Agriculture in India and Pakistan, 1900-95: A Further Note *

Takashi KUROSAKI †

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Abstract

This paper re-investigates the performance of agriculture in India and Pakistan, c.1900-1995 from historical and comparative perspectives. A new decomposition formula is applied to the data set used by the *EPW* 1999 paper, which corresponds to the current border in India and Pakistan. The decomposition results show that aggregate changes in crop mix were one of the most important sources of land productivity growth in India and Pakistan. Their contribution has become more important in recent decades in India whereas their contribution was the most important in Pakistan during the 1950s, i.e., the period just prior to the Green Revolution.

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†Institute of Economic Research, Hitotsubashi University, 2-1 Naka, Kunitachi, Tokyo 186-8603 JAPAN. Phone: 81-42-580-8363; Fax: 81-42-580-8333; E-mail: kurosaki@ier.hit-u.ac.jp.

1 Introduction

The performance of agriculture in India and Pakistan, c.1900-1995, is re-investigated in this paper from historical and comparative perspectives in the context of economic liberalization during the 1990s. Based on a data set that corresponds to the current border, Kurosaki (1999) shows a distinct turnaround at the Partition in 1947 — the stagnant performance of agriculture in India and Pakistan during the colonial period was turned into a sustained growth since 1947, with a stronger performance in India especially in terms of per-capita food production.

To quantify Kurosaki's (1999) conjecture that changes in crop mix played an important role in land productivity growth, a new decomposition formula is applied to the same data set. The new decomposition method structurally associates changes in aggregate land productivity with changes in crop mix. Empirical results of this paper will show that aggregate changes in crop mix were indeed one of the most important sources of land productivity growth. Their contribution has become more important in recent decades in India whereas their contribution was the most important in Pakistan during the 1950s, i.e., the period just prior to the Green Revolution.

In the following, Section 2 presents the decomposition framework with discussion on theoretical background. Data for the empirical analysis are briefly described in Section 3, followed by Section 4 that presents decomposition results. Section 5 summarizes the paper with discussion on policy implications.

2 Crop Shift as a Growth Source of Agriculture

Agriculture plays important roles in economic development, such as provision of food to the nation, enlarging exports, transfer of manpower to nonagricultural sectors, contribution to capital formation, and securing markets for industrialization [Johnston and Mellor 1961, pp.571-581]. Improvement in agricultural productivity is key to the realization of each of these roles. Historical records have shown that agricultural productivity has been growing due to introduction of modern technologies, commercialization of agriculture, capital deepening, factor shifts from agriculture to nonagricultural sectors, etc. This whole process could be called 'agricultural transformation,' to which the contribution of each of these factors has been quantified in the existing literature [Timmer 1988].

The importance of changes in crop mix on agricultural development has not yet been analyzed well in decomposition analysis, however. This paper therefore attempts to apply a decomposition method known as the shift-share method used in studies on inter-sectoral resource allocation effects on manufacturing productivity growth [Syrquin 1984; Timmer and Szirmai 2000; Sonobe and Otsuka 2001] to the case of agriculture in India and Pakistan.

Define $Y_t \equiv Q_t/A_t$, where Q_t is aggregate farm output in real Rupees and A_t is the gross sown area that produces Q_t. Therefore, Y_t shows land productivity at the macro level in terms of real output value per acre. Letting subscript i denote subsectors comprising various crops, the agricultural growth from year 0 to year t can be decomposed as

$$\ln(Q_t/Q_0) = \ln(A_t/A_0) + \ln(Y_t/Y_0) \approx \frac{A_t - A_0}{A_0} + \frac{Y_t - Y_0}{Y_0} \tag{1}$$
$$= \frac{A_t - A_0}{A_0} + \frac{1}{Y_0}\left[\sum_i s_{i0}(Y_{it} - Y_{i0}) + \sum_i (s_{it} - s_{i0})Y_{i0} + \sum_i (s_{it} - s_{i0})(Y_{it} - Y_{i0})\right],$$

where $s_{it} \equiv A_{it}/\sum_k A_{kt}$, which is the area share of crop i in year t. The first term of the last expression shows area effects and the block within a bracket shows land productivity effects. One of the innovation of this paper is the decomposition of the land productivity term into three elements following the terminology by Timmer and Szirmai (2000): the first term in the bracket shows crop yield effect; the second term is called 'static' shift effect; and the third term is called 'dynamic' shift effect. The 'static' shift effect becomes more positive when the area under crops whose yields were initially high increases relatively. In contrast, the 'dynamic' shift effect becomes more positive when the area under dynamic crops (i.e., crops whose yields are improving) increases relative to the area under non-dynamic crops.

