

**Revealed Comparative Advantage and the Measurement of
International Competitiveness for Agricultural Commodities: An
Empirical Analysis of Wool Exporters**

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Revealed Comparative Advantage and the Measurement of International Competitiveness for Agricultural Commodities: An Empirical Analysis of Wool Exporters.

Trade liberalization and *laissez-faire* economics are altering the structure of agricultural production and trade. The principle of comparative advantage, a classic tenet of economics, is a useful tool for understanding the future of world agriculture. This study employs a “Revealed Comparative Advantage” approach to investigate patterns of comparative advantage among six major wool exporting countries.

Introduction

The decline of the U.S. sheep industry is a well-documented fact. Sheep numbers have fallen from 56 million in 1942 to less than 8 million today. Predator problems, falling consumer demand for mutton and lamb, labor shortages, the elimination of wool incentive payments, along with the expansion of synthetic fiber use, are some of the suggested reasons for this decline (ITC, 1995; Purcell, 1995; Whipple and Menkhaus, 1989).

While other countries have not been immune to similar adversities, the American experience appears to be unique. Worldwide, sheep populations and wool production have been relatively stable. Despite significant structural change and waning consumer demand, a few nations have managed to maintain their preeminence in the global wool market. In 1961, six countries - Argentina, Australia, New Zealand, South Africa, the United Kingdom and Uruguay - accounted for more than 83% of world exports of raw and scoured wool. Today, the same six are still responsible for about 75% of the international market (FAOSTAT, 1999).

The pattern of success within the global wool industry, however, is uneven. As producers face new challenges and opportunities, their fortunes can rise and fall at the whim of the marketplace. The political and economic turmoil of 1989 to 1991, for example, sparked a crisis in world wool markets, led to a surge in stockpiles, and eventually forced the Australian and New Zealand governments to discontinue their price reserve systems. Lately, other governments also have joined the *laissez-faire* bandwagon, and have curtailed or abolished many of their marketing and price support functions. For wool producers, the absence of a governmental safety net has made the future all the more daunting. Though producers can now benefit from increased market access, due in large part to the GATT Uruguay Round and the phase-out of the Multi-Fiber Agreement, there is still a lingering uneasiness about the future.

Whether there ought to be more concern for the decline of an industry is an issue that is

probably best left to those within the political arena. Economists, however, can elucidate on reasons for why industries rise and fall. By returning to a classical tenet of economics, the Law of Comparative Advantage, one can seek answers to the questions of “who exports what and why?” Analysis of comparative advantage (CA) is certainly not a novel idea. But, despite a plethora of studies in the last 50 years, few have specifically addressed agricultural trade. Some suggest that the conspicuous absence of CA analysis from agriculture may be due, in part, to the magnitude of distortion brought by governmental policy (Haley, 1985). In the 1950’s, Wassily Leontief argued that “...fluctuations in yield here and abroad, not to speak of government intervention, affect foreign trade in farm products to such an extent that the amounts of agricultural commodities exported and imported in one single year can be expected to reflect long-run comparative costs much less than is the case for any other type of good.” (Leontief, 1956) Clearly, the strength of this argument has been weakened by recent developments in agricultural trade liberalization. As agricultural producers become more exposed to market forces, and as dependence on foreign markets increases, the relevance of CA is increasingly apparent.

The object of this study is to apply theoretical and empirical principles of CA to better understand national patterns of production and export of wool. Specifically, this study analyzes patterns and variations of CA in six wool producing countries over a 37-year time frame. The results of this analysis should contribute to a greater awareness of why the U.S., or any other country, is in the position it is regarding its wool industry. The selection of wool, for the purposes of this study, is not accidental. Wool is a widely traded non-perishable commodity – more than 50% of world production is currently traded on the international market – by comparison, only 20% of wheat production and 3% of rice production is traded internationally. Wool is not a highly localized commodity. Unlike coffee, bananas or sugar cane, factors

employed in the production of wool can be found almost anywhere. Finally, wool has a long and distinguished history that transcends cultural differences. An examination of its past may reveal some interesting implications for agriculture as a whole.

