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Measuring Assistance to the Agricultural Industry in Australia using a Production Assistance Index

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Abstract

The history of the reforms of the assistance given to Australian agriculture over the past fifty years is a remarkable story, especially when contrasted with the experiences of most other OECD countries. The effects of these reforms have been captured by the Productivity Commission (and its predecessors) and by Lloyd through time series of the nominal rates of assistance to individual agricultural commodities and to the industry as a whole. In this paper the concept of a partial equilibrium production assistance index is developed to obtain a more accurate picture of the implicit welfare consequences of this assistance for the period 1955–59 to 2000–04. This index is a mean of order 2. It is shown that the conventional average, the mean of order 1, substantially underestimates the mean of order 2, which is the correct definition of the average level of assistance.

Key Words: Production Assistance Index; industry assistance; Trade Restrictiveness
Index; Australian agricultural policy

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Measuring Assistance to the Agricultural Industry in Australia using a Production Assistance Index

Donald MacLaren and **Peter J. Lloyd**

1. Introduction

The history of the reforms of Australian agricultural policy over the past five decades is documented by Edwards (2006). In a recent study, Anderson *et al.* (2007) have measured the distortions induced by these changing sets of policy measures and have provided time series of measures of support for the agricultural and the non-agricultural sectors. Estimates of the nominal rates of assistance to these sectors were based on series calculated by the Productivity Commission (and its predecessors) over the period 1970–71 to 2004–05 and by Lloyd (1973) for the period 1946–47 to 1970–71. These sources provide evidence that the Australian agricultural sector has become deregulated to a substantial degree in absolute terms.[1]

During the 1950s and 1960s the overall objective of Commonwealth governments was to increase production (Edwards). A variety of instruments was used, e.g., output subsidies, input subsidies, stabilisation measures, tax provisions, government involvement in research and development and publically-funded infrastructure. By the 1970s, some reassessment was undertaken and by the 1980s the agricultural sector did not escape the drive for microeconomic reform. This reform continued into the 1990s with the continuation of government involvement at State and Commonwealth levels subject to satisfying the criteria set out in National Competition Policy. The reforms that began in the 1980s culminated in the reform of the dairy sector in 2000, one of the last of the major commodities to be deregulated.

The objective in this paper is to examine in welfare terms the nominal rates of assistance provided to the Australian agricultural sector over the period 1955 to 2004. This examination is undertaken in section 2 using a production assistance index which is derived from a partial equilibrium version of the Trade Restrictiveness Index (TRI) developed by Anderson and Neary (2005) and extended by Lloyd and MacLaren

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[1] When compared with the limited reforms of agricultural policy that have occurred in other OECD countries (New Zealand excepted) despite the introduction of the Agreement on Agriculture in the World Trade Organization, the reduction in support has been remarkable (see OECD (2008b). For a time series of support to farmers across the OECD countries for the period 1986–2006).

(2008). The data used to estimate this index are those in Anderson *et al.* for the period 1955–59 to 2000–04. A time series of the arithmetic mean of assistance in Anderson *et al.* is contrasted with the production assistance index. Conclusions are presented in section 4.

2. A Partial Equilibrium Production Assistance Index

The inability to aggregate assistance across commodities in a theoretically meaningful way has remained until recently an important weakness in the calculation of the average level of assistance to a sector or to a whole economy. However, through the development of the TRI, Anderson and Neary solved the problem for a small, open economy in which imports are restricted by tariffs and non-tariff measures (NTMs). This index is a general equilibrium measure of the welfare cost associated with a tariff structure in which tariff rates vary across tariff lines. It is the uniform tariff that would generate the same welfare loss as the differentiated structure of tariffs. Feenstra (1995) showed that under certain assumptions, the general equilibrium measure of the index could be simplified to a partial equilibrium equivalent.[2] This form of the TRI is given by

$$T = [\sum_{i=1}^{n} t_i^2 w_i]^{\frac{1}{2}} \tag{1}$$

where: $w_i = [(p_i^*)^2 \, \mathrm{d}m_i / \mathrm{d}p_i]/[\sum_{i=1}^{n}(p_i^*)^2 \, \mathrm{d}m_i / \mathrm{d}p_i]$ is the weight attached to good *i*; and t_i is the *ad valorem* tariff rate on good *i*. This is a mean of order 2.[3]