When do crop shifts contribute to agricultural growth according to equation (1)? For a macro region to change its crop mix toward high value crops, it is necessary to trade with outside regions. In that sense, development of international trade is important. The development of agricultural produce markets within a country is also important since it reduces the gap between market prices and farm-gate prices received by farmers. With substantial transportation costs, farmers may optimally choose a crop mix that *does not* maximize expected profits evaluated at the market prices but that *does* maximize expected profits evaluated at the farm-level shadow prices [Omamo, 1998a; 1998b]. Such a crop mix reflect more of farmers' consumption preferences. When rural markets develop, however, the discrepancy between the market price of a commodity and its shadow price at the farm level is reduced, thereby farmers are provided with incentives to grow crops whose prices in the market are lucrative rather than crops that satisfy their consumption needs. Needless to say, technological development, e.g., introduction of irrigation or tractor technology, which increases flexibility in crop choices, facilitates farmers' response to market incentives. In other words, a large contribution of crop shift effects in decomposition (1) indicates that agricultural growth is accelerated by market and technological development that allows farmers to adopt production choices that reflect their comparative advantages more closely.[1]

3 Data

The model in the previous section is applied to a data set used in Kurosaki (1999) that corresponds to the current border in India and Pakistan and covers a period c.1900-1995. As in Kurosaki (1999), the area currently in Pakistan before 1947 is treated 'fictiously' as a macro region called 'Pakistan,' since the focus of this paper and Kurosaki (1999) is on the investigation of agricultural trends for specific geographic regions. Kurosaki (2000) presents the compiled data as well as the details of data compilation procedures. Original data sources before independence are *Agricultural Statistics of India*, *Estimates of Area and Production of Principal Crops*, and various provinces' *Season and Crops Reports*. Post independence data are compiled from official government publications of agricultural statistics.

The data set covers production information of principal crops only, which are important in contemporary India and Pakistan, and for which detailed data on production and prices are available from the British period. For India, eighteen crops are included: rice, wheat, barley, jowar (sorghum), bajra (pearl millet), maize, ragi (finger millet),

[1]A similar decomposition can be applied to the effects of crop shifts over space. When farms or districts with comparative advantages in growing specific crops increase the area share of such crops, the macro level productivity (real Rupees per acre) of such crops will increase. Development of rural markets again facilitates this change. See Kurosaki (2001) for the application to the case of West Punjab, in which the effects of inter-district land re-allocation on land productivity growth are analyzed.

gram (chickpea); linseed, sesamum, rape and mustard, groundnut; sugarcane, tea, coffee, tobacco, cotton, and jute. For Pakistan, all twelve crops included in the major crops subsector of the national accounts are covered, i.e., rice, wheat, barley, jowar, bajra, maize, gram; rape and mustard, sesamum, sugarcane, tobacco, and cotton.

To compile variables Q_t and Y_t in equation (1), the gross output values from these crops need to be aggregated. As in Kurosaki (1999), fixed prices of 1960/61 were adopted for India and those of 1959/60 were adopted for Pakistan.[2] To remove temporal variation due to weather shocks and others, moving average over three years (MA(3)) was applied to cropped area data and MA(5) was applied to output data, with the mid year used in notation.

4 Empirical Results

Before investigating the effects of changes in crop mix on land productivity, findings from Kurosaki (1999, Tables 1 and 2) regarding the source of agricultural growth are summarized. In areas currently in India, the total output increased at 0.5% per annum before independence and the growth rate was accelerated to 2.9% since independence. Area effects explained all of the pre-independence growth whereas land productivity effects accounted for 76% of the post-independence growth.