Theory and Methodology

The notion of CA is attributed to the work of John Stuart Mill, Adam Smith and David Ricardo. It is largely derived from the propositions on opportunity cost and labor specialization. Smith and Mill first advanced the concept of absolute advantage, claiming that a nation will export an item when it is the lowest cost producer of that item. Ricardo refined the idea of CA by recognizing that a nation tends to allocate its resources to their most productive use. A nation may therefore import a good even when it is the lowest cost producer of that good.

More recently, Eli Heckscher and Bertil Ohlin revolutionized trade theory by emphasizing international differences in resource (or factor) endowments. “Factor abundance theory”, or the Heckscher-Ohlin (H-O) model, predicts that a country will export commodities that are relatively intensive in the factor with which the country is relatively well endowed. Thus, a land-abundant country will export land intensive goods, while a capital-abundant country will export capital intensive goods. The purview of the H-O model has been subsequently extended through the work of Wassily Leontief, Paul Samuelson, Jaroslav Vanek, and others (Memedovic, 1994).

Empirical tests of CA often use cost or price information to measure efficiency in production, as well as availability and allocation of scarce resources. Transportation models and linear programming techniques, for example, have determined CA through market proximity or cost minimizing solutions, subject to resource availability and prices. These forms of analysis, however, are often constrained by a lack of reliable and internationally comparable data. Even when survey methods are used to overcome data scarcity, the estimation of exchange rates,

purchasing power and valuation of local land, labor and capital can be problematic. Further complications also arise when taking into account the so-called “milieu factors”, such as government policy, history and other likely sources of CA that do not easily lend themselves to quantification.

Ideally, measures of CA should reflect regional or cross-country differences in a hypothetical pre-trade environment, known as autarky. Autarky is the condition where equilibrium prices are unaffected by influences external to an economy (Houk, 1986). Since, in reality, all countries engage in some level of international trade, “true” CA in autarky cannot be directly observed. In 1965, Bela Balassa introduced the notion of “Revealed Comparative Advantage” (RCA) as a way to approximate CA in autarky. According to Balassa, “the concept of RCA pertains to the relative trade performances of individual countries in particular commodities. On the assumption that the commodity pattern of trade reflects inter-country differences in relative costs as well as in non-price factors, this is assumed to reveal the comparative advantage of trading countries.” (Balassa, 1977) If trade performance is determined by CA, then direct observations of trade performance should “reveal” CA. Barring production or export subsidies, the stronger a nation’s relative trade performance in a certain commodity, the greater the CA in the production of that commodity. The plausibility of this condition has almost certainly been strengthened by recent trends in trade liberalization.

Balassa and others have used production, consumption, import, and export data to construct various trade performance indicators. While there is little justification for selecting any one measure over another, the most easily adaptable to the UN Food Agriculture Organization statistical databases, and perhaps the most relevant for an analysis of wool exports, appears to be an index based on export data only. The export based RCA index is calculated by dividing a country's share in raw and scoured wool exports by its share in the combined exports

of agricultural goods.

$$(1) \quad RCA_{ijt} = \left(\frac{X_{ijt}}{X_{iwt}} / \frac{\sum X_{ajt}}{\sum X_{awt}} \right) \times 100$$

Where:

- RCA_{ijt} = Revealed Comparative Advantage index value for the wool industry in country j in year t .
- X_{ijt} = Exports of wool industry in country j in year t .
- X_{iwt} = Total world exports of wool industry in year t .
- $\sum X_{ajt}$ = Sum of agricultural exports in country j in year t .
- $\sum X_{awt}$ = Sum of world agricultural exports in year t .

The higher the RCA index value, the greater the importance of wool relative to other agricultural exports. Thus, an index value of 120 would indicate that a country's wool export share for a given year is 20% higher than its share in total world exports of agricultural goods.

