produce nothing then their losses are equal to fixed cost. The farm will never select a production point of 0 in the short run since production at both B and Q* enable the farm to cover all variable costs and a portion of fixed costs. Therefore, the farm will produce at Q* in the short run if and only if area $(d – b_2)$ is less than area b_1, or the loss at Q* is less than the loss at B.

However, it can be shown that area $(d – b_2)$ is strictly less than area b_1. Fixed costs at B are equal to area $(b_1 + b_2 + c + e)$ which is equal to fixed costs at Q* represented by area $(c + d + e + f + g)$. Therefore, area b_1 is equal to area $(d – b_2 + f + g)$ and area b_1 is strictly greater than area $(d – b_2)$. As a result, cross-subsidization will always deter industry exit and leads to a short run production level of Q* when P* is greater than average variable cost at Q* and profits at B are negative.

In the long run, the farm will produce at Q* if and only if profits at Q* are positive. This occurs when area b_2 is greater than area d, in other words the realized cost savings from increasing returns are greater than the additional costs associated with expanding output that are not covered by P*. If area b_2 is greater than area d, then cross-subsidization will be observed. In this case, cross-subsidization deters industry exit and leads to production at Q*. However, if area b_2 is less than area d, then the producer will exit the industry in the long run.

In figure 4, T is again below ATC_B but P* is also less than AVC*, thus indicating that without the infra-marginal payment the farm would not produce in either the long run or the short run. Although profits are strictly negative at B and the market price is below the average variable cost of production at Q*, it is still possible that cross-subsidization will lead to production at Q* in both the short run and the long run.

Once again, the farm will try to minimize losses in the short run. Short run losses at B are equal to area b_1, while losses at Q* are equal to area $(d + g - b_2)$. Area $(d + g)$ are additional costs due to increased production which are not offset by P*. Area b_2 is the realized cost savings due to increasing returns. Thus, in the short run, the farm will produce at Q* if and only if area b_1 is greater than area $(d + g - b_2)$, or the losses associated with production at Q* are less than the losses associated with production at B.

In the long run, area b_2 must be greater than area $(d + g)$ for cross-subsidization to occur. If the realized cost savings due to increasing returns are greater than the additional costs of the expanded output which are not offset by the market price, then the producer will produce at Q*. Otherwise, the producer would exit the industry and produce nothing.

In the case when profits at the base are negative, it is not the infra-marginal payment that deters industry exit as the infra-marginal payment acting alone returns negative profits. Rather the cross-subsidy resulting from the infra-marginal payment is responsible for the farm's decision to remain in the industry. In other words, the farm would exit the industry in the long run if cross-subsidization did not occur.

Due to the convexity of the cost function, if the farm would produce at B, then the farm can increase its profits (minimize its losses) by increasing production to Q* (see de Gorter, Just and Kropp (2007) for the full mathematical proof). Thus, cross-subsidization always occurs with exit-deterrence.

Table 2 provides a summary of production outcomes in the presence of infra-marginal payments for the four cases corresponding to figures 1-4. Producers experiencing positive profits at B will always produce at Q*, while those experiencing negative profits at B will produce 0 or at Q*.

Can infra-marginal subsidies be more distorting than an equivalent coupled subsidy?

If the infra-marginal support program is transformed into a fully coupled production subsidy (holding total payments fixed), then it is theoretically possible for the infra-marginal subsidy to lead to larger distortions. Both types of programs deter industry exit. Denote the new price farms face under the coupled subsidy program by T', where T' is equal to the free market price plus the per unit coupled subsidy. T' is less than the infra-marginal support price T, but greater than the market price P*. Since T is greater than T', it is possible that more high cost firms will stay in business under the infra-marginal subsidy program. Under the infra-marginal policy, all farms that enter the industry produce at Q* as a result of cross-subsidization. Under the fully coupled scheme some farms will enter, but all farms, both those entering and those already in the market, will select a level of production equal to Q' (> Q*) where T' equals the marginal cost of production. Which policy is more distorting depends critically on the cost structures and distribution of farm sizes, along with the level of the subsidy and base quantity. Under either policy, the larger the total expenditure on the subsidy, the larger the distortion becomes.