Lloyd and MacLaren began instead with a single commodity in a partial equilibrium context and obtained, through aggregation, the same result as Feenstra's. Through beginning with the welfare analysis of a tariff in the partial equilibrium setting, they were able to draw out important economic consequences of the nature of the index. In particular, they showed why the square of the tariff rate appears in the index and why the TRI is a mean of order 2 and not a mean of order 1; and they extended the index to account for non-tariff measures which are not equivalent to a tariff.

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[2] These assumptions are: first, that the import demand function for each good is linear; and second, that the quantity imported is a function of own-price only.

[3] In general, the mean of order *r* is defined as $M_r \equiv [\sum_{i=1}^{n} t_i^r w_i]^{\frac{1}{r}}$.

Government intervention through the provision of support for the agricultural sector in the OECD economies involves many measures, not merely tariffs on competing imports. Some instruments operate at the border while others are domestic. Some are commodity specific while others are sector-wide. In measuring the support provided through these diverse instruments, the OECD has used the concepts of producer subsidy equivalent (now referred to as Producer Support Estimate), of nominal rate of assistance to producers and of nominal protection coefficient (see OECD, 2008a). Parallel concepts have also been defined for consumers. Consistent estimates of these variables are now available for over twenty years (see OECD, 2008b). The original purpose for these calculations was to be able to monitor through time the levels of support given by member governments of the OECD to their agricultural sectors (Cahill and Legg, 1989–1990). The purpose was positive rather than normative.

From the economist's perspective, in contrast to that of the trade negotiator's, the welfare effects of government intervention are the main concern. However, measurement of these effects is complicated where the instruments used are not equivalent to a tariff. Invariably, the price-equivalent effect of the non-equivalent measure is used but this approach is incorrect. The complication is especially prevalent in the agricultural sector in which there is a range of instruments which affect market access or domestic production or exports in different ways. It is for this reason that the OECD adopted the Producer Support Estimate. However, the development of the TRI and its extension now allows NTMs to be measured in a way that is theoretically correct.

Before exploring this method, it is necessary to decide which index is the most relevant to the task at hand. For example, the index could be based upon the volume of imports (defined by Anderson and Neary as the Mercantilist TRI) or on domestic welfare (the TRI) or, in some instances, on export volumes. As the instruments of support that have been given to Australian producers of agricultural products have been largely domestic rather than at-the-border, the version that will be developed and used here is the deadweight cost-equivalent domestic production subsidy.[4] It is assumed in the derivation to follow that the policy instrument provides support to

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[4] However, in a study more elaborate than that being undertaken in this paper, it would be possible to construct separate indexes for import-competing, non-tradeables and export industries and then to aggregate them. For a discussion in a general equilibrium context, see Anderson and Neary pp. 204-08.

domestic producers through increasing the producer price, while leaving the consumer price unaffected. This is a reasonable assumption in the small country case.

In a small, open economy with perfect competition, a production subsidy on good i creates a welfare loss. The loss, for a non-small subsidy, is approximated by the triangular area under the domestic supply function comprising the gain in producer surplus net of the budgetary cost of the subsidy

$$L_i = \tfrac{1}{2} \Delta y_i \Delta p_i$$

where Δy_i is the change in quantity supplied as a consequence of the subsidy and Δp_i is the *ad valorem* subsidy. With the subsidy in place, the producer price is $p_i = p_i^*(1 + s_i)$, where p_i^* is the world price and s_i is the rate of subsidy; and the consumer price remains at p_i^*. Assuming that the domestic supply function is linear, the welfare loss can be written as

$$L_i = \tfrac{1}{2}(p_i^* s_i)^2 \, \mathrm{d}y_i / \mathrm{d}p_i$$

where $dy_i / dp_i = const$ is the slope of the domestic supply function. Note that the loss is proportional to the square of the subsidy rate.

