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The Debate on Agriculture-Industry Terms of Trade in India

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Abstract

In this paper, we focus on the vast literature that involved analysis of the agriculture-industry terms of trade in India. We first state the key policy issues that are found to be associated with changes in terms of trade variable, and subsequently discuss specific issues concerning the empirical estimation of agricultural terms of trade. We find that the barter terms of trade measure may not only be subject to an aggregation error associated with the index number construction, but is also exposed to the aggregation problems of empirical estimation. We also undertake a set of statistical tests to examine the difference among various agricultural net barter terms of trade series on India. The results indicate that in spite of the methodological differences, the alternate series reflect similar attributes over comparable time periods.

JEL Classification: Q11, C14 and C43

Keywords: agricultural linkage, price policy, index number and aggregation, non-parametric methods.

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1. Introduction

The agriculture-industry terms of trade question has been extensively studied in both the academic and policy making circles in India. The issues emerging out of this literature can be classified into two categories. While one set deals with the methodological and data related aspects associated with the empirical estimation of terms of trade (hereafter TOT), the other set analyzes the variable in relation to specific policy considerations. Thamarajakshi [1969] pioneered the act of systematically estimating the TOT for aggregate agricultural sector in India by identifying commodities that are actually traded by the sector, and using their share as weights to define the composite price index of prices received and prices paid by agriculture. Subsequently, Kahlon and Tyagi [1980], Tyagi [1987], Mungekar [1992] and Palanivel [1999] provided estimates of agricultural TOT using alternate prices data and different trading baskets. The assertion by Kahlon and Tyagi [1980, 1983] that TOT have moved against agriculture, contrary to Thamarajakshi's conclusion, generated considerable debate in the literature. This debate which was carried out in the pages of the *Economic and Political Weekly* among Vittal [1986], Tyagi [1988], Vittal [1988], Thamarajakshi [1990] and Mungekar [1993][1], has also generated some amount of doubt on the direction of Indian agricultural TOT movement for the period between mid-60's to mid-70's.[2] It may further be noted that since agricultural TOT is often used to charter policies in India, the Government of India provides two different series that are individually estimated by the Commission for Agricultural Costs and Prices (CACP), and Directorate of Economics and Statistics (DES). In recent times, there appears to be some inter-departmental squabbles within the Ministry of Agriculture with regard to the methodology followed to construct agricultural TOT indices, thereby replicating the academic debates.[3]

[1] This issue is best manifested in Vittal [1986], who provided a piercing critique on the objections raised by Tyagi [1979] and Kahlon and Tyagi [1980] on the method of TOT construction pursued in Mitra [1977] and Thamarajakshi [1969]. This elicited a response in Tyagi [1988] and a rejoinder in Vittal [1988]. Subsequently, Thamarajakshi [1990] claimed that as far as the methodology of agricultural TOT estimation is concerned, Kahlon and Tyagi had not made any original contribution. Since the methodological framework was already "given", their effort can at best be described as "another attempt" to update her paper. Mungekar's [1993] article provides an assessment of specific issues involved in the debate.

[2] Refer Krishnaji [1990], Bharadwaj [1997], Mohan Rao and Storm [1998].

[3] Refer GOI [1995, 1998 and 1999].

Apart from the debate on the estimation methodology, the examination of a number of economic concerns has been informed by the analysis of agricultural TOT in India. On one hand, the agricultural price policy analysis has pointed out various implications of a TOT change in the economy.[4] On the other, studies such as Bhagwati and Chakravarty [1968], Chakravarty [1974, 1979], Krishna [1982], Rangarajan [1982a], Ahluwalia [1986], Ahluwalia and Rangarajan [1989], Sen [1996], Fan and Hazell [2000], Desai and Namboodiri [2001], Desai [2002] and others have discussed the impact of TOT on specific development policy issues, such as the interaction of agriculture-industry growth; rural wage and poverty; technology (HYV) adoption, spread of irrigation, private investment, government expenditure and total factor productivity growth in agriculture.

In this background, this paper deals with two objectives. First, it provides a critical review of the issues associated with the empirical estimation of agricultural TOT, and second, it verifies as to what extent various agricultural TOT series in India are different from one another. Our analysis proceeds in the following sequence. In section 2, we review the key policy issues associated with agricultural TOT in India. Section 3 presents different variants of the TOT measure. In section 4, we discuss various methodologies of estimating the agricultural TOT. Section 5 takes up specific issues involved in the estimation debate. In section 6, we discuss a set of problems associated with the empirical estimation of aggregate sectoral indices in the barter TOT framework, focussing in particular on the possibilities of *aggregation error* and *aggregation problem*s. Finally, in section 7 we undertake a set of statistical tests to verify whether the various net barter TOT (NBTOT) series in India are really different from one another. The parametric and non-parametric test compare the NBTOT series estimated by Thamarajakshi [1994], Tyagi [1987], Mungekar [1992], Palanivel [1999], and also the two official series provided by CACP and DES. Section 8 concludes.

[4] Refer, e.g. Dantwala [1967, 1976, and 1993], Dharm Narain [1973], de Janvry and Subbarao [1986], Krishnaji [1985, 1988, and 1990], Storm [1995], Abler and Sukhatme [1996], Acharya [1997] and Bharadwaj [1997].

2. Policy Discussions Concerning TOT

This section reviews policy discussions in the Indian context with respect to agricultural NBTOT variable, viz. its linkages with industrial growth; output response, technology adoption, investment behavior, government expenditure and total factor productivity growth in agriculture; and its effect on the rural economy through its impact on rural poverty, rural wages and rural-urban migration. Table 1 provides a snapshot view of various studies along with the description of their use of alternate proxies of TOT.

Supply and Demand Linkages with Industrial Growth: Chakravarty [1974] made one of the early observations on the broader policy implications of agricultural TOT. He examined the *wage goods constraint* on Indian industries, based on the linkage through foodgrain supply, as proposed by Lewis [1954].[5] He postulated that beginning from 1964/65, a favorable agricultural NBTOT was instrumental in squeezing the profit margins of the industrial sector through an increase in the product wage rate. The higher level of relative food price was also held responsible for a decline in the domestic savings rate of the economy. Ghosh [1988] provided empirical support for this thesis.[6] On the savings (and capital formation) front, studies by Rangarajan [1982a] and Ahluwalia and Rangarajan [1989] showed that while a rise in agricultural NBTOT affected the rural household saving favorably, the same did not happen for the corporate or public sector savings in India. However, Desai [1981] and Ahluwalia [1985a, 1985b] did not subscribe to the *wage goods constraint* hypothesis. Using different indices, both the studies perceived that the trend of agricultural NBTOT did not reveal an improvement during mid-60 to mid-70.[7] To some extent, this was due to the use of different agricultural NBTOT indices; viz.