Under the infra-marginal policy, producers are either at 0 or Q*. Changing the infra-marginal payment to a fully coupled payment will cause some of the producers currently at Q* as a result of cross-subsidization to exit the market. All producers remaining in the market will now select a production level equal to Q'. Thus, all producers remaining in the market under the fully coupled scheme will expand their output from Q* to Q'. If the decline in production due to producers exiting the market is greater than the increase in production from the remaining producers expanding their output, then the infra-marginal payment is more trade distorting.

Effects of Base Levels and Fixed Costs

Changing the Base

The effects on output of changing the base while keeping the maximum payment per farm the same are ambiguous. Consider the scenario in which the base is decreased by half and the payment is doubled. This causes the payment to become infra-marginal for a larger number of farms. First, consider the effects of the change in base on the farms who previously viewed the payment as infra-marginal. For these farms the decrease in the base has an ambiguous effect on the level of output distortion due to cross-subsidization. The outcome would depend on the relative sizes of the pertinent graphical areas (change in cost savings due declining average costs relative to change in extra costs of the additional output), which in turn depends on the slope of the cost curves. Since the payment to each farm is fixed, a decrease in the base leads to a higher domestic support price T. However, the average total costs of production at the base amount are also higher. In addition, the difference between the base amount and Q* becomes larger as the base is decreased. Therefore, the unmet costs associated with expanding production beyond Q* become larger. Conversely, the cost savings of expanding output could become larger or smaller, depending on the slope of the average total cost curve. Thus, the increase in the level of production could be larger under either base scenario depending on profits at the base, the cost savings of expanding output, and the extra cost associated with the additional production. If the average total cost curve has a steep slope, then the smaller base will cause a larger increase in the level of production and cause a larger number of farms to remain in the industry.

So far we have ignored two important aspects necessary to determine how a change in the base amount might affect the level of cross-subsidization. First of all, as previously stated, a smaller base causes the payment to become infra-marginal for more producers. Therefore, more farms are likely to engage in cross-subsidization. Increased cross-subsidization will lead to more farms remaining in business and will ultimately lead to a higher increase in the level of production. Furthermore, if the infra-marginal payment increases some farms which previously faced negative profits at the base level of production will now face positive profits at the base quantity. If these farms have average variable cost of production at Q* less than the prevailing market price, then theory indicates that these farms will always select a production level of Q*. Under the larger base, some of these farms did not produce; therefore an increase in the level of production would occur as well as an increase in the number of farms engaging in production. When these two important aspects are considered, a smaller base could lead to increases in the level of production and farm numbers regardless of the slope of the cost curves. This is true for both the short run and long run.

Increasing Fixed Costs

The WTO panels discussed fixed costs as one key element leading to cross-subsidization, arguing that high prices received for a portion of output allowed farms to cover their fixed costs and engage in cross-subsidization. Here increasing returns are identified as the driving force leading to cross-subsidization. While fixed costs are a sufficient condition for decreasing average costs, it is not a necessary condition. Fixed costs guarantee declining average costs as output is increased, since the per unit fixed cost decreases as output increases. However, it is possible to have declining average costs without fixed costs as long as the average variable cost curve has a downward sloping portion. Hence, cross-subsidization can occur even if there are no fixed costs as long as the cost savings associated with the expanded output are greater than the extra unmet costs associated with the additional output.

How the relative proportion of fixed cost to total costs affects the level of cross-subsidization and exit deterrence is an empirical question that cannot be easily answered in a theoretical context. If fixed costs increase while total cost are held constant the slopes of the average total cost, average variable cost and marginal cost curves would change. As a result, the relative pertinent graphically areas (cost savings of expanding output beyond B versus additional unmet costs associated with expanding output beyond B) would also change. Therefore, the effects of the relative proportion of fixed costs are ambiguous.