If there were n products subject to different subsidy rates, then the aggregate welfare loss, assuming no cross-price effects in production, is given by

$$L = \tfrac{1}{2} \sum_{i=1}^{n} (p_i^* s_i)^2 \, \mathrm{d}y_i / \mathrm{d}p_i$$

The uniform production subsidy rate that generates an aggregate deadweight loss identical with that of the differentiated set of subsidy rates is determined by solving the following equation for S

$$\tfrac{1}{2} \sum_{i=1}^{n} (p_i^* s_i)^2 \, \mathrm{d}y_i / \mathrm{d}p_i = \tfrac{1}{2} \sum_{i=1}^{n} (p_i^* S)^2 \, \mathrm{d}y_i / \mathrm{d}p_i$$

The result is

$$S = [\sum_{i=1}^{n} s_i^2 v_i]^{\frac{1}{2}} \qquad (2)$$

where $v_i = [(p_i^*)^2 \, \mathrm{d}y_i / \mathrm{d}p_i] / [\sum_{i=1}^{n} (p_i^*)^2 \, \mathrm{d}y_i / \mathrm{d}p_i]$ and the weights sum to unity. This expression will be referred to as the Production Assistance Index: it is the uniform production subsidy that gives the same deadweight production loss as the actual differentiated structure of assistance. Conceptually, it is similar to the TRI except that the welfare effect is entirely on the supply side and the measurement is being

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undertaken in terms of production weights and not import weights. It is the mean of order 2 in the subsidy rates and not the mean of order 1. The distinction between these two means will turn out to be very important in interpreting the deadweight costs associated with assistance to domestic production.

The production assistance index that is defined in equation (2) can be re-expressed in a way which makes use of the definition of the variance of the distribution of the production subsidies. Recalling that $E\{x^2\} = E^2\{x\} + Var\{x\}$, then equation (2) is

$$S = [E^2\{s\} + Var\{s\}]^{\frac{1}{2}} \tag{3}$$

It is clear from this representation of the index that it is sensitive to the dispersion of subsidy rates and, in particular, to subsidy peaks.

There are three adjustments that are required to equation (2) to make it operational on the basis of a minimal amount of data. First, noting that the slopes of the supply functions are not usually known, the weights can be re-written as

$$v_i = \sigma_i (p_i^* y_i^*) / \sum_{i=1}^{n} (p_i^* y_i^*)$$

where σ_i is the price elasticity of supply for the ith good in the no-intervention situation and ($p_i^* y_i^*$) is the value of production without assistance. Second, these values of production in the absence of the subsidies are not known but they can be recovered by using the elasticities of supply and the relationship between the subsidised producer prices and the unassisted prices. The resulting algebra gives

$$v_i = [\sigma_i (p_i^* y_i^s) / (1 + s_i)] / \sum_{i=1}^{n} \sigma_i (p_i^* y_i^s) / (1 + s_i)$$

where y_i^s is the output of good i with the subsidy of s_i being provided. Third, if the strong assumption is made that the price elasticities of supply are the same for all goods, then the last equation reduces to

$$v_i = [(p_i^* y_i^s) / (1 + s_i)] / \sum_{i=1}^{n} (p_i^* y_i^s) / (1 + s_i)$$

The implication of these simplifications is that the weights no longer depend upon the constant value chosen for the elasticity. Clearly, this is an advantage because, under the assumption of linearity, the price elasticity of supply will be different at the level of assisted production and at the level of production that would pertain in the absence of that assistance.