This pattern is shared with Pakistan, where the growth rates were more favorable than in India throughout the period. In areas currently in Pakistan, the average growth rate of the total output was 1.3% per annum before independence and 3.7% since independence. Area effects explained 71% of the pre-independence growth whereas land productivity effects accounted for 65% of the post-independence growth. Although these growth rates were higher than India's, per-capita growth performance was worse in areas currently in

[2] Three notes should be given to the choice of our aggregation procedure. First, to infer the possible bias from using output values instead of value-added figures, the value-added ratio to the sum of gross output values was investigated since the early 1950s. The ratio was found to be relatively stable. Second, our method of calculating output values per acre implies that 'comparative advantages' discussed in this paper are conditional on these fixed prices. They may not reveal the 'real' comparative advantages evaluated at social shadow prices if the governments seriously distort the relative prices. Third, to infer the possible bias from adopting a specific year for the price base, other base years (e.g., 1938/39 and 1980/81) were also tried for aggregation weights [Kurosaki 2000]. The 1938/39 prices were relatively free from price distortions created by the government. The results reported in this paper were insensitive to the choice of base years, including the 1938/39 price.

Pakistan due to its higher population growth rates.

Therefore, the stagnant performance of agriculture in India and Pakistan during the colonial period was turned into a sustained growth since 1947. The main engine of this turnaround was land productivity growth. To what extent was the land productivity growth explained by changes in crop mix?

Table 1 shows results of decomposition according to equation (1) for areas currently in India. First, the contribution of total crop shift effects is substantial, explaining more than 20% of post-independence growth in land productivity. Second, with more detailed period demarcation, it is shown that the relative importance of crop shift effects has been increasing throughout the post-independence period. During the 1950s, less than 5% of land productivity growth was attributable to crop shift effects; during the 1990s, more than 20% was due to crop shifts. Third, the dynamic crop shift effect was an important source of productivity growth only during the 1960s. In other periods, the static crop shift effect was more important than the dynamic effect. Fourth, during the pre-independence period, crop shift effects played a positive role under adverse conditions of declining crop yields. But for the positive contribution from static and dynamic crop shift effects, the total land productivity growth rates would have been much more negative in the four decades from the 1910s to 1940s.

These results show that changes in crop mix have been a stable source of land productivity growth in areas currently in India throughout the twentieth century. The stability of their contribution seems to be consistent with continuous development of agricultural produce markets throughout India. The recent increase of their importance seems to suggest the positive impact of more liberalized market environments faced by farmers under the economic reforms.

Table 2 shows decomposition results for the case of Pakistan. In areas currently in Pakistan, the crop yield effect explained about 70% both in pre- and post- independence periods. The rest was explained mostly by dynamic shift effect before 1947 and by both dynamic and static shift effects after 1947. The importance of dynamic shift effect before independence could be attributable to the development of Canal Colony as an agricultural export base in British India. As is discussed in Section 2, the dynamic crop shift effect becomes more positive when the area under dynamic crops increases relative to the area under non-dynamic crops. During the colonial period, rice and cotton were the dynamic crops in West Punjab and the cultivation of these two crops was regionally concentrating into advantageous districts [Kurosaki 2001].

In the table, contribution in each decade is also shown, which indicates a post-independence pattern opposite to India's. The importance of crop shift effects was the highest during the 1950s and it has been declining since then. During the 1950s, more than 45% of land productivity growth was attributable to crop shift effects; during the 1980s and 90s, only around 10% was due to crop shifts. During the 1950s, the contribution of static shift effect was in a magnitude close to that of yield improvements. Therefore, the conjecture in Kurosaki (1999) that land reallocation toward high value crops was the main engine of agricultural growth during the pre-Green Revolution period after independence is strongly supported for the case of Pakistan. In India, similar phenomena might have occurred at the state level, but might have been cancelled each other at the national level during the pre-Green Revolution period after independence, since India is geographically more diverse than Pakistan.

These results indicate that the changes in crop mix were an important source of growth in land productivity both in India and Pakistan. The contrasts found between the two countries and among decades are consistent with prevailing market conditions and characteristics of agricultural development in the regions.

5 Conclusion

In this paper, the contribution of changes in crop mix to agricultural growth is quantified for the areas currently in India and Pakistan for the period c.1900-1995. This exercise sheds light on the role of agricultural trade on growth from an angle different from cross-country growth regressions.

Application of a new decomposition method shows that, first, a significant part of land productivity growth was attributed to changes in crop mix in post-independence India and in areas currently in Pakistan (pre- and post-independence). Even in pre-independence India, the positive contribution of changes in crop mix was significant in weakening the impact of negative growth in crop yields. Second, against our expectations, the conjecture in Kurosaki (1999) that land reallocation toward high value crops was the main engine of agricultural growth during the pre-Green Revolution period after independence is supported strongly for Pakistan only. In India, in contrast, the importance of changes in crop mix to land productivity growth has been increasing throughout the post-independence period.

