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NOTES

Use of the single factoral terms of trade to analyse agricultural production*

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The aim in this note is to reintroduce the single factoral terms of trade into the policy arena. This economic concept has scarcely been used by analysts or policy makers over the past three decades. It is defined and compared favourably with other terms of trade concepts in terms of their usefulness to agricultural policy makers in Australia. A distinction is made between the single factoral terms of trade from the viewpoint of the farm business and from the viewpoint of the farm household, but only slightly different indices are specified in each case because of the very high positive correlation between farm prices paid and consumer prices. Developing industry-level indices appears to be a more attractive way to proceed given the substantially different rates of growth in total factor productivity (TFP) between agricultural industries. Despite its usefulness, challenges lie ahead in accurately estimating each of the two components of the single factoral terms of trade, the net barter terms of trade and TFP, and the relations between these two components.

Key words: net barter terms of trade, single factoral terms of trade, total factor productivity.

1. The search for a shorthand measure of the returns to farm resources

The aim in this note is to reintroduce into the policy arena an economic concept that has lain dormant for the past three decades, the single factoral terms of trade. A case is put for its usefulness as a shorthand measure of the returns to factors engaged in agricultural production in Australia. Four terms of trade concepts are typically discussed in international trade text books that could be applied at the sector level as measures for this purpose.

The two most commonly used concepts are too crude to provide any meaningful comparison and one, while theoretically superior, is impractical because of its stringent data requirements. The crudest and simplest concept, the net barter or commodity terms of trade, is the most commonly used measure. For example, the farmers' terms of trade are regularly reported by the Australian Bureau of Agricultural and Resource Economics (ABARE 2004a) and featured strongly in a recent survey of trends in Australian agriculture conducted by the Productivity Commission (2005, pp. 116–117) using

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estimates of productivity change summarised by ABARE (2004b). While it has some limited use, it takes no account of changes in input and output relations and, in itself, is unsuitable as a measure of sectoral returns to resources. The income terms of trade are an improvement on the net barter terms of trade in that they take into account changes in farm output quantities, but they ignore changes in farm input quantities.

The third concept, the utility terms of trade, is ideal for quantifying welfare changes in that it measures the utility gained by agricultural producers in trading the goods they produce (Viner 1937, p. 560). Measuring farmers' utility gains each year is out of the question, but it is possible to use revealed preferences so long as annual consumption data for producers are available. Sadly, this is not the case.

The fourth concept, and the one best suited as a shorthand measure of the returns to factors engaged in agricultural production in Australia, is the single factoral terms of trade. The concept of single factoral terms of trade has a long history, dating back to its first use by Viner (1937, p. 559), building on the early work of Mill (1844) and Edgeworth (1894). It incorporates changes in inputs and outputs, through changes in total factor productivity (TFP), and changes in prices paid and received by farmers, through the net barter terms of trade. The estimates of changes in TFP and farmers' prices paid and prices received that are needed to calculate the single factoral terms of trade in the Australian agricultural sector are all widely available and can be decomposed to the agricultural industry level.

2. Calculating the single factoral terms of trade

Meier (1968) defined and discussed the merits of the four terms of trade concepts. The single factoral terms of trade index is defined here using a more recent definition and notation by Appleyard and Field (1998, pp. 120–122). Appleyard and Field (1998, p. 120) begin by defining the net barter terms of trade (TOT_N) in the usual manner as the ratio of an index of export prices (P_X) and an index of import prices (P_M). They then use these net barter terms of trade to define the single factoral terms of trade as:

$$TOT_{SF} = (P_X/P_M)O_X, \tag{1}$$

where O_X is the TFP index. This equation simplifies to:

$$TOT_{SF} = TOT_N O_X. \tag{2}$$

As originally defined, the single factoral terms of trade index covers all activities involved in producing a product or group of products to the point of export. As the purpose of this note lies in examining welfare implications for agricultural producers as a specific group in the economy, we define the single factoral terms of trade in terms of farm output prices (P_Y) (ABARE 2004a),

rather than export prices, and TFP in terms of farm production (O_F), rather than production to the point of export. The appropriate index to use as the denominator is the index of prices paid by agricultural producers (P_I) (ABARE 2004a), which is the 'import price index' for farm businesses in the agricultural economy that is equivalent to the import price index for participants in the national economy. The single factoral terms of trade index for Australian farm businesses is therefore defined as:

$$TOT_{SF} = (P_Y/P_I)O_F. \tag{3}$$

This index enables us to determine whether a decline in the farm-gate prices producers receive for their output relative to farm input prices (as has historically been the case in Australian agriculture) is less than the percentage rise in productivity in their production, in which case 'more [goods and services] can be purchased for a given amount of employment time of the factors of production' (Appleyard and Field 1998, p. 120). If the price decline is greater, returns to the factors engaged in their production would fall. Because the index measures factor income relative to factor inputs and input prices, an increase implies an improvement in farmers' welfare. A decrease means farmers are sharing the gains of any productivity increase with participants in the rest of the domestic economy or overseas.