[5] In the Lewis [1954] formulation, a wage goods constraint originates from the fact that food availability is limited and the agricultural NBTOT is high. As a result, a rise in the product wage rate in industry, i.e., money wage deflated by the relative price of industrial goods, manifests a squeeze on its profitability.

[6] While Chakravarty [1974] based his arguments on the basis of using Thamarajakshi series, Ghosh [1988] used the ratio of implicit price deflator for agriculture to that of manufacturing, as the proxy of NBTOT.

[7] Ahluwalia [1985b] maintained, "… neither the terms of trade showed a secular movement in favor of agriculture, … [thus], it would be very difficult to subscribe to a hypothesis that wage good constraint operating through a squeeze of profits back the growth of industry over the period under consideration."

Table 1: Various Application of Agricultural TOT (Relative Price) in India.

Applications	Thamarajakshi Series	Kahlon & Tyagi Series	Mungekar Series	Palanivel Series	CACP Series	Other Series
1. Supply Response of Agriculture	Thamarajakshi [1977], Krishna [1982], Thamarajakshi [1994] Desai and Namboodiri [1997 a]		Mungekar [1997]	Palanivel [1995]		Narayana, Parikh & Srinivasan [1991], Misra & Hazell [1996], Misra [1998]
2. Wage Goods Constraint	Chakravarty [1974]	Ahluwalia [1985 b]				Desai [1981] Ghosh [1988]
3. Growth of Industry (or industrial consumption goods)	Rangarajan [1982 a] Mathur 1990]					Ahluwalia and Rangarajan [1989] Rao and Maiti [1996]
4. Impact on domestic saving and capital formation	Chakravarty [1974] Rangarajan [1982 a]					Ahluwalia and Rangarajan [1989]
5. Impact on Agricultural Wage Rate				Palanivel [1992]		Bhattacharya et al [1991] ILO [1996] Fan and Hazell [2000]
6. Trickle Down of Rural Poverty				Palanivel [1992]		Saith [1981], Mundle [1983], Ahluwalia [1986], Ghose [1989], Gaiha [1989], Bhattacharya et al [1991], Sen [1996], Misra & Hazell [1996], Datt & Ravallion [1997], Desai & Namboodiri [1998 b], Ravallion [1998], Fan & Hazell [2000]
7. Impact on Private Investment in Agriculture					Hanumantha Rao [1997], Gulati and Bathla [2001] Chand [2001]	Pandit [1985], Gulati & Bhide [1993], Storm [1993], NCAER [1995], Gandhi [1996], Misra & Hazell [1996], IEG-DSE [1997], Misra [1998]
8. Impact on Govt.Exp. in Agriculture	Desai and Namboodiri [1997 b]					
9. HYV/ Irgtn. Adoption in Agriculture						Fan and Hazell [2000]
10. TFP Growth in Agriculture	Desai and Namboodiri [1998 a]					

Note:

1) Other series include those based on the ratio of WPI, CPI or GDP deflators of food (or agricultural) products and manufactured (or non-food, non-agricultural or all) products.

2) Mundle [1983], Gandhi [1996] and Datt and Ravallion [1997] included a nominal price index instead of relative prices (or TOT).

Desai [1981] based his arguments on the WPI data on agriculture and industry, while Ahluwalia [1985 a] used the Kahlon and Tyagi [1980] series.

An additional linkage that has been postulated around the TOT, is the rural demand for manufactured consumption goods (Raj 1976, Mitra 1977, Chakravarty 1979, Mundle 1985). It is argued in this context that a rise in foodgrain prices would reduce the demand for industrial consumption items, since expenditure on food constitutes a major segment of the income by lower income classes (Nayyar 1978, Patnaik 1981, Rangarajan 1982b and Krishnaji 1984). In fact, Rao and Maiti [1996] have provided evidence that the impact of a rise in relative foodgrain price on the demand for industrial consumer goods was significantly negative during 1952-90.

Effects on Output, Investment and Technology Adoption in Agriculture: Another important focus has been the issue of agricultural *supply response* to price incentives.[8] Thamarajakshi [1977] and Krishna [1982] examined this relationship for the aggregate agricultural sector in India and noticed a statistically significant positive relation between farm output and the *supply shifter* variable. As far as the effect of TOT is concerned, while Thamarajakshi [1977] did not find any statistically significant impact, Krishna [1982] noticed only a marginally significant price coefficient.[9]

The supply response issue has become more important in India ever since the introduction of agricultural reforms designed to turn the TOT in favor of agriculture (Hanumantha Rao and Gulati 1994, Singh 1995, Pursell and Gulati 1995, Ahluwalia 1996, Gulati 1996, Hanumantha Rao 1998, Dev and Ranade 1999). However, even the recent evidence has corroborated the significance of technology variables in sustaining agricultural growth (Thamarajakshi 1994, Subramanian 1994, Palanivel 1995, Misra and Hazell 1996, Desai and Namboodiri 1997a Mungekar 1997, Storm 1997, Misra 1998). Although, a different view has been put forward by Misra and Hazell [1996] and Misra [1998], who argue that favorable shifts in TOT noticed after the onset of economic reforms have helped to raise overall agricultural production in India. Desai and D'Souza [1999] have contested the reasoning of the

[8] On this issue, see Krishna [1963, 1967], Dharm Narain [1965], Chibber [1988a, 1988b], Mohan Rao 1989, Storm 1997, Mohan Rao and Storm 1998.
[9] The NBTOT series used in both the studies came from Thamarajakshi [1977].

work by Misra [1998].[10] Table 2 provides a list of studies along with their results on supply response as well as their policy issues.