Estimated patterns of the sources of land productivity growth are generally consistent with our hypothesis that development of rural markets and improvement in agricultural technology are key to the realization of farmers' economic rationality. A large contribution of crop shift effects was indeed observed when agricultural development was accelerated by market and technological development that allow farmers to pursue their comparative advantages more freely. In this sense, this paper reinforces the argument in Kurosaki (1999) that sustained growth in agriculture was achieved when public investment in and for agriculture was substantial and that public investment has a role to play to make sustainable the boom experienced during the 1990s in response to newly opened opportunities.

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Table 1: Contribution of Crop Shifts to Land Productivity Growth in India

	Average annual growth rates(%)				Relative contribution (%)		
Period	Crop yield effect	Static crop shift effect	Dynamic crop shift effect	Total	Crop yield effect	Static crop shift effect	Dynamic crop shift effect
1901-02 to 1911-12	0.90	0.00	-0.04	0.85	105.1	-0.1	-5.1
1911-12 to 1921-22	-0.35	-0.07	0.26	-0.17	209.5	43.8	-153.3
1921-22 to 1931-32	-0.34	0.14	0.05	-0.14	234.6	-97.2	-37.4
1931-32 to 1941-42	-0.36	0.30	-0.06	-0.12	290.9	-239.7	48.8
1941-42 to 1951-52	-1.48	0.30	-0.01	-1.20	124.0	-25.1	1.1
1951-52 to 1961-62	2.76	0.14	-0.01	2.89	95.3	5.0	-0.3
1961-62 to 1971-72	1.55	0.15	0.20	1.90	81.6	8.0	10.3
1971-72 to 1981-82	1.83	0.35	0.09	2.28	80.6	15.4	4.0
1981-82 to 1991-92	3.11	0.43	0.14	3.68	84.4	11.8	3.8
1991-92 to 1995-96	1.59	0.39	0.04	2.03	78.6	19.4	2.0
1901-02 to 1947-48	-0.24	-0.05	0.23	-0.06	423.5	82.2	-405.7
1947-48 to 1995-96	2.59	0.23	0.53	3.36	77.1	7.0	15.9

Source: Author's estimates.
Notes: See equation (1) for decomposition. The 'total' land productivity growth rates reported in this paper are slightly different from Kurosaki (1999) because growth rates in Kurosaki (1999) were estimated by regression analysis on raw data whereas growth rates here are estimated by usual decomposition on data adjusted by taking moving averages.

Table 2: Contribution of Crop Shifts to Land Productivity Growth in Pakistan

Period	Average annual growth rates(%) Crop yield effect	Static crop shift effect	Dynamic crop shift effect	Total	Relative contribution (%) Crop yield effect	Static crop shift effect	Dynamic crop shift effect
1901-02 to 1911-12	1.84	-0.19	0.09	1.74	105.4	-10.8	5.4
1911-12 to 1921-22	0.06	-0.05	0.02	0.02	254.3	-226.2	71.9
1921-22 to 1931-32	-0.35	0.03	0.02	-0.31	113.4	-8.5	-4.9
1931-32 to 1941-42	1.51	0.16	0.32	1.99	75.8	8.2	16.0
1941-42 to 1951-52	-0.80	0.18	0.03	-0.58	136.6	-30.6	-6.0
1951-52 to 1961-62	1.03	0.85	0.03	1.92	53.8	44.4	1.8
1961-62 to 1971-72	3.37	0.52	0.28	4.16	80.8	12.5	6.7
1971-72 to 1981-82	1.72	0.63	0.13	2.49	69.2	25.4	5.4
1981-82 to 1991-92	2.36	0.05	0.21	2.63	89.8	2.1	8.1
1991-92 to 1995-96	0.89	0.14	0.00	1.03	87.1	13.2	-0.4
1901-02 to 1947-48	0.55	-0.03	0.22	0.74	74.5	-4.0	29.6
1947-48 to 1995-96	2.38	0.48	0.61	3.47	68.6	13.8	17.6

Sources and Notes: Same as Table 1.