Wool industry RCA index values are calculated for Australia, Argentina, New Zealand, South Africa, the United Kingdom and Uruguay for the years 1961 to 1997. F-tests, t-tests and correlation coefficients are also estimated to identify particular patterns among the six wool exporting countries. Two questions are of particular interest. First, have patterns of RCA changed as a result of declining government activism and greater trade liberalization? Second, are there any similarities in RCA between countries in the same region or between countries that specialize in similar kinds of wool production?

A regression model, loosely based on H-O assumptions, was also developed to uncover factors that might be influencing year-to-year changes in RCA. In theory, the model attempts to follow a relationship expressed as:

$$(2) \quad RCA_{WOOL} = f(LABOR \ CAPITAL \ LAND \ TECHNOLOGY \ etc \ \dots)$$

Where the exogenous variables need not take into account all possible determinants of CA.

Balassa noted that “this would be a rather laborious exercise and, in view of the difficulties of assigning numerical values to these variables, it might bring disappointing results.” The obvious

data and statistical difficulties aside, this model also presents an equivalence or balance problem between the endogenous variable, RCA_{WOOL} , and the exogenous variables for land, labor, capital etc... According to the classic H-O model, exports tend to reflect relative factor abundance (or in the case of the Ricardian model, factor productivity). This prediction, however, is not commodity specific. H-O, in fact, can only account for broad patterns of CA – for example, capital intensive relative to labor intensive exports. To understand CA at a commodity specific level, one needs to re-focus the idea of opportunity cost, bringing it closer to a producer decision-making framework. The production decision to select one form of enterprise or another is only partially based on factor abundance and factor cost. “Milieu” factors, such as history, environment, climate, available infrastructure, as well as relative risk and expected prices, also influence producer decision-making.

To account for the dynamics of opportunity cost at the commodity specific level, the model should reflect a range of producer choice in allocating resources to or away from wool production. For this reason, three exogenous variables were selected to represent a range of alternative opportunities or choices a wool producer might typically face. While there is no strong justification for the selection of the exogenous variables, MILK and WHEAT (both measured in terms of annual production in metric tons), there is some evidence to suggest that dairy, in rain-fed areas, and wheat, in drier semi-arid regions, appear to have attracted a number of producers away from the sheep industry (Morris and Stogdon, 1996). The last exogenous variable, industry value added as a percentage of GDP (GDP), attempts to measure relative levels of industrialization. This, in a way, could account for growth and relative size of non-agricultural sectors. The model formulated as,

$$(3) \quad RCA_{WOOL} = f (MILK_{PRODUCTION} \ WHEAT_{PRODUCTION} \ GDP_{INDUSTRY \ VALUE \ ADDED})$$

draws upon FAO and World Bank data from 1971 to 1993. The equation was estimated,

using pooled data and country slope shifters, with the Parks Method Time-Series Cross-Sectional Regression Procedure in SAS (TSCSREG), correcting for heteroscedasticity and serial correlation (SAS/ETS, 1993).

Results and Discussion

After calculating wool RCA index values for 1961 through 1997 in each of the six countries, t-tests, F-tests and correlation coefficients were estimated to unveil significant patterns and differences between countries, and between pre- and post-liberalization periods. Liberalization was defined by the landmark Punta del Este Declaration, which launched the GATT Uruguay Round in 1986. Although the actual implementation phase did not begin until after the 1994 Marrakesh Agreement, it is assumed that the negotiations themselves had an impact on expectations in the world market.

The correlation analysis reported in Table 1 reveals a significant relationship between seven different country pairings ($\alpha = 0.10$). In all cases except for New Zealand – Australia and New Zealand – United Kingdom, countries that produce similar types of wool tend to be positively correlated, while countries producing different types of wool tend to be negatively correlated. The New Zealand – Australia exception appears to follow a second pattern where countries in the same region tend to be positively correlated. This could suggest that factors affecting supply or demand influence RCA indices of similar countries, or of countries within a particular region, in the same way. A more focused examination of the data reveals a stronger explanation for why these patterns exist.