Early analysis has also suggested that escalation of agricultural prices reduce the public investment in agriculture, because as agricultural prices rise, the tax revenue to the government, which is mainly derived from industrial income, would go down (Chakravarty 1974, Raj 1976, Vaidyanathan 1977). Subsequently, Mohan Rao [1994] and Mohan Rao and Storm [1998] have claimed that an increase in agricultural TOT will actually shrink the public investments in large irrigation projects, rural electrification, transport, storage, agricultural research and extension due to a fiscal squeeze in the government budget.[11]

A number of recent studies have been concerned about the impact of changing TOT on the private component of agricultural investment level (Misra and Hazell 1996, 1997, Alagh 1997, Hanumantha Rao 1997, Misra 1998, Chand 2001, Gulati and Bathla 2001). Results by Misra and Hazell [1996], Misra [1998] and Gulati and Bathla [2001] indicate that a favorable agricultural TOT helped to raise the private investment in Indian agriculture.[12]

Recently, Fan and Hazell [2000] examined the impacts of TOT on the technology (HYV) adoption as well as the spread of canal and private irrigation, and noticed a significant and positive influence of the TOT variable. On the contrary, the respective results by Desai and Namboodiri [1997b and 1998a] indicate that an

[10] Desai and D'Souza [1999] pointed out several analytical misconceptions contained in Misra's [1998] work. They particularly argued that his interpretation of an "interaction term" (involving price and technology instrument) in the supply response equation is faulty. A discussion on the introduction and interpretation of such interaction term can be found in Schiff and Montenegro [1995].

[11] By quoting evidence from Bhattacharya [1984], Krishnamurty [1985], Rangarajan and Arif [1990], which reported rising budget deficit due to agricultural price inflation, and hence a negative relationship between farm prices and public investments (Bhattacharya, Burman and Nag 1994); Mohan Rao and Storm [1998] define several channels through which a fiscal squeeze may arise. These include, 1) increase in wage costs and simultaneous fall in profit rates of public and private sector, 2) higher food-subsidy bill, and 3) decline in the effective demand of industrial goods due to eroding purchasing power of net-buyers of food.

[12] Misra and Hazell [1996] and Misra [1998] used the ratio of IPD of agriculture to that of non-agriculture, while Gulati and Bathla [2001] included the CACP series, as proxy for NBTOT.

Table 2: Results of the Application of Agricultural TOT (Relative Price) Variable in India.

Applications	Study	Period	Impact of Terms of Trade/Other Remarks
1. Supply Response of Agriculture	Thamarajakshi [1977]	1951/52-73/74	Insignificant negative
	Krishna [1982]	1952/53-75/76	Marginally significant positive
	Thamarajakshi [1994]	1967/68-90/91	Insignificant negative
	Palanivel [1995]	1951/52-87/88	Significant positive
	Misra and Hazell [1996]	1952/53-88/89	Significant positive
	Mungekar [1997]	1970/71-90/91	Insignificant negative
	Desai and Namboodiri [1997 a]	1951/52-65/66 & 1966/67-89/90	Significant negative
	Misra [1998]	1967/68-95/96	Significant positive
2 Growth of Industry (or industrial consumption goods)	Rangarajan [1982 a]	1961-72	Negative impact
	Ahluwalia and Rangarajan [1989]	1960/61-79/80	Significant negative
	Mathur [1990]	1950/51-81/82	Significant negative
	Rao and Maiti [1996]	1951/52-1989/90	Significant negative
3. Impact on domestic saving and capital formation	Rangarajan [1982 a]	1961-72	Positive impact on household saving, and negative impact on both public saving and corporate investment
	Ahluwalia and Rangarajan [1989]	1960/61-79/80	Significant positive impact on GDCF by household sector, and insignificant negative impact on both public saving and GDCF by corporate sector
4. Impact on Agricultural Wage Rate	Bhattacharya et al [1991]	1958/59-73/74	Significant negative
	Palanivel [1992]	1956/57-87/88	Significant negative
	ILO [1996]	1973/74-90/91	Significant negative
	Fan and Hazell [2000]	1970-94	Significant negative
5. Trickle Down of Rural Poverty	Saith [1981]	1956/67-73/74	Significant positive
	Ahluwalia [1986]	1956/57-77/78	Significant positive
	Ghose [1989]	1956/57-83	Significant positive
	Gaiha [1989]	1956-73 & 1957-77	Significant positive
	Bhattacharya et al [l991]	1958/59-73/74	Significant positive
	Sen [1996]	1960/61-93/94	Significant positive
	Misra and Hazell [1996]	1960/61-87/88	Significant positive
	Datt & Ravallion [1997]	1960/61-92	Significant positive
	Desai and Namboodiri [1998 b]	1961/62-93/94	Insignificant negative
	Ravallion [1998]	1958-1994	Spurious Correlation
	Fan and Hazell [2000]	1970-94	Significant positive
6. Impact on Private Investment in Agriculture	Krishnamurty [1985]	1962-80	Significant positive
	Storm [1993]	1962/63-86/87	Significant positive
	Gulati and Bhide [1993]	1965/66-89/90	Significant positive
	NCAER [1995]	1960/61-89/90	Significant positive
	Gandhi [1996]	1952/53-92/93	Insignificant
	Misra and Hazell [1996]	1960/61-89/90	Significant positive
	IEG-DSE [1997]	1970/71-1994/95	Significant positive
	Hanumantha Rao [1997]	1980/81-1994/95	Significant positive
	Misra [1998]	1961/62-1995/96	Significant positive
	Gulati and Bathla [2001]	1980/81-98/99	Significant positive
	Chand [2001]	1980/81-95/97	Significant positive
7. Impact on Govt. Expenditure in Agriculture	Desai and Namboodiri [1997 b]	1951/52-1989/90	Significant negative
8. HYV/ Irrigation Adoption in Agriculture	Fan and Hazell [2000]	1970-94	Significant positive
9. TFP Growth in Agriculture	Desai and Namboodiri [1998 a]	1966/67-89/90	Significant negative

Note: *Mundle [1983], Gandhi [1996] and Datt and Ravallion [1997] included a nominal price index instead of relative prices (or TOT)*

increase in TOT lowers the total factor productivity growth and government expenditure in agriculture.[13]

Impact on the Rural Economy: A number of studies such as Ahluwalia [1986], Ghose [1989], Gaiha [1989], Bhattacharya et al [1991], Ghosh [1996] have examined the role of agricultural NBTOT on the *growth-poverty* relationship in India. While Ahluwalia [l986] found a weak and statistically insignificant, though positive influence, both Ghose [l989] and Gaiha [l989] identified a strong and statistically significant direct impact of prices on rural poverty levels. Subsequently, other analysts (Ravallion and Datt 1996, Sen 1996, Desai and Namboodiri 1998 b and World Bank 2000) have claimed that the rise in rural poverty in India noticed during the first half of 1990's is due to the high agricultural price inflation.

Bhattacharya et al [1991], ILO [1996] and Fan and Hazell [2000] analyze the impact of changes in NBTOT on rural wage levels. The evidence suggests an inverse relationship between NBTOT and rural wage earnings. This is also consistent with the hypothesis by Bhaduri [1993], suggesting that a rise in TOT leads to higher out-migration by pushing out the rural population who are net buyers of foodgrain.