Empirical Analysis of Infra-marginal U.S. Dairy Subsidies

The 2002 U.S. Farm Bill introduced the Milk Income Loss Contract (MILC) Program which financially compensates dairy producers when domestic milk prices fall below a specified level (USDA, 2002). These counter-cyclical payments limit the amount of production eligible to receive the payment to 2.4 million pounds per farm per year. Farms are required to produce in order to receive the payment. Therefore, the MILC program is a classic example of a taxpayer financed infra-marginal support program. We estimate cost functions by size and region to determine the effects of infra-marginal subsidies on output distortion due to cross-subsidization, using a comparative static analysis. Regression results are summarized in table 3. Distortion due to extra-marginal output is distinguished from that due to exit deterrence. The effects are compared to both the status quo and that of an equivalent coupled subsidy.

Impact of Infra-marginal Subsidies on Aggregate Output and Farm Numbers

Each farm could fall into one of several behavioral groups. In the short run, farms receiving the payment could either produce 0, *B*, or Q^*, the point where price equals marginal cost. We evaluate farms that are only in business because of the subsidy (except for analysis in table 7 later). The first column of table 4 shows that the infra-marginal subsidy increases production by 5.9 percent and the number of farms by 4.2 percent. In the long run, production increases less, but farm numbers increase more than in the short run. The baseline for the short run differs from that of the long run. While more farms produce absent the payment in the short run than in the long run, the infra-marginal payments deters exit for more farms in the long run. But the latter need not be the case; the outcome depends on cost structures and size distribution of farms, as well as the size of the infra-marginal payment relative to the market price and the level of infra-marginal output receiving support.

Table 5 decomposes the long run effects of cross-subsidization into the distortion due to exit deterrence and the distortion due to the extra-marginal output. The first two columns of table 5 represent farms that would produce at *B* if limited to (and would not be in business without the subsidy). The increase in production from 0 to *B* is 7.2 million hundredweight, while the increase from *B* to *Q** is about half as much. However, the increase in production due to the infra-marginal subsidy is much higher for firms that would not in business if the policy restricted production to *B* (reflected by the third column in table 5). These are a subset of farms that produce at *Q** (because of the subsidy) or 0 if production is limited to *B*. This has important policy implications because much of the output increase due to the infra-marginal subsidy would be eliminated if the government limited output to *B* in this empirical example of U.S. dairy subsidies. It was ruled that both the EU and Canada would be in compliance with their export subsidy commitments if output was restricted to the quota. Canada subsequently prohibited dairy farms from producing beyond the quota.

The last column in table 5 shows the total effect of cross-subsidization on production and farm numbers in the long run. Production increased by 4.4 percent and the number of farms increased by 5.6 percent.

To put the output distortion effects of infra-marginal subsidies in the U.S. dairy sector into perspective, we calculate the distortions that would occur if the same level of total payments were fully coupled. This calculation requires the determination of both short run and long run coupled subsidies that generate the same total budgetary outlay as in the infra-marginal policy scenario ($0.32 and $0.40 per hundredweight, respectively). In the fully coupled scenarios, the subsidy is given for every unit of production. The simulation was conducted using the same methods described above, with the only production choices being 0 or where marginal cost equals price plus the per unit subsidy.

Table 6 shows that in the short run, production would increase almost as much as a fully coupled subsidy. In the long run, the increase in production due to the infra-marginal subsidy is 34 percent of an equivalent fully coupled subsidy. This is still quite significant.

As for relative impacts on farm numbers, the second row of table 6 shows that infra-marginal subsidies deter exit far more than coupled subsidies in both the short and long run. In the long run, infra-marginal subsidies increased the number of farms by 31 percent more than that with a coupled subsidy. This has implications for understanding the effects of infra-marginal subsidies on farm structure. The increase in production with coupled subsidies can be broken down into two components: that due to entry and that due to existing farms expanding output. In the short run, approximately 92 percent of the increase in production is attributed to the expansion of output by farms already in the industry. However, about half of the increase in production in the long run is attributed to entry. The infra-marginal payment deters exit more in both the short and long run as well as having a smaller production distortion. Therefore, more farms are kept in business per tax dollar spent with an infra-marginal subsidy compared to coupled subsidies.