When Australia and New Zealand are excluded from the analysis, all significant pairings are positively correlated. The t-tests in Table 2 further indicate that the RCA indices for the four non-Oceanic countries have dropped significantly since the start of the GATT Uruguay Round in 1986. This appears to suggest that liberalization, among other factors, has had an

equally detrimental effect on the comparative advantage of the non-Oceanic countries. While New Zealand's RCA has not changed significantly in the post-liberalization period, Australia has actually seen a substantial rise in its RCA. In the analysis, Australia emerges as the only clear winner of the post-1986 period. Its unparalleled dominance in international wool exports could be due in large part to economies of scale and the role of the "specialist" enterprise, which derives the majority of its cash receipts from sheep and wool production, and collectively accounts for almost half of Australia's total wool production (ABARE, 1998).

Table 1. Pearson Correlation Coefficients / Prob > |R| under H₀: Rho = 0 / N = 37

	Argentina	Australia	N. Zealand	S. Africa	United Kingdom	Uruguay
Argentina	1					
Australia	-0.69320 (0.0001)	1				
N. Zealand	0.03542 (0.8352)	0.38417 (0.0189)	1			
S. Africa	0.08691 (0.6090)	-0.12426 (0.4637)	-0.01057 (0.9505)	1		
United Kingdom	0.60369 (0.0001)	-0.82771 (0.0001)	-0.34366 (0.0373)	0.14839 (0.3808)	1	
Uruguay	0.58803 (0.0001)	-0.20633 (0.2205)	0.36968 (0.0243)	0.19789 (0.2404)	0.04376 (0.7970)	1

Note: Parentheses contain the significance probabilities under the null hypothesis that the correlation is zero.

Table 2. Means, Standard Deviations and Results of the t- and F-Tests

	Argentina	Australia	N. Zealand	S. Africa	United Kingdom	Uruguay
RCA Pre-1986 m	203.3842	1151.3703	1053.6056	606.2278	134.899	1118.6102
RCA Pre-1986 s	40.9668	193.1456	327.1552	143.1245	26.6451	259.3204
RCA Post-1986 m	125.4585	1740.1609	1106.6932	520.6718	91.9608	887.8678
RCA Post-1986 s	35.7720	161.1325	134.2687	141.3816	15.5889	287.2651
t-test	5.6306 (0.0000)	-9.1273 (0.0000)	-0.6981 (0.4898)	1.7087 (0.0964)	6.1562 (0.0001)	2.4478 (0.0195)
F-test	1.31 (0.6561)	1.44 (0.5403)	5.94 (0.0038)	1.02 (1.0000)	2.92 (0.0675)	1.23 (0.6452)

Note: Parentheses contain the significance probabilities under the null hypothesis that the difference in means or the difference in variances are zero.

The estimation of a modified equation (3) lends further credence to this theory. Using Australia as a base, country slope shifters were included in the equation to account for any significant differences between countries:

$$\begin{aligned}
 \text{RCA} = & 522.302583 + 0.023328 \text{ WHEAT} - 0.02103 \text{ AWHEAT} + 0.085542 \text{ NWHEAT} + \\
 & (4.97) \quad (3.99) \quad (-3.02) \quad (0.22) \\
 & 0.091010 \text{ SWHEAT} - 0.026965 \text{ UWHEAT} - 0.082370 \text{ RWHEAT} + \\
 & (1.78) \quad (-4.20) \quad (-0.30) \\
 & 0.202336 \text{ MILK} - 0.245437 \text{ AMILK} - 0.163661 \text{ NMILK} - 0.225760 \text{ SMILK} - \\
 & (7.01) \quad (-7.86) \quad (-3.89) \quad (-1.67) \\
 & 0.21367 \text{ UMILK} - 0.735026 \text{ RMILK} - 21.585806 \text{ GDP} + 18.855768 \text{ AGDP} + \\
 & (-7.26) \quad (-4.95) \quad (-3.66) \quad (3.07) \\
 & 33.430307 \text{ NGDP} + 19.185485 \text{ SGDP} + 16.462943 \text{ UGDP} + 55.769223 \text{ RGDP} \\
 & (3.44) \quad (1.96) \quad (2.57) \quad (8.00) \\
 \\
 R^2 = & .93 \quad \quad \quad (\text{t-values are parentheses})
 \end{aligned}$$

Where each exogenous variable is specified by individually by country, (A)rgentina, (N)ew Zealand, (S)outh Africa, (U)nited Kindom and U(R)uguay.