In addition to the concerns listed above it needs to be noted that recently TOT have also informed the discussion surrounding moves to "reform" the agricultural sector in India. It has been argued that an improvement in TOT leads to technological modernization and growth in agriculture (Singh 1995, Ahluwalia 1996). In this context, concern has been expressed with regard to the impact of price liberalization on growth and equity,[14] though some studies have also indicated that the improvement in TOT over the post 1991 period has mainly occurred due to the frequent upward revision in minimum support prices.[15]

[13] While, Fan and Hazell [2000] used the TOT measure defined by the ratio of agricultural to non-agricultural GDP deflator, Desai and Namboodiri [1997b and 1998a] put to use the Thamarajakshi [1994] series.

[14] See e.g, Gulati and Sharma [1992, 1994], ILO [1993], Bhatia [1994], Hanumantha Rao [1994], Subramanian [1994], Vyas [1994], Nayyar and Sen [1994], Acharya [1997], Storm [1997], Mohan Rao and Storm [1998] and Gulati [1998].

[15] Refer Balakrishnan [2000].

We notice from this brief review that the results of the policy analysis on TOT variable sometimes reached almost opposite conclusions with regard to its possible impact on various macro variables (table 2). To some extent this could be due to the use alternate NBTOT series that are connected with different base years. It may also be surmised from the above discussion that the perceptions on the role of agriculture-industry TOT in the Indian development process have not remained static. As perceptions of the development process have changed, so has the perceived role of agricultural TOT. In their latest role, TOT are viewed largely as a policy instrument to get agricultural prices "right" and, improvements in agricultural TOT are perceived to indicate the success of an agricultural reforms program.

3. The Terms of Trade Measure

The barter TOT has been widely used to examine the changes in relative price between two competing sectors. Various indices of TOT, which were originally discussed in the context of international trade between the developed and less-developed regions, can be found in Kindleberger [1956]. A TOT index generally referring to NBTOT is defined by:

$$NBTOT = \frac{P_X}{P_M}, \qquad (1)$$

where, P_X and P_M refer to composite price indices of exports and imports, respectively.

The two composite price indices are defined in such a way as to represent the aggregate price movements of exportable and importable commodities, which requires the respective commodity weights to be assigned on the basis of items actually traded by a given nation. The other index that evaluates the quantum of tradable referred as the gross barter TOT (GBTOT) is defined by:

$$GBTOT = \frac{Q_X}{Q_M}, \qquad (2)$$

where, Q_X and Q_M stand for quantities (or values) of exports and imports, respectively.

Some other indices of TOT were also developed, e.g. income TOT (ITOT), single factorial TOT (SFTOT) and double factorial TOT (DFTOT). The ITOT takes into account the effects of changes in prices of traded goods and the value of exports (or imports). That is, while Dorrance [1950] defined ITOT as the value index of exports divided by the price index of imports, viz.

$$ITOT = \frac{Q_X P_X}{P_M}, \tag{3}$$

Staehle [1951] specified ITOT as the value index of imports divided by the price index of exports, viz.

$$ITOT = \frac{Q_M P_M}{P_X}, \tag{3.1}$$

While the former determines the *capacity to import* (or *purchasing power of exports*), the latter indicates the *required import bill* (or *value of required exports*) in a nation's foreign trade.

On the other hand, the DFTOT and SFTOT take into consideration relative change in the productivity levels of export and (or) import originating sectors. The SFTOT is defined as the commodity TOT multiplied by an index of domestic productivity level. The DFTOT also takes into account the foreign productivity level and is defined by the commodity TOT multiplied by the ratio between domestic and foreign productivity levels. For empirical estimation, DFTOT is worked out as the ratio of unit value index of exports to that of imports after adjusting for the changes in their productivity levels, viz.

$$DFTOT = \frac{P_X T_X}{P_M T_M}, \tag{4}$$

where, T_X and T_M denote productivity indices in the export and import sectors, respectively.

The TOT worked out for Indian agriculture mainly refer to the indices of NBTOT and ITOT. The basic methodology, pioneered by Thamarajakshi [1969], has involved the construction of composite indices of prices received and prices paid by agriculture for its traded goods. The methodology for approximating quantum of agricultural exports in terms of the marketable surplus also owes much to

Thamarajakshi's study. Subsequently, Kahlon and Tyagi [1980, 1983], Tyagi [1987], Mungekar [1992] and Palanivel [1992, 1999] have attempted empirical estimation of NBTOT and ITOT. The indices of ITOT were developed on the lines of Dorrance's measure. Palanivel [1992] also provides estimates of DFTOT by utilizing total factor productivity indices in agriculture and manufacturing.

4. Agricultural NBTOT Indices

Early attempts in India at the empirical estimation of agricultural NBTOT worked out the series on *parity indices* between prices received and prices paid at the level of individual crops (Poduval and Sen 1958, Mathur 1958, Randhawa 1959 and Thingalaya 1966).[16] Subsequently, the focus shifted towards examining the NBTOT between aggregate agriculture vis-a-vis industry. Dar [1968], Shetty [1971], Dantwala [1976], Mitra [1977] and others analyzed agricultural NBTOT on the basis of straight comparison of wholesale price indices (WPI) of all agricultural *vis–a-vis* all industrial (or non-agricultural) commodities. On the other hand, Ahluwalia [1979,1985 b], Roy Choudhury and Mukherjee [1984] and more recently, Misra and Hazell [1996], Misra [1998] and Acharya [2001] have used the ratio of implicit price deflator (IPD) of agriculture to that of non-agriculture to define domestic TOT in India. A major criticism against this approach is that the individual commodity weights used to devise the composite prices are quite different from the "true" weights that prevail in actual sectoral trade. Since a particular sector does not necessarily consume all the goods produced by the competing sector, it is argued that only the existent consumption patterns should be used in formulating the commodity weights.

4.1. Methodology

The first systematic study incorporating this refinement was Thamarajakshi [1969], who provided estimates of NBTOT and ITOT from 1951/52 to 1965/66. In this study, the WPI of individual commodities traded between agriculture and non-agriculture were aggregated using a derived set of weights. A total of 13-commodity group(s), 7 for the purpose of intermediate use and 6 for final use were selected to

[16] These crop-specific *parity ratios* have been defined as a ratio of the output price and the weighted index of input prices.

represent the total purchase by agriculture from non-agriculture.[17] Similarly, 18 groups (12 for intermediate use and 6 for final use) were used to represent the total sales by agriculture to non-agriculture.[18] The commodity weights were derived from the value of sectoral purchase of individual commodities by using the following method.