Finally, table 7 reports the change in output and farm numbers in the long run for a subset of farmers who have negative profits with production at *B* but would produce at *Q* without the subsidy*. This may appear to be a mere theoretical curiosity, but Canada, in complying with the dispute settlement panel ruling, shut down dairy farms producing only for the export market and mandated that all farms produce more no than B. Results in table 7 show that a similar policy for the U.S dairy industry would have huge impacts on production, almost as much as that of cross-subsidization reported in table 4 but about half as much impact on farm numbers. In addition, close inspection of tables 5 and 7 indicates that the total level of output under such a restrictive policy would be less than that of a free trade policy with no subsidy. The increase in output due to the subsidy deterring exit (7.2 million hundredweight) is less than the reduction in output due to the restriction (36.2 million hundredweight).

Conclusions and Implications

This paper develops the first general theory of cross-subsidization. The issue is motivated by two recent WTO panel rulings on Canadian dairy and EU sugar policies. Over-quota production exported at prices below average total costs of production was deemed cross-subsidized. We provide an economic justification for the WTO rulings. Our paper reverses the conclusions of a well established literature that argued infra-marginal support is non-trade distorting. In fact, our model shows that it is theoretically possible for an infra-marginal subsidy to be more output distorting than an equivalent fully coupled subsidy.

The analysis in this paper uncovers several components of output distortion associated with cross-subsidization beyond that considered in the WTO panel. In addition to over-quota production, we show that quota production itself can be output distortion (even though it is not exported). This is due to the exit deterrence effect of infra-marginal support. Some farms produce at the quota only because of the subsidy; they otherwise would exit the industry. But we prove theoretically that any farm that produces at the quota (or any other infra-marginal level of output receiving support) will always expand output to the point where world market price equals marginal costs, regardless if price is above average variable costs. The WTO panel only focused on fixed costs and assumed (incorrectly) that it was necessary for market price to exceed variable costs for cross-subsidization to occur.

Another source of exit deterrence is that some farms have negative profits at the quota (with the support) but are profitable only if allowed to produce the extra-marginal output. Overall profits at the expanded level of output are positive, even though market prices fail to cover average costs of production at the expanded level of output. This exit deterrence component of cross-subsidization was also overlooked in the WTO panel rulings.

The WTO panels ruled that limiting production to the quota would make the policy in compliance. The results of this paper have several direct implications. Output can still be greater than free trade output because the quota can deter exit. Farms that are profitable without the subsidy are also required to reduce output (whether profitable at the infra-marginal level of output or not). Some farms producing only for the export market will also be shut down (as in the case of Canadian dairy). This output reduction can be greater than the output enhancement effect of the infra-marginal subsidy, resulting in an output level below free trade output.

In an empirical analysis of the infra-marginal dairy subsidy program, we isolate the various components of cross–subsidization and compare them to an equivalent fully coupled subsidy. Interestingly, the infra-marginal subsidy deters the exit of farms more than an equivalent coupled subsidy, but infra-marginal subsidies generate about 34 (98) percent of the output distortion in the long (short) run compared to the fully coupled subsidy. This is significant, given the sensitivity of trade negotiations to magnitudes of output distortion. The WTO panels on EU sugar and Canadian dairy infra-marginal support did not calculate an empirical estimate of the distortion. Empirical analysis here suggests distortions from infra-marginal support are significant and hence have potentially important policy implications for both trade negotiations and disputes for several other agricultural policies.

Although the WTO cases were consumer financed infra-marginal support for exporters, cross-subsidization also distorts output for taxpayer financed support and for importers. Hence, the results of this paper have ramifications for all types of infra-marginal support in agriculture, which is growing in absolute amount and relative to that of coupled support. For example, the results of this paper have implications for the current WTO trade negotiations on agriculture focusing on the redefinition of the Blue Box and deciding on the criteria used to determine which polices go into which of the three "boxes".

