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The productivity of Western Australia's wheat and sheep industry

By Tim Coelli, Lecturer, Department of Econometrics, University of New England, Armidale, N.S.W. and Ross Kingwell, Economist, Department of Agriculture, South Perth

A popular economic lament is that Australian industries and workers are not as productive as they should be. Politicians and economic commentators preach the need for productivity improvement and workplace reform, and criticise inefficiency and lack of endeavour.

Can such criticism be fairly levelled at farmers and agricultural scientists?

What is productivity and how is it measured? What is the productivity of Western Australia's main agricultural industry — wheat and sheep farming?

This article addresses these questions and shows that our wheat-sheep industry can be moderately proud of its productivity record.

The estimate of productivity improvement in our wheat-sheep industry was 2.7 per cent per year from 1953-54 to 1987-88. Such a rate of improvement is comparable to that of other Australian industries and our international competitors.

This rate of productivity improvement has allowed more farmers to remain in farming despite the adverse terms of trade. It has helped generate higher incomes than would otherwise have been possible if the productivity of our wheat-sheep farmers was less, or the productivity of our competitors was much greater.

What is productivity?

Productivity is a widely used and abused word. Most economics texts define productivity as the ability of a productive unit (for example, a farm) to combine and use inputs (for example labour, machinery, fertilizers) in the best possible way to produce an output (for example, wheat, wool).

An industry or farm can experience productivity improvement by using fewer inputs to produce the same level of output, or by producing more from an improved combination of inputs.

In practice, productivity improvement comes from better management, a more skilled workforce, improvements in technology, economies of scale, new knowledge, research innovations and better marketing.

How do we measure productivity?

There is no uniform measure of productivity. The most common measure of productivity is labour productivity. This is calculated by dividing the output of an industry by its workforce. However, by focusing on labour other important factors of production (for example, land, capital) are overlooked.

In agriculture we also tend to focus only on one input – land. Many farmers and agricultural scientists focus their attention on yields per hectare. Although there are desirable technical
reasons for focusing on the productivity of land, the contributions of other factors of production (for example, management, capital) are not explicitly recorded. Often this results in researchers committed to yield improvement being slightly dismayed when examinations of historical data reveal subdued progress in improving yields (land productivity) within an industry.

Preferred productivity measures are those that jointly consider an industry's main inputs and outputs. There are two broad kinds of preferred measures - multifactor productivity and total factor productivity.

A measure of multifactor productivity considers a subset (subgroup) of an industry's outputs and inputs, while a measure of total factor productivity attempts to include almost all of an industry's inputs and outputs. These measures are expressed as a ratio of industry output to input. Usually the industry output and input is calculated from indices that allow suitable weightings to be given to each item of input and output that characterize the industry.

To examine productivity improvement within the wheat-sheep industry we developed a measure of total factor productivity using Tornqvist indices. These indices rely on historical data on industry inputs and outputs and their prices.

We used a specially selected subset of Australian Bureau of Agricultural and Resource Economics (ABARE) agricultural and grazing industry survey data. The data were sample means per farm from 1952-53 to 1987-88 for all farms surveyed in Western Australia's wheat-sheep zone. The data excluded large pastoral properties, yet included farms with more than

\[
\text{Harvesting wheat in the Tammin area.}
\]

\[
\text{TOP: Shearing sheep at Wagin.}
\]

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1 For example, a Tornqvist input index for the case where only two inputs are used over two years is:

\[
\text{Tornqvist Index} = \exp\{A_1 \ln(X_1 / X_0) + A_2 \ln(X_2 / X_0)\} * 100
\]

where

\[
A_1 = (C_1 + C_2) / 2
\]

\[
A_2 = (C_1 + C_2) / 2
\]

\[
C_j = \left( \frac{P_j * X_j}{(P_1 * X_1) + (P_2 * X_2)} \right)
\]

\[
C_j = \left( \frac{P_j * X_j}{(P_1 * X_1) + (P_2 * X_2)} \right)
\]

Each \( C_j \) is the budget share of the \( j \)-th good in the \( j \)-th year. \( A_1 \) and \( A_2 \) are the averages of the budget shares across the two years.
Five broad groupings of industry output were formed: grains, wool, sheep meat, cattle and other production. There were also five input groupings: livestock, materials and services, labour, capital, and land. Each input and output group was given an appropriate weight depending on its revenue or cost share within the industry for each year from 1952-53 to 1987-88. Indices of output and input were formed with the ratio of output to input becoming the measure of total factor productivity.