3. Assistance to Australian Agriculture

Estimates of the nominal rates of assistance to individual agricultural commodities are given in Anderson *et al.* (Table 2). These rates are provided for 12 exportable commodities (rice, wheat, barley, oats, total grapes, sugar, cotton, wool, beef and veal, mutton and lamb, pig meat and milk), five import competing commodities (maize, sorghum, oilseeds, tobacco and chicken meat) and two non-tradeable commodities (eggs and potatoes), over five-yearly periods from 1946–49 to 2000–04.[5]

For the period 1955–59 to 2000–04, the nominal rates of assistance for exportables, import-competing and non-tradeables are shown separately (Figure 1). For exportables, the nominal rate of assistance rose between 1955–59 and 1965–69 from 6.4 per cent to 10.0 per cent, thereafter falling to 0.0 in 2000–04. Much of the increase was due to increased support for wheat, total grapes, sugar, cotton and milk. For import-competing commodities, support rose from 13.4 per cent in 1955–59 to 18.3 per cent in 1970–74, thereafter falling to 0.1 per cent in 2000–04. All of the increase was due to the five-fold increase in support for tobacco. For non-tradeables, support increased from 31.4 per cent in 1955–59 to a high of 78.1 per cent in 1965–69, thereafter falling to 0.0 per cent in 2000–04.[6] This increase was entirely due to the tripling of support for eggs.

A series for the weighted arithmetic mean of the three series shown in Figure 1 is shown in Figure 2. This series does not properly reflect the welfare effects of support over the period because the dispersion of that support has been ignored. From equation (3), it is known that this dispersion is important in determining the deadweight costs of intervention. Anderson *et al.* also provide a time series of the standard deviation of the support to the commodities covered. It increased from 17.0 per cent for 1955–59 to a high of 53.3 per cent in 1970–74 before falling to 0.4 per cent in 2000–04 (Figure 2). Comparing support for each commodity in each of these two time periods indicates that support for rice, wheat, total grapes, cotton, wool and tobacco increased, while support for barley, sugar, milk and eggs fell (Anderson *et al.*,

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[5] Data are also provided for non-specific support but those data are ignored in what follows here. For importing-competing commodities, quarantine restrictions may also have impeded imports. Such protection is not included in the commodity-specific, nominal rate of assistance.
[6] During the first two periods (1946–49 and 1950–54), some commodities were being taxed rather than supported, giving rise to an overall nominal rate of assistance for the commodities covered of –7.0 per cent and 1.8 per cent, respectively.

Table 2). Together, these variations in rates of support increased the standard deviation.

Figure 1: Nominal Rates of Assistance to Australian Agriculture, 1955–59 to 2000–04
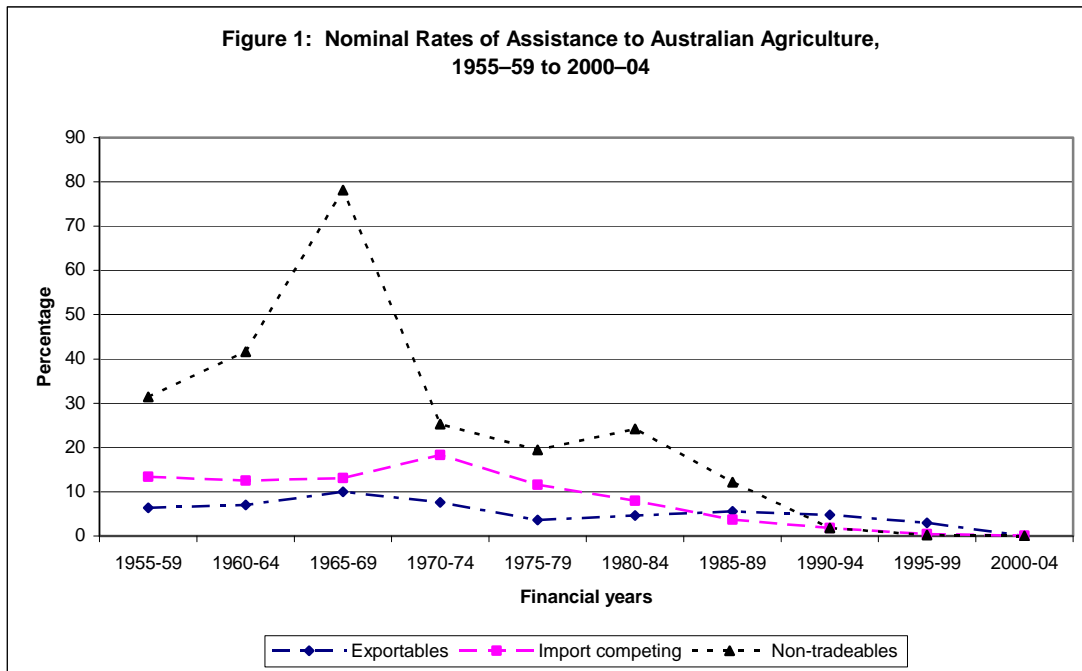
Source: Anderson *et al.* (2007) Table 2