In addition to a straight forward infra-marginal subsidy analyzed here, the analysis has implications for many other decoupled payment programs where farmers are technically not required to produce in order to receive payments (and hence cross-subsidization would not apply). However, there are features of these types of programs that may generate cross-subsidization. In the case of the U.S. programs, land also has to be kept in "good agricultural use" while EU payments are forthcoming only if you are a "bona fide farmer".[5] Likewise, payments under the rubric of "multifunctionality" in the EU like those conditional on compliance with environmental regulations may also cross-subsidize output. Furthermore, Harrington (2005) argues that the interaction of decoupled with coupled subsidies behaviorally recouples the decoupled payments. Clearly, the analysis developed in this paper needs to be extended and modified to incorporate the specific details of each of these so-called decoupled programs. We leave a detailed analysis of all of these issues to future research.

The results of this paper also have implications for analyzing the effect of government policies on the structure of agriculture. Leathers (1992) has shown that the impact of agricultural programs on the structure of agriculture cannot be predicted by theory alone. Chau and de Gorter (2005) analyze the effects of infra-marginal subsidies on industry exit, while Ahearn, Yee and Korb (2005) and Key and Roberts (2006) provide evidence of farm subsidies increasing both farm exits and the share of large farms at the expense of small farms. Both the theoretical and empirical results of this paper show the potential importance of infra-marginal payments in increasing the number of farms in business and decreasing farm size. The empirical analysis shows that the infra-marginal policy accomplishes this better than the fully coupled policy for the U.S. dairy sector. However, the outcome depends on the relative numbers and sizes of farms across cost levels and the choice of both the level of infra-marginal output and per unit support. This paper introduces a new theory of how infra-marginal subsidies can affect farm structure. Further research is required to analyze this specific issue for different types of decoupled programs.

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[5] Other aspects of the payment programs act like a "requirement for production". For example, the tenant receives the payment so it acts like one needs to produce to get the payment. Also, base acres and program yields are updated, tying payments to current production as farmers anticipate updating. New decoupled payments were added in the meantime, as were new coupled payments and new crops to each type of program.

The results of this paper also have implications for the literature on transfer efficiency. Although we show that the trade literature cited earlier may be incorrect in concluding that infra-marginal support is an efficient form of redistribution, it may be the case that infra-marginal support is an efficient way of maintaining as many farms in business as possible. Traditional analysis measures the transfer efficiency of alternative polices in terms of deadweight costs per unit transfer to farmers (e.g., Gardner, 1983). But perhaps the goal of governments is to maintain as many farms in business as possible so the efficiency per farm saved may be higher for infra-marginal subsidies. Future research should adapt the model developed in this paper to explore such issues for different types of policies.

This paper also has implications for the literature on the political economy of farm policy. Many theories have been put forward as to why governments use inefficient methods of transferring income to farmers (de Gorter and Swinnen, 2002). Some models of political economy argue that inefficient redistribution policies like price supports are enacted to encourage newcomers in order for farmers to maintain future political power (Acemoglu and Robinson, 2001). Others argue that the form of redistribution to farmers is relatively efficient (Gardner, 1987). Our paper shows that that infra-marginal support can be more or less trade distorting than a coupled subsidy. In addition, our results suggest that infra-marginal support can be more efficient in maintaining more farms in total. This lends support to Acemoglu and Robinson's (2001) theory that governments use inefficient price supports to attract newcomers (or prevent exit) in order to maintain the political power of farmers. But Acemoglu and Robinson (2001) argue further that subsidies conditional on production or acreage controls may be useful to limit entry so farmer wealth is not diluted. Our model has the exact opposite result if farmers are allowed to produce beyond the controlled amount. Clearly, more research needs to be done.

In addition to extending our model to analyze the aforementioned issues, a priority for future research is to improve upon the methods used in the development of our model in this paper. For example, we ignore sunk costs by taking the conventional approach that all costs become variable in the long run. Foltz (2004) shows how coupled subsidies helps overcome sunk costs. Hence, such an analysis should be extended to include infra-marginal subsidies and the impacts of cross-subsidization as sunk costs affect returns to scale and introduces asymmetry between exit and entry. There is also a need to incorporate dynamic investment decisions and expectations on future policy decisions into the analysis. Sensitivity analysis should also be undertaken with respect to the size of the base, the size of the payment, the fixed cost share and alternative farm size/cost structures. More accurate estimates could be obtained using farm level data, allowing the direct estimation of more detailed cost functions and introducing more heterogeneity. These and other methodological improvements are left to future research.