The value of bilateral sales and purchases by each sector was approximated by using the National Sample Survey's (NSS) per capita rural and urban consumption expenditure data, Central Statistical Organization's (CSO) estimate of aggregate private consumption expenditure and value of product estimates. The NSS data on rural and urban per capita expenditure were assumed to denote the agricultural and non-agricultural consumption pattern, respectively. Next, estimates of agriculture's sales to and purchases from non-agriculture were constructed for individual items of intermediate and final use. The value of agriculture's sale of intermediate items has been generated after allowing for retention in the CSO value of agricultural product. The agricultural purchase of intermediary inputs was worked out using the disaggregated CSO information. The agriculture's sale and purchase of final use items have been estimated by applying the blown-up NSS per capita consumption data to the CSO's aggregate consumption expenditure data. By using the value of sectoral purchases as weights, the composite price indices were constructed under 6 commodity classifications, *viz.* prices received by agriculture from non-agriculture for the latter's purchase for intermediate, final and all uses and prices paid by agriculture to non-agriculture for the formers purchase for intermediate, final and all uses.

The income TOT was derived according to equation (3). Agriculture's export to non-agriculture has been denoted by the formers marketable surplus, which the latter purchases for its final and intermediate consumption. The marketable surplus

[17] Thamarajakshi's [1969] list of commodities that agriculture purchases from non-agriculture included: 1) fertilizers, 2) repair and maintenance of fixed farm assets, 3) oil-cakes, 4) drugs, medicine and salt for work animals, 5) electricity for farm production, 6) diesel oil and 7) pesticides & insecticides, for items of intermediary inputs. The items for agriculture's final consumption contained 1) edible oil, 2) sugar, 3) salt, 4) clothing, 5) fuel and lights and 6) non-food items.

[18] The list of non-agriculture's purchase from agriculture for items of intermediary inputs were: 1) oilseeds, 2) cotton, 3) raw jute, 4) other fibers 5) tea, 6) coffee, 7) rubber, 8) sugarcane, 9) tobacco, 10) hides, 11) skins and 12) wools. The final consumption items included: 1) foodgrains, 2) pulses, 3) milk and milk products, 4) meat, egg and fish, 5) fruits and vegetables and 6) other food.

of final consumption goods was generated by applying the per capita NSS consumption expenditure data to aggregate CSO data. That is, first the value of total consumption expenditure of non-agricultural sector on agricultural products, and the total expenditure of the economy were generated by applying the sector-wise population estimates to the NSS data. Then the ratio of expenditures on agricultural products by non-agriculture to the economy's total expenditure was applied to CSO's total consumption expenditure of the economy. From this, the value of imports for cereals, fruits and vegetables in the economy was deducted to arrive at the non-agriculture's expenditure on domestic agricultural products. These estimates after a deflation by the composite WPI (base: 1960/61) were used in the analysis.

Kahlon and Tyagi [1980] introduced some changes with regard to the commodity coverage, price data and commodity weights in TOT calculations.[19] The selection of commodities and estimation of weights were undertaken by using information on consumption expenditure data (both NSS and CSO), estimates of gross capital expenditure (Debt and Investment Surveys, Reserve Bank of India), and some disaggregated information from CSO. To represent the final consumption by agriculture, 17-commodity group(s) were selected from the details provided in 26th. Round of NSS consumption expenditure survey for cultivator households (rural, 1978). Another 7 items were selected from the information available in National Accounts Statistics (CSO) for agriculture's basket of intermediate purchases. Finally, 8 items for capital formation were included from the information provided in All India Debt and Investment Surveys.[20] The commodities that non-

[19] Kahlon and Tyagi [1983] begins with the claim that, " ... most of the studies cited on the subject suffer from serious limitations on account of limited coverage, use of improper weights, inappropriate price indicators, adoption of incorrect method for estimating the volume of exports, and the use of a method for constructing the price indices which, on a priori reasoning, would underestimate the rise in the prices of non-agricultural goods and inflate the rise in the prices of agricultural commodities."

[20] The 32 items considered by Kahlon and Tyagi [1980] are as follows: 1) edible oils, 2) sugar, 3) salt, 4) kerosene oil, 5) matches, 6) electricity, 7) coal, 8) tobacco and tobacco products, 9) textiles, 10) footwear, 11) drugs and medicines, 12) cosmetics, soap and detergent, 13) metal products, 14) paper & paper products, 15) utensils, 16) cycles, and 17) consumer services, for items of final consumption. Similarly, 1) cement, 2) lime, 3) transport equipment, 4) machinery and machine tools, 5) iron and steel, 6) log and timber, 7) tools and implements and 8) bricks and tiles, were included for items of capital formation. Finally, 1) chemical fertilizers, 2) electricity, 3) diesel oil, 4) pesticides and insecticides, 5) repair and maintenance of fixed capital, 6) oil-cakes and 7) salt and medicines for animals, were considered for elements of intermediate consumption.

agriculture purchases from agriculture for final and intermediate use contained 22 items.[21]

A major difference in Kahlon and Tyagi [1980] from Thamarajakshi [1969] is that farm harvest prices (FHP) have been used to reflect the prices received by agriculture.[22] This was justified by emphasizing that price data in TOT analysis should capture the prices at which inter-sectoral transactions take place. The all-India FHP was estimated as an average of states' FHP weighted by the state's production share in the all-India production of each commodity. Further, in view of the mismatch between NSS and CSO consumption expenditure data, estimation of commodity weights were undertaken by separately using data from these two sources. Kahlon and Tyagi [1980] also differed with regard to the estimation of agriculture's marketable surplus used in constructing the ITOT series. They contended that Thamarajakshi [1969] has overestimated the marketable surplus due to the application of NSS proportions to CSO's data. Kahlon and Tyagi [1980] therefore applied the CSO distribution to the blown up NSS estimates of consumption expenditure.

They provided alternate estimates of prices received and prices paid by agriculture by using separate weights derived from the NSS and CSO data, as well as by using the Laspeyer's and Pasche's formula. In all 3 set of NBTOT estimates, viz. using Laspeyer's formula and NSS weights, Laspeyer's formula and CSO weights and Pasche's formula with CSO weights have been constructed. These series with trienium ending 1971/72 as base were provided for the period 1967/68 to 1977/78.