The production assistance index for Australian agriculture was calculated from the two time series in Figure 2 using equation (3) above. The resulting index is shown

Figure 2: The Arithmetic Mean and Standard Deviation of the Nominal Rates of Assistance to Australian Agriculture, 1955–59 to 2000–04
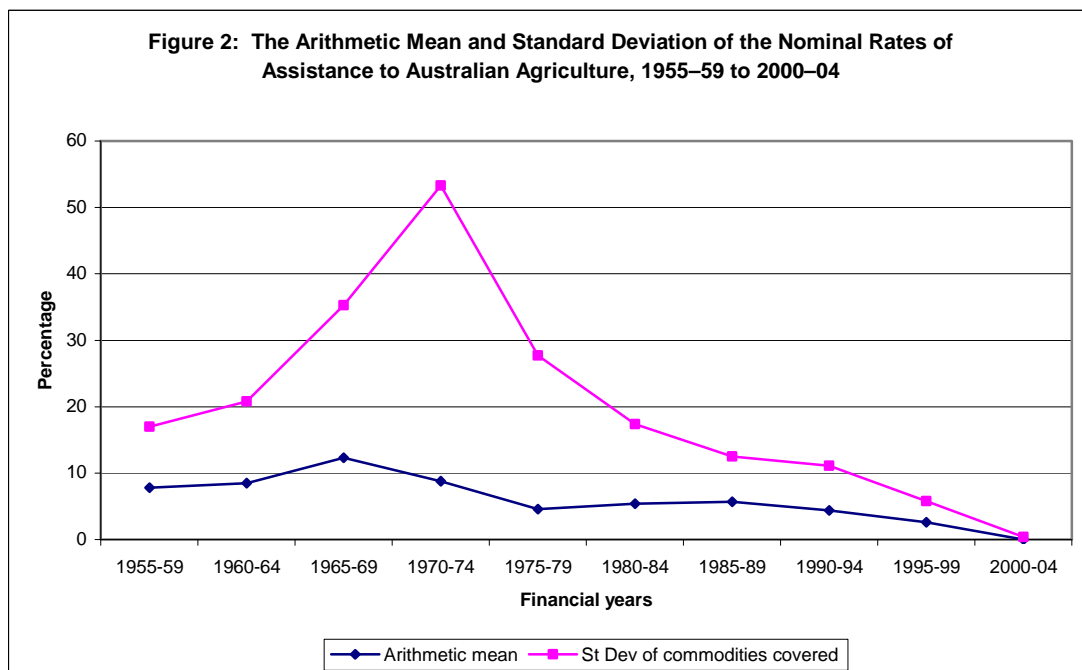
in Figure 3. Three features of this index stand out. First, the time series of the index lies everywhere above the series of the arithmetic mean. This outcome is to be

expected because the mean of order 2 always exceeds the mean of order 1 (except in the case in which all values are identical). The index is very heavily influenced by the standard deviation (compare the two series in Figures 3 and 2, respectively).

The welfare implications of this result are important because the values of these two means are very different. Using the arithmetic mean, the support would be regarded as modest: using the mean of order 2, the support would be regarded as substantial, especially for time periods 1965–69 to 1975–79.

Second, the index peaks in 1970–74 and not in 1965–69 when the arithmetic mean peaked. The latter period was the one during which support to exportables and non-tradeables was at its highest. The index peaked in 1970–74 partly because that is the period during which support to import-competing commodities peaked but, more significantly, the period during which the standard deviation of support to the covered commodities reached its peak.