The single factoral terms of trade index has been left on the shelf chiefly because of a lack of time-series data on productivity. This lack of data remains a problem at the export level because it has proven especially difficult to obtain reliable TFP estimates at all levels of economic activity from primary production to the point of export. It has now been largely overcome at the agricultural production sector level in Australia, yet the concept has not regained currency as a consequence here or elsewhere.

3. The single factoral terms of trade and its implications for welfare change

In its original use, the concept of single factoral terms of trade had as its denominator the import price index. It is argued above that the equivalent measure for the farm business is the prices paid by farmers, notated as P_I in Equation (3). However, this index does not capture fully the welfare effects of change on the farm household. Given the predominance of family farms in Australian agricultural production, we need also to take account of the purchasing power of the farm household from the net farm income earned and for which the consumer price index is a suitable proxy. The relevant single factoral terms of trade for the farm household then becomes:

$$TOT_{SH} = w_F(P_Y/P_I)O_f + w_H(P_Y/P_C)O_F, \tag{4}$$

where w_F is the weight applied to the expenditure by the farm household on farming operations, measured as the proportion of farm costs to the gross

value of farm production, w_H is the weight applied to the expenditure by the farm household on consumer goods and services, measured as the proportion of the net value of farm production to the gross value of farm production, and P_C is the consumer price index.

The single factoral terms of trade concept has an advantage over profit concepts in that it is a comprehensive measure of returns to all factors of production whereas other measures of profit are expressed in terms of a particular factor, such as returns to capital, or farm business. Also, it has the useful attribute that changes in it are readily decomposable into changes in output prices, input prices, technical efficiency, allocative efficiency and scale efficiency. In the following section, some estimates are provided of both the farm business single factoral terms of trade and the farm household single factoral terms of trade in Australia.

4. Empirical evidence in Australian agriculture

Although the Productivity Commission (2005, chap. 6) did not refer to the single factoral terms of trade index, it reported and commented on trends in the data needed to calculate it. To illustrate the use of the concept, data from ABARE (2004a,b) are now reorganised to provide some empirical evidence of trends in Australian agriculture at both the sectoral and individual industry levels. Figure 1 shows the trend in the single factoral terms of trade index for the whole agricultural production sector over three decades from 1974/1975

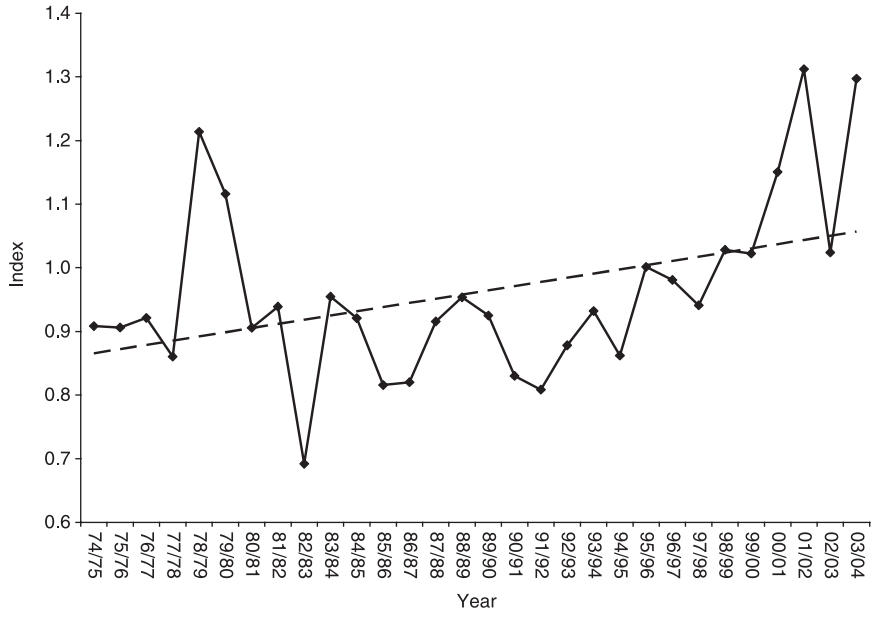

Figure 1 Single factoral terms of trade for the agricultural production sector, 1974/1975 to 2003/2004.
Sources: ABARE (2004a, b), Productivity Commission (2005).