**Productivity results**

Changes in the industry's output, input and total factor productivity indices are given in Figure 1.

Regression analysis of the data in Figure 1 indicates that the output per farm in Western Australia's wheat-sheep zone has increased over the 35 years of the study period. The average annual rate of increase has been 5.3 per cent.

Seasonal influences and some fairly rapid changes in the output mix of some of the wheat-sheep farms cause some deviations about the trend of increasing output. For example, the early 1970s was characterized by a surge into cattle production, removal of wheat quotas plus some seasons favourable for grain production. These features led to a burgeoning output from wheat-sheep farms.

However, conversely, the late 1970s and very early 1980s saw a massive withdrawal from cattle production by wheat-sheep farmers, plus some poor seasons in many parts of the wheat-sheep zone.

In the 1980s, the most noticeable output changes among wheat-sheep farms have been increases in wool and lupin production, and livesheep sales.

The annual rate of increase for the index of inputs has been 2.6 per cent. The volatility of the input index is much less than that of the output index, mainly because of the lesser effect of seasonal influences upon input use, particularly for land, labour and capital.

The increase in input use, however, is not consistent. There are periods of stagnation in input use, such as 1957 to 1964 and 1968 to 1972. There are also periods of declining input use such as 1973 to 1975 and 1982 to 1986.

Use of inputs in the period 1968 to 1972 was probably constrained by the financial pressures arising from the twin impacts of wheat quotas and the severe 1969 drought. The fall in input use from 1973 to 1975 was probably in response to the dramatic increase in farm costs (Figure 2) at the start of the pronounced inflationary period 1972 to 1986.

During the other period of less severe declining input use, 1982 to 1986, the rate of increase in input prices outstripped that for output prices. This caused a marked decline in the profitability of farming and thereby restricted input use.

**Productivity improvement of 2.7 per cent**

Western Australia's wheat-sheep industry has shown productivity improvement because the rate of growth in farm output has exceeded the rate of growth in input use.

Total factor productivity is estimated to have increased at an annual rate of 2.7 per cent. This measure of productivity compares favourably to those described by Lawrence and McKay (1980) and ABARE (1988). Lawrence and McKay estimated that the rate of improvement in total factor productivity for the Australian sheep industry from 1952-53 to 1976-77 was 2.9 per cent per year.

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2 Estimates of the average percentage change in each index were derived by regressing the logarithm of the index upon a time trend. For example, for the total factor productivity index (TFP) the regression equation was:

\[ \ln(\text{TFP}_t) = a + b \cdot t + e, \]

where \( a \) is the intercept, \( e \) is the error or disturbance term, \( t \) is the year and \( b \) is the average annual percentage change in productivity over the period examined.
The ABARE study estimated the improvement in total factor productivity for Australian agriculture, forestry and fishing was 2.8 per cent per year from 1965-66 to 1985-86.

Another study by Englander and Mittelstadt (1988) showed that from 1960 to 1973 total factor productivity across many Australian industries averaged 2.1 per cent per year. The OECD average was 2.8 per cent per year.

Recent research by Ergas and Grose (1989) indicates that the comparative productivity of Australian agriculture outstrips that of many other primary exporting countries, and is greater than that recorded in many Australian manufacturing industries. Given that the productivity measurement in our study is consistent with that found in similar national studies, it follows that the wheat-sheep industry in Western Australia can boast that its historical productivity has surpassed that of many of its international competitors.

**Terms of trade**

Although productivity improvement in Western Australia’s wheat-sheep industry is laudable, nonetheless it has been necessary to help offset the industry’s declining terms of trade (Figure 2). An industry’s terms of trade is a ratio of its output prices to its input prices.

From 1952-53 to 1987-88 the wheat-sheep industry’s input prices increased 8 per cent per year while output prices increased by only 3.7 per cent per year. Hence, the industry’s terms of trade fell by 4.3 per cent per year.

Improving productivity by 2.7 per cent per year has meant that the actual ratio of returns to costs declined by only 1.6 per cent per year. Given that output per farm has increased by 5.1 per cent per year, an implication is that the return to management increased by about 3.5 per cent per year in nominal terms.

In real terms, however, this represents a declining return; a result consistent with other studies of farm income. In short, there has not been enough productivity improvement in the wheat-sheep industry to prevent declining real farm incomes. Nonetheless, if it were not for productivity improvement, the incomes and numbers of farmers in Western Australia’s wheat-sheep industry would be much less than it is today.

**References**