Figure 3: The Production Assistance Index, Australian Agriculture, 1955–59 to 2000–04
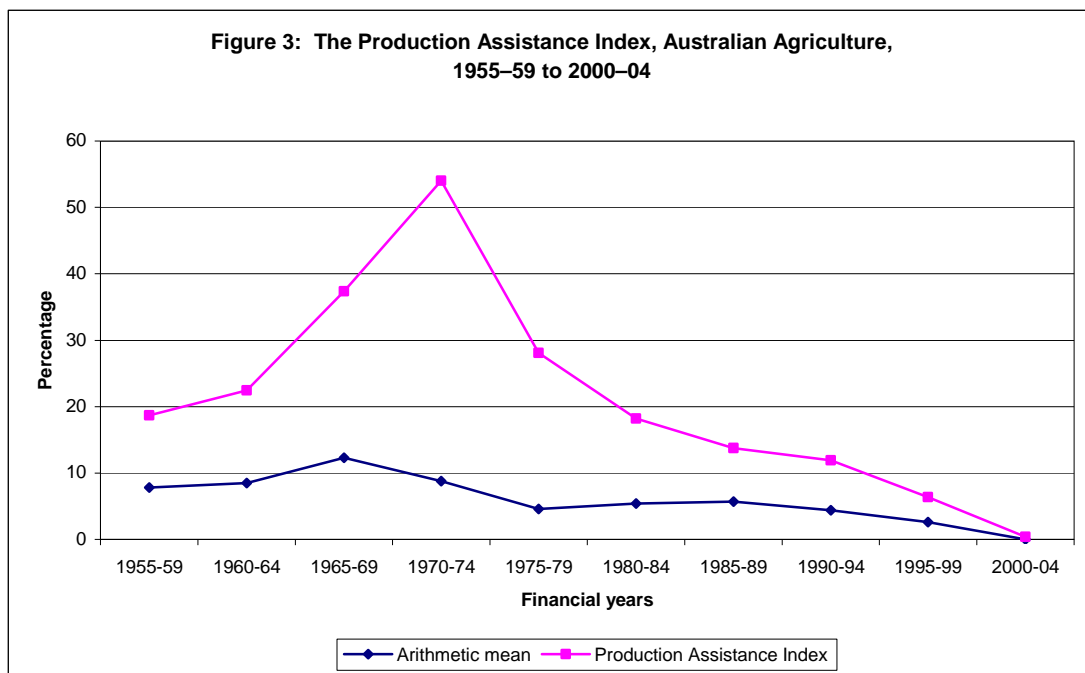
Third, during the period 1975–79 to 1985–89 while the arithmetic mean was increasing, the production assistance index was decreasing. The difference in the behaviour of the two series is explained by the behaviour of the standard deviation of assistance over this period – it was falling from 27.7 per cent to 12.5 per cent. Therefore, the welfare implications are different: the deadweight cost was actually decreasing over this period rather than increasing as implied by the series of the arithmetic mean.

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4. Conclusion

Over the past fifty years, the nominal rates of assistance to exported Australian agricultural commodities have been modest, ranging from a high of 10.0 per cent in 1965–69 to 0.0 per cent in 2000–04. For import-competing commodities, the corresponding percentages were 18.3 in 1970–74 and 0.1 in 2000–04; and for non-tradeables, they were 78.1 in 1965–69 and 0.0 in 2000–04. The series of the weighted arithmetic mean of the three series was consistently below 10 per cent, with exception of the period 1965–69. However, the production assistance index was not only at a much higher level but it showed more variability. This variability reflected the changes in the standard deviation of support across commodities.

Until the period 2000–04, the inferences to be drawn about the deadweight costs associated with support differ very markedly between the means of order 1 and order 2 for of the period examined. The production assistance index shows that the welfare effects of the support were considerably greater than those that would be inferred from the mean of order 1, especially in the period prior to the 1990s. In particular, the index shows that the dispersion of the rates of support, which was provided through government intervention in the agricultural sector, had substantial effects on the deadweight costs of production.

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