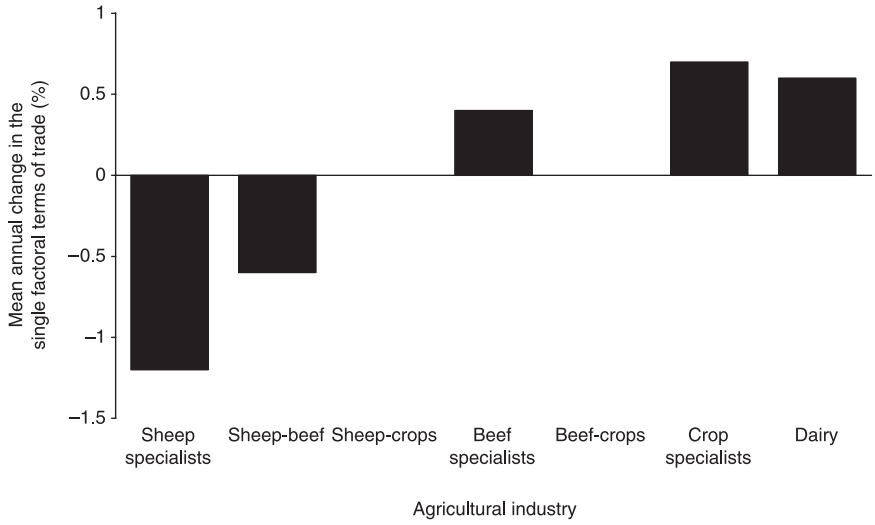

Figure 2 Mean annual change in the single factoral terms of trade for selected agricultural industries, 1977/1978 to 2001/2002.
Sources: ABARE (2004a, b), Productivity Commission (2005).

to 2003/2004. The index is from the perspective of the farm business (there is negligible difference between this index and the index from the viewpoint of the household). A linear trend line is included that clearly shows an upward trend. Despite the fact that the prices paid index increased by an average 1.62 per cent more per annum than the prices received index, the single factoral terms of trade index increased on average by 0.65 per cent per annum, significant at the 3 per cent level. Farm businesses and households have been able gradually to purchase more goods and services for given levels of use of their factors of production.

While there was a general increase in the index, fortunes varied substantially over the period between farmers in different agricultural industries. Mean annual changes in the farm business single factoral terms of trade index for selected agricultural industries from 1977/1978 to 2001/2002 (1978/1979 to 2001/2002 for the dairy industry) are presented in Figure 2 using ABARE (2004a,b) estimates summarised by the Productivity Commission (2005, p. 129). Sheep specialists and sheep–beef producers suffered deterioration in the single factoral terms of trade index, sheep-crops and beef-crops producers experienced a static index, and beef specialists, crop specialists and dairy producers enjoyed improvements in the index. The annual rate of decline for sheep specialists was greater than 1 per cent.

5. Challenges ahead

A number of challenges lie ahead in accurately measuring change in the single factoral terms of trade in the Australian agricultural sector. Not least among them is a need to incorporate changes in the stocks of environmental

resources on the farm into estimates of the TFP component of the index. Randall (2006) observed that increased TFP in Australian agriculture may have been at an environmental cost. He called for analysts of TFP change to account more fully for changes in stocks of land (soil erosion and degradation/enhancement; loss/gain of habitats and species; degradation/improvement of landscape amenities), other environmental assets (water abstraction; exhaustible resource abstraction; air pollution; water pollution) and flows of environmental services (landscape amenities; land-based biodiversity services; nuisance; waste generation).

Concerns have also been expressed about the accuracy of estimates of change in the net barter terms of trade component of the single factoral terms of trade index. In particular, quality changes have been difficult to take into account when measuring the index, as differentials in quality change are likely between manufactured goods and most primary products (Findlay 1981, p. 438). For example, Lipsey (1994) reported that the annual growth rate in the price index of exports of manufactured products from developed countries could be over-estimated by up to 1 per cent because of a failure to account for quality improvements in manufactures.

Finally, it is demonstrated above that TFP growth has helped to counter the impact of adverse relative price movements on agricultural industries. Note, however, that prices are not independent of TFP growth because higher output resulting from TFP growth can lead to a fall in prices. If foreign demand is very inelastic, this price fall may negate the gains from TFP growth and even produce 'immiserising growth'. Analyses of this relationship have become more sophisticated over time, to the point where general equilibrium modelling can now be used to estimate the impact of TFP growth on farmers' welfare.

6. Conclusion

The concept of single factoral terms of trade is shown to be a useful addition to the arsenal of agricultural policy makers in Australia in that it can be used as an index to track changes in the welfare of farm households in the agricultural sector in general and farmers within an agricultural industry in particular. Evidence is presented to show that TFP growth has helped to counter the impact of adverse relative price movements on some agricultural industries. But the usefulness of the concept depends on an ability to measure accurately changes in its components, the TOT_N and TFP, and the potentially negative relation between these two components.

While it is possible to distinguish between the single factoral terms of trade from the viewpoints of the farm business and the farm household, only slightly different indices are reported because of the very high positive correlation between farm prices paid and consumer prices. Rather than distinguishing indices according to the farm business or household, a more rewarding course of action would be to develop indices for groups of farm businesses

according to the agricultural industry in which they operate. The main reason for following this line of analysis is that substantial differences exist in the rates of growth in TFP between agricultural industries. A related argument for specific industry analysis is that differences in market structure for agricultural and other primary industries, such as export market concentration and other idiosyncratic factors, influence any analysis of gains from trade.

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