Figure 1: Positive profits at B, cross-subsidization to Q* (P* > AVC*)

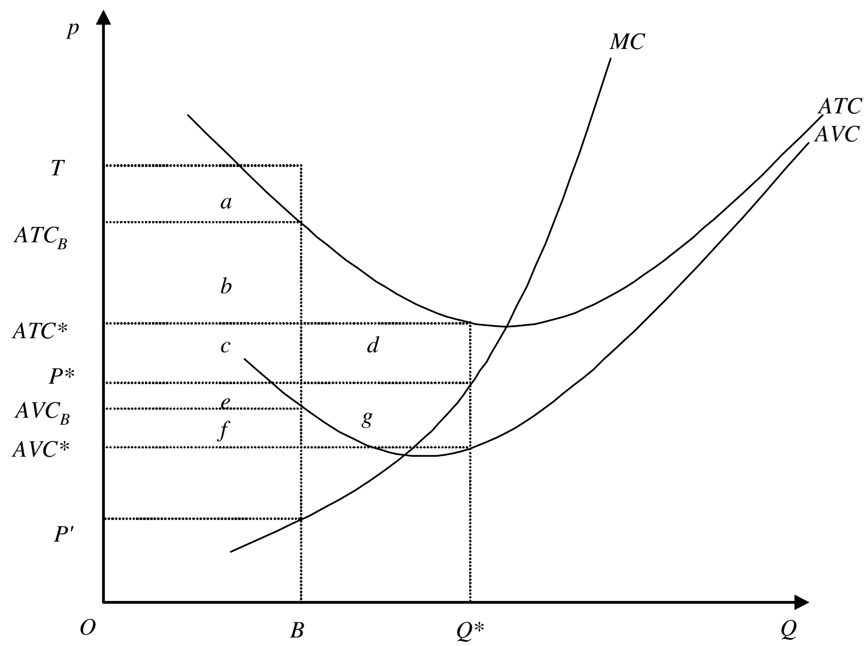

Figure 2: Positive profits at B, possible cross-subsidization to Q* (P* < AVC*)

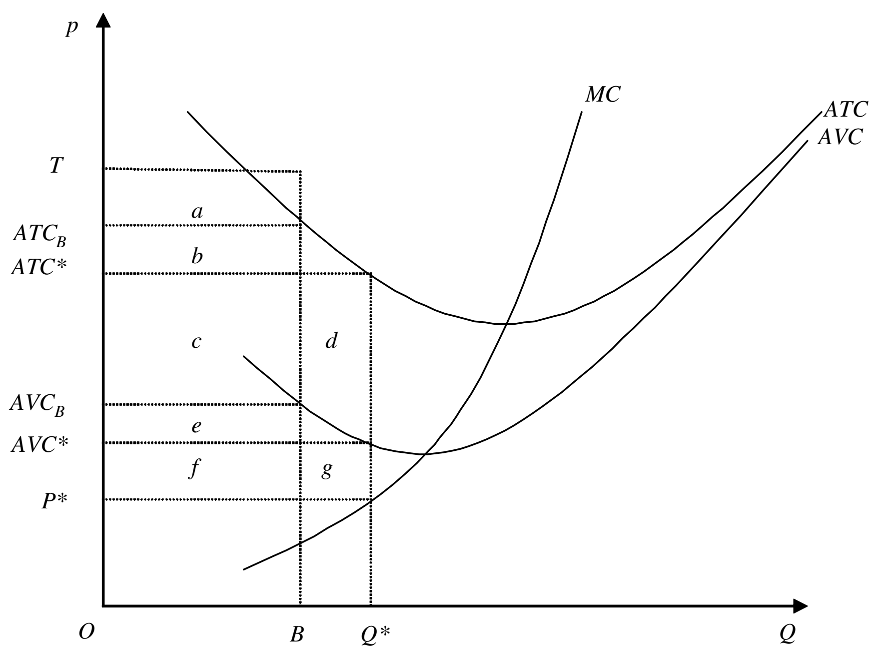

Figure 3: Negative profits at B, possible cross-subsidization to Q* (P* > AVC*)