In the estimated equation, wheat and milk production does not adversely affect Australia's wool RCA. In fact, the three forms of enterprise appear to easily co-exist within Australia's agricultural production capacity. The "specialist" enterprise, which accounts for almost of Australia's wool production, appears to be unaffected by the possible trade-off between wool and milk or wheat production. The same, however, cannot be said for four of the other five countries. In countries where "specialist" wool enterprises are less of a factor, milk production in particular seems to detract from wool RCA. This is evident in the cases of Argentina, South Africa, the United Kingdom and Uruguay. Wool producers in these four non-Oceanic countries face a trade-off or a greater opportunity cost associated with their decision to produce wool. As can be seen in the model, an increase in milk production leads to a decrease

in the RCA value for wool.

Although the robustness of the last exogenous variable, GDP, is questionable, it appears to confirm an assumption that there is an inverse relationship between wool RCA and levels of industrialization. Germany, Spain and the United Kingdom have all seen a substantial decline in their wool production as their industrial capacity increased. In the estimated equation however, trend or other influences could be skewing the results, as is perhaps the case with New Zealand and Uruguay.

Summary and Conclusions

In 1976, Gottfried Haberler remarked that “no sophisticated theory is necessary to explain why Kuwait exports oil, Bolivia tin, Brazil coffee and Portugal wine.” (Goldin, 1990). This paper contends that the analysis of comparative advantage for agricultural commodities has not only become relevant, but may in fact be an important tool for understanding the future of world agriculture. Although autarky precludes direct observations of CA, measures of RCA can provide useful approximations of CA.

While Balassa's export-based RCA index overlooks aspects of domestic consumption and value-added processing, it is nevertheless a meaningful gauge for measuring the relative strength or weakness of agricultural exporters. In the case of wool, the measurement of RCA has shown that CA is a dynamic, not a static condition. The dynamics of CA have become increasingly apparent as agricultural markets become less insulated by government trade and support policies. This study has shown that, since the start of the GATT Uruguay Round in 1986, RCA indices have changed significantly. For the four non-Oceanic countries, wool RCA index values have decreased significantly, while for Australia, the RCA index has actually increased despite the recent fall in sheep numbers.

Economies of scale and the importance of the “specialist” enterprise are perhaps the

best explanations for Australia's relative success in wool exports. A model, developed to account for variations in RCA over time and across countries, appears to confirm Australia's distinctiveness relative to other major wool exporters. The model, loosely based on H-O (factor abundance) and Ricardian (factor cost / productivity) assumptions, attempts to re-focus the idea of opportunity cost, bringing it closer to a producer decision-making framework. Assuming a nation's producers are collectively rational, it is at this level that one can fully account for climate, relative risk, expected prices, costs, endowments and productivity of land, labor and capital, as well other "milieu" factors – history, environment, available infrastructure, knowledge of the industry, etc...

The decision to allocate resources to and away from wool production is represented in the model by measures of dairy (for rain-fed areas) and wheat (for semi-arid regions) production. A measure of industrialization is also included in the model to account for the relative growth and size of the non-agricultural sectors in the economy. If enterprise production decisions for a given commodity ultimately determine international competitiveness, trade-offs with competing forms of enterprise, or with competing sectors of an economy, will likely detract from the international competitiveness of that given commodity. Although Australia and New Zealand RCA indices appear to be largely impervious to this form of trade-off, milk production in the remaining four countries has been shown to detract from wool RCA.

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