[21] These are, 1) rice, 2) wheat, 3) jowar, 4) bajra, 5) barley, 6) maize, 7) ragi, 8) milk and milk products, 9) meat, fish and eggs, 10) vegetables, 11) fruits, 12) gram and pulse products, 13) gur, 14) groundnut, 15) sesamum, 16) rapeseed and mustard, 17) linseed, 18) castorseed, 19) cotton, 20) jute and mesta, 21) rubber and 22) sugarcane and tobacco.

[22] Data on farm harvest price as defined by the prices at which producers dispose of their produce at the village site during the harvesting period (6 to 8 weeks after the commencement of the harvest), are collected from selected villages in each district. The district estimates are prepared by computing the average of weekly price quotations prevailing at the important marketing centers neighboring the major producing area. The districts' production share of the crops in the state are used as weights to arrive at some weighted average farm harvest prices for the state.

5. The Debate and Subsequent Estimation Attempts

The Kahlon and Tyagi [1980, 1983] conclusion, which upheld that TOT has moved against agriculture and their criticisms on the methodology and database adopted in earlier studies, initiated a vigorous academic debate in the 1980's. A discussion on Indian TOT remains incomplete without an account of the issues involved in this "debate". Such a consideration also helps us to understand the extent to which the debated issues have influenced the subsequent estimation attempts.

To begin with, a major criticism of Kahlon and Tyagi [1980] of Thamarajakshi's [1969] methodology is the use of WPI, which they believed are not representative of either prices received or prices paid by agriculture. By carrying forward the Tyagi [1979] claim, they maintain that WPI series in India has simultaneously overestimated the price rise in agriculture and underestimated those for industrial commodities, due to its inconsistent method of compiling price quotations. They accordingly advocated the use of FHP for agricultural commodities so as to capture the prices actually received by agriculture. However, Raj [1983], Vittal [1986] and Kumar [1988] raised certain objections against the use of FHP in TOT calculations. Vittal [1986] claimed that the use of FHP may misrepresent the prices received for major part of the volume of grain traded, since the lean season sales by surplus producers and also the small farmers' repayment in kind, remains outside the harvesting price records. Subsequently, Thamarajakshi [1990] reiterated that WPI are more appropriate because these data are collected throughout the year, and not just during the harvesting periods. Recently, Mungekar [1993] provided support for the use of FHP by arguing that: (1) the bulk of agricultural produce is disposed during the harvest period, and (2) some evidences reflect that WPI overstate the price received by agriculture.

There are a number of issues associated with estimating a composite price index of price received by agriculture on the basis of FHP. First, FHPs are available only for a portion of items marketed by agriculture which are used in TOT calculations, viz. cereals, oilseeds, fibres, sugarcane and tobacco. Consequently,

WPI or some other price deflators have to be used to represent the prices for rest of the product sold by agriculture (e.g. meat, eggs, fish, milk, milk products, fruits, vegetables and other food items). A number of data approximations are needed to combine these two price series into an aggregate price index.[23] This raises the possibility of an *aggregation problem* in the estimation of such a composite index of prices received by agriculture. This is further elaborated in section 6 below.

Second, Kahlon and Tyagi's method of approximating the all-India FHP is based on a weighted average of states' FHP, using state's production share in all-India as weights. Vittal [1986] has argued that the share of each state in total (all-India) marketed surplus of crops would be a more appropriate weight. But, since the state-wise estimates of marketed surplus are difficult to compute, Tyagi [1987] and subsequent studies have continued to use the state's production share as weights. In our opinion, FHP need to be weighted by the marketed portion, because the pattern of self-consumption of agricultural commodities is likely to be quite diverse across states. Thus, it appears that while FHP may be better indicators of prices received by agriculture, they may not be better suited for the purpose of TOT calculations, due to the practical estimation problems. Furthermore, the debate concerning the choice of WPI or FHP of agricultural commodities seems to be in surplus, in view of the indication that the difference in movements of final NBTOT indices derived by alternative use of WPI and FHP may remain only marginal.[24] These considerations cast doubt on the view that the use of FHP can provide different (or better) estimates of agricultural NBTOT.

In addition to these methodological considerations, there are differences between Thamarajakshi and Kahlon & Tyagi with regard to the coverage of commodities in agriculture's trading list. While Kahlon and Tyagi maintain that Thamarajakshi's shopping list understates the number of items purchased by

[23] An indication of the kinds of approximation can be had from the following observation, viz. "while using the data on farm harvest prices and Economic Adviser's Index Numbers of Wholesale prices for various products, a number of adjustments and modifications, wherever necessary, were required to be made under certain assumptions with a view to make the relevant data comparable, and in some cases even to fill in the gaps in the data themselves." (Mungekar 1992, page 54).

[24] Palanivel [1992] ascertains that the use of WPI instead of FHP, neither underestimates nor overestimates the NBTOT significantly (found to the extent of 0.1 percentage points per annum) when the entire period is taken into account.

agriculture, Thamarajakshi's [1990] subsequent article asserts that there is an understatement of agriculture's sales in Kahlon and Tyagi. Of particular issue is the inclusion of items for capital formation in agriculture's purchase by Kahlon and Tyagi, while Thamarajakshi [1969] had included items relating to current consumption and production only.[25] At a broader level, Mungekar [1993] objected to Kahlon and Tyagi's use of the expenditure pattern of rural cultivator class, to identify commodities pertaining to agriculture's final purchases. He suggested that since the TOT is for the entire agricultural sector and not just for farmers, the average consumption pattern of all rural expenditure classes should have been incorporated.

Another significant criticism by Kahlon and Tyagi [1980] had been with regard to the method followed in evaluating agriculture's marketable surplus of final consumption goods, and the approximation of respective commodity weights. Thamarajakshi [1969] developed these estimates by combining the NSS's household level consumption expenditure data with CSO's total consumption expenditure of the economy. Kahlon and Tyagi [1980] and subsequent studies have broadly pursued this method only. However, while Thamarajakshi [1969] applied the NSS proportions to CSO data, Kahlon and Tyagi [1980] choose to use the break-ups of both NSS and CSO information to provide alternate weights. Further, they used the CSO distribution on blown up NSS estimates so as to estimate the agricultural marketable surplus. In this regard, Vittal [1986, 1988] and subsequently Thamarajakshi [1990] claimed that these techniques by Kahlon and Tyagi were more the use of "alternative data" rather than any "alternative methodology". Later, Mungekar [1993] maintained that Thamarajakshi's series on marketed surplus does not suffer from any methodological limitations, except for the fact that her series was linked with a low base year value.

Finally, Kahlon and Tyagi [1980] expressed doubt on the concept of ITOT used by Thamarajakshi - similar to the conventional definition of ITOT suggested by Dorrance - on the ground that it did not portray an analogous sectoral relationship. That is, TOT improvement for one sector is not necessarily accompanied by

[25] Vittal [1986] however questioned the inclusion of items like building material for this category. She remarked, "If their (Kahlon and Tyagi's) list were to be adopted as the definitive one, terms of trade -

deterioration in the other. They claimed that the definition of ITOT is *"misleading*" since it is based on the volume of export of only one sector. Vittal [1986] suggested some modifications to the measure, viz. to adjust the expression of agriculture's ITOT with its imports from non-agriculture. She derived a formula to represent agriculture's *purchasing power* as: $(P_X/P_M*Q_X/Q_M)$, where P_X, Q_X, P_M and Q_M are the price and quantity of exports from and imports to agriculture, respectively. On this particular issue, Mungekar [1993] maintains that both Kahlon and Tyagi's and Vittal's statement s on the concept of ITOT are not reasonable, since the ITOT measure incorporating the volume of imports already existed (see equation 3.1).

It can be noticed that subsequent studies that estimate agricultural NBTOT have chosen to remain silent on this debate. The studies by Mungekar [1992] and Palanivel [1999] have constructed their own estimates of agricultural NBTOT, but did not explicitly discuss any of the debated issues surrounding the data and methodology. As a result, it is difficult to discern whether their methodology and estimates can be distinguished from earlier attempts. It is apparent that the basic methodology involved in either Mungekar or Palanivel is not very different from Thamarajakshi [1969]. However, modifications with regard to the use of alternate price data, wider commodity coverage and alternative set of commodity weights draw upon the claims of Kahlon and Tyagi [1980] and Tyagi [1987, 1988]. Table 3 sums up the basic features of different agricultural NBTOT series in India.

For instance, both Mungekar [1992] and Palanivel [1999] made a strong case for the use of FHP and retail prices so as capture the components of prices received and prices paid by agriculture, respectively. Palanivel [1999] in fact incorporates the rural retail price (RRP) data to capture the *rural purchase price* on non-agricultural commodities. However, this data as available from the Monthly Abstracts of Statistics (CSO), is accessible only since 1970/71. Palanivel [1999] resolved this problem by supplementing it with WPI data for observations prior to 1970/71. The estimation of commodity weight in both the studies was accomplished by following the earlier practice, viz. by applying the NSS proportions to aggregate CSO data.

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by whatever measure: net barter, income or purchasing power - could not but help appear to be against the agricultural sector, simply because of their introduction of capital formation goods."

Palanivel [1999] estimates farmer's NBTOT referring to the cultivators' class,[26] and agricultural NBTOT referring to 8 commodity groups.[27] Finally, he provides several alternative NBTOT series using FHP, RRP and also the WPI data set.

Table 3: Features of Various Agricultural NBTOT Series in India.

Series	**Thamarajakshi [1969,1977, 1994]**	**Kahlon & Tyagi [1980] and Tyagi [1987]**	**Mungekar [1992]**	**Palanivel [1999]**	**CACP**	**DES**
Aagriculture's Selling List	Final Use and Intermediate use	Final Use, Intermediate Use, Capital Formation				
Prices Received Data	WPI	FHP and WPI				FHP, WPI and MSP
Prices Paid Data	WPI			RRP and WPI	WPI	RRP & WPI
Base Year	1960/61 1960/61 1978/79	Trienium ending 1971/72	1961/62 and 1971/72	Trienium ending 1971/72		Trienium ending 1990/91
Period of Series	1952-66 1952-75 1952-92	1968-78 1953-84	1953-87	1951-88	Ongoing since 1970/71	Ongoing since 1981/82

Note: *WPI, FHP, RRP and MSP represent wholesale, farm harvest, rural retail and minimum support price, respectively*.

In addition to these studies, the Commission for Agricultural Costs and Prices (CACP) in the Ministry of Agriculture, GOI, has also been compiling indices of TOT between agriculture and non-agriculture, with triennium ending 1971/72 as base. The CACP report (GOI 1998) has recently published a new TOT series estimated by Directorate of Economics and Statistics (DES) in the Ministry of Agriculture. The DES series is claimed to be better in terms of larger coverage of traded items, as it covers 71 and 48 items respectively for items of prices paid and prices received by the farm sector, as against 32 and 21 items respectively used in the CACP series (GOI 1999).

[26] Palanivel [1999] distinguished the farmer's NBTOT as opposed to agriculture's TOT in which the labor services are included as a purchased input, and the plantation crops are excluded from agriculture's salable items.

[27] These are, cereals, pulses, foodgrains, final consumption crop products, final consumption livestock products, all final consumption goods, oilseeds, intermediate crop products, intermediate livestock products and all intermediate agricultural products.

6. Problems of Estimating Aggregate Agricultural NBTOT

The empirical exercise of developing aggregate agricultural NBTOT is subject to certain estimation problems. The basic methodology in NBTOT estimation involves the creation of composite price indices of prices received and prices paid for the goods traded by agriculture. However, this approach can run into certain implementation problems. Two such likely sources of problems, viz. *aggregation error and aggregation problems* are discussed below.

6.1. Aggregation Error (Commodity Basket)

A considerable portion of the debate on NBTOT construction is due to the difference in selection of commodities traded by agriculture. The specification of a complete shopping list of agricultural sales and purchases is not possible, since no such full-information data exists at the aggregate level.[28] Consequently, TOT studies in India have ended up working with dissimilar *shopping lists*. The selection of traded commodities as well as the sampling design used in their selection has a bearing on the precision of a composite index number. A quick overview of the coverage of items used by various researchers is provided in table 4, where substantial differences can be seen to exist with regard to the selection of agriculture's *buying or selling list*.

Table 4: Items of Inter-sectoral Exchange in Agricultural NBTOT Estimation

Series	**Agriculture's purchase from Non-Agr.**				**Agriculture's sales to Non-agr.**		
	Final Use	Intermediate Use	Capital Formation .	Total	Final Use	Intermediate Use	Total
Thamarajakshi	6	7	-	13	6	12	18
Kahlon and Tyagi	17	7	8	32	12	10	22
Mungekar	7	8	6	21	6	5	11
Palanivel	-	-	-	120	-	-	44
CACP	16	7	9	32	11	10	21
DES	49	9	13	71	39	9	48

Source: *Thamarajakshi [1969], Kahlon & Tyagi [1980], Mungekar [1992], Palanivel [1992], and GOI [1999] for CACP and DES series.*

[28] Such a comprehensive data set can be conceived only at disaggregated levels, e.g, the farm management studies or the cost of cultivation surveys.

This discrepancy does not lead us to gather any insight on the notion of a *representative* shopping-list that should be used in developing aggregate agricultural NBTOT. Further, a notable exclusion from agriculture's shopping list can be found in respect of both factor and non-factor service items.[29] The studies estimating agricultural NBTOT have usually left out the service items, particularly non-factor services.[30] In our opinion, a sampling bias is likely to be induced in the final NBTOT estimates if subsets of commodities are only selected depending on the availability of information.

6.2. Aggregation Problems

The estimation process of agricultural NBTOT at aggregated levels is also subject to *problems of aggregation* over individual data.[31] All the studies (Thamarajakshi 1969, Kahlon and Tyagi 1980, Tyagi 1987, Mungekar 1992 and Palanivel 1992) have resorted to a joint application of aggregate and disaggregated data. For example, consumption expenditure at household levels are blown up and applied to the aggregate economy's consumption expenditure to derive the value of sectoral consumption. Similarly, price details such as wholesale, farm harvest, rural retail and some implicit price deflators have been assembled together to design a composite price variable.[32] Further, several adjustment and approximations over the data are involved for the purpose of final estimation.[33]

[29] The factor services refer to services provided by the factors of production (labor, capital and land), while the non-factor services could be services supplied by transport and communication, trade, commerce and other government services.

[30] Palanivel [1992] did attempt to include some of factor service items relating to agricultural labor use, but failed to incorporate the non-factor services. An indication as to what extent these non-factor services are important in the agriculture's purchase can be had from the Input-Output Transactions tables by GOI [1990]. For instance, the share of transport, communication and trade sector has registered a noticeable increase in the percentage distribution of inputs used in the primary sector during 1978/79 and 1983/84.

[31] The *aggregation problem* may crop up in the process of empirically estimating a macro variable by employing disaggregated data. In a survey article on this issue, Stoker [1990] differentiated among 3 major approaches toward empirical modeling, which are: 1) modeling the aggregate data, 2) modeling with disaggregated data, and 3) a joint modeling of individual and aggregated level data. Subsequently, he maintained that in order to implement a consistent model on economic data, aggregate level models should be applied to an aggregate level data, and so on.

[32] Each of these price series has a distinct definitional character, further the concept and methods of data collection are quite different for the WPI, FHP and RRP series. Similarly, the divergence between the NSS and CSO data on consumption expenditure is well known.

[33] For instance, studies that use FHP data estimate the series on composite price received by agriculture on the basis of employing FHP for the crop segment and WPI for the non-crop segment. In

Although, much of the TOT debate in India involved the methodology and data used in the aggregation procedure, the aspects of aggregation problems have not been examined until recently. The precision of a joint modeling of individual and aggregated data may need validation in the context of calculating aggregate NBTOT. This can be done by examining how far the aggregate level TOT built in this fashion is consistent with TOT at disaggregate levels. Research developments in this area have suggested some *aggregate goodness of fit* tests as a part of checking restrictions involved in such a micro-macro model. For instance, Pesaran, Pierce and Kumar [1989] have developed one such econometric test.[34] The basic idea behind this test is to compare the coefficients derived from any individual (or group) behavioral equation with that of the aggregate equation. A possible application of this test can be made with respect to agricultural supply response at aggregated and individual crop(s) level. The aggregate agricultural NBTOT developed by Palanivel [1999] along with the set of disaggregated commodity (commodity groups) specific NBTOT indices can be employed for this kind of test. A comparison of the individual (or group) output response function to changes in respective NBTOT with that of the aggregate behavior can provide an indication as to the extent of aggregation problems in NBTOT series.

7. Comparison among Various NBTOT Series

Studies have not been able to arrive at a common conclusion on the movement of agricultural TOT in India.[35] Thamarajakshi [1969, 1977] maintained that domestic NBTOT remained favorable to agriculture during the 60's and till about mid-70. Kahlon and Tyagi [1980] differed by claiming that NBTOT moved against agriculture during this period.[36] However, Tyagi [1987] revised the position taken by

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the other extreme, Palanivel [1999] develops the composite price paid series by agriculture, where observations prior to 1970/71 and beyond are based on the use of RRP and WPI, respectively.

[34] Lee, Pesaran and Pierce [1990] provide a related discussion. Early representation of ideas on this issue can be found in Grunfeld and Grilliches [1960].

[35] There has been a previous disagreement on this issue, viz. while Schultz [1968], Mason [1966] and Lipton [1977] argued that agricultural prices are kept systematically low, Falcon [1970] and Griffin [1974] believed that there is no deliberate under-pricing of agriculture in India.

[36] Kahlon and Tyagi [1980] asserted, "A comparison of these results with those derived from the calculation of Thamarajakshi [1977] by adopting the trienium ending 1971/72 =100 showed that whereas for the period 1967/68 to 1974/75 (the common period between ours and her study) according to her data the terms of trade moved in favor of agriculture from 100.63 to 107.79, using the

Kahlon and Tyagi [1980], to argue that TOT in India did favor agriculture during mid-60 to mid-70.[37] Thamarajakshi [1990] subsequently extended her series referring to the base 1978/79 and demarcated two sub-periods, viz. 1961/62 to 1973/74 and 1974/75 to 1987/88, which showed a reversal in the trend of agricultural NBTOT. She found that NBTOT moved in favor of agriculture at an annual compounded growth rate of 2.38% during the first period and deteriorate at 0.99 % annually in the second period. Mungekar [1992] also found the NBTOT movement favorable to agriculture during 1952/52 to 1973/74 and unfavorable later. Palanivel [1992] identified only periodic swings in agricultural NBTOT instead of any uniform trend during the overall period, viz. 1950/51 to 1987/88. His series indicated a significant dip in NBTOT during the pre-green revolution period and a rally in the later part. Subsequently, Thamarajakshi [1994] updated her earlier series and also provided a modified series. She could not detect any distinct trend in either of the NBTOT series during 1971/72 to 1991/92.[38] Apart from these studies, both the CACP and DES series as published in GOI [1998] reveal an improvement in agricultural NBTOT during 1981/82 to 1990/91, and a further improvement between the period 1990/91 to 1994/95. Recently, Thamarajakshi [2000] has provided a new NBTOT series between 1990/91 and 1998/99, with 1993/94 as base. This series reflects favorable agricultural TOT during the entire post-reform period. All the series with their original base years have been reproduced in appendix table A-1.

7.1. Graphical Comparison

This section compares the NBTOT series constructed by Thamarajakshi [1