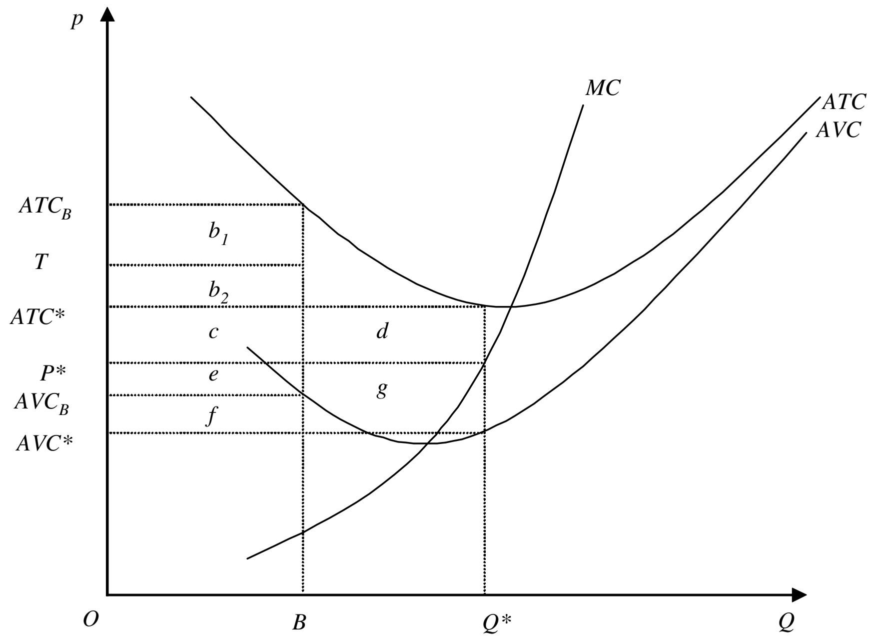

Figure 4: Negative profits at B, possible cross-subsidization to Q* (P* < AVC*)

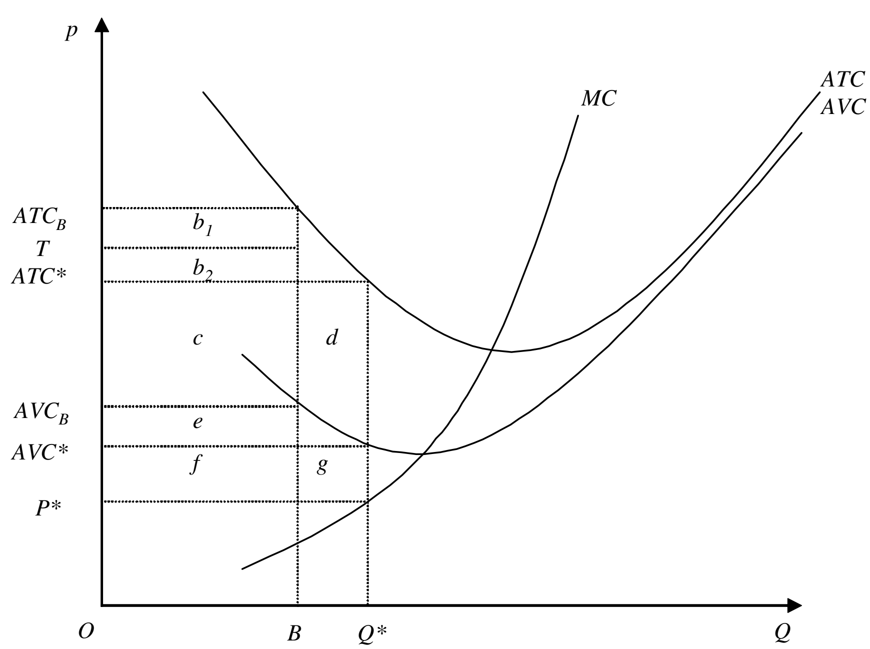

Table 1. OECD Producer Support Summary.

(billions of $)	**1986**	**1990**	**1994**	**1999**	**2004**
Total Producer Support	173.91	182.04	199.55	213.54	225.78
Border Support	120.34	124.26	128.90	121.15	113.10
Share of Total Producer Support	*69%*	*68%*	*65%*	*57%*	*50%*
Infra-marginal	28.71	28.98	36.68	31.92	25.14
Share of Total Producer Support	*17%*	*16%*	*18%*	*15%*	*11%*
Share of Border Support	*24%*	*23%*	*28%*	*26%*	*22%*
Domestic Support	53.57	57.77	70.65	92.39	112.68
Share of Total Producer Support	*31%*	*32%*	*35%*	*43%*	*50%*
Infra-marginal	25.98	22.50	42.70	51.24	73.16
Share of Total Producer Support	*15%*	*12%*	*21%*	*24%*	*32%*
Share of Domestic Support	*48%*	*39%*	*60%*	*55%*	*65%*
Infra-marginal Support	54.69	51.48	79.38	83.16	98.30
Share of Total Producer Support	*31%*	*28%*	*40%*	*39%*	*44%*

Table 2. Summary of Production Outcomes in the Presence of Infra-marginal Payments.

Positive profits at B with market price….

	Above AVC (Figure 1)		Below AVC (Figure 2)	
Production	Short Run	Long Run	Short Run	Long Run
0	-	-	-	-
B	-	-	-	-
Q*	Always	Always	Always	Always

Negative profits at B with market price….

	Above AVC (Figure 3)		Below AVC (Figure 4)	
Production	Short Run	Long Run	Short Run	Long Run
0	-	b2 < d	-	$b_2 < d + g$
B	-	-	-	-
Q*	Always	$b_2 > d$	Always	$b_2 > d + g$

Table 3. Parameter Estimates of a Quadratic Cost Function for Dairy Production in the U.S.

	Heartland		Northern Crescent-East		Northern Crescent-West		Eastern Uplands		Fruitful Rim	
Size[a]	*2*	*3*	*2*	*3*	*2*	*3*	*2*	*3*	*2*	*3*
a_1 (1st order effect)	2.02	12.15	4.15	10.19	1.85	11.40	3.45	11.66	2.23	7.43
Fixed Cost	28,304	111,105	29,417	136,333	27,141	109,482	28,631	144,968	30,596	141,995
	(8768)	(12446)	(8506)	(9394)	(7194)	(9193)	(11871)	(11672)	(12036)	(6436)

	Size 2	*Size 3*
a_2 (2nd order effect)	1.60 × 10-4	1.04 × 10-6
	(4.36 × 10-5)	(2.67 × 10-7)

Standard errors are in parentheses. The cost function calculates total cost per farm in dollars as a function of milk production measured per cwt. The coefficients a_1 were calculated through restrictions placed on a_1 and a_2. We report only the standard errors for a_2.
a. Size group 2 includes farms for which production subsidies are infra-marginal with less than 300 cows. Group 3 consists of farms with 300 or more milking cows.

Table 4. Effect of Infra-Marginal Subsidies on Production Levels and Numbers of Farms

Increase in	*Short Run*	*Long Run*
Production (Million Cwt.)	54.2	34.3
Percent of Production	5.9	4.4
Number of Farms	531	586
Percent of Farms	4.2	5.6

Table 5. Effect of Cross-Subsidization on Production and Numbers of Farms in the Long Run

	Profitable at B		Unprofitable at B	Total
Increase in	*0 to B*	*B to Q**	*0 to Q**	
Production (Million Cwt.)	7.2	3.8	23.3	34.3
Percent of Production	0.5	0.9	3.0	4.4
Number of Farms	301		285	586
Percent of Farms	2.9		2.7	5.6

Table 6. Effects of Infra-Marginal Subsidy as a Percent of Equivalent Coupled Subsidy

Increase in	*Short Run*	*Long Run*
Production	98%	34%
Farms	193%	131%

Table 7. Effect on Exit if Production Limited to B in the Long Run (But Farms Profitable at Q* without the Subsidy)

Increase in	
Production	36.2
Percent of Production	4.6
Number of Farms	278
Percent of Farms	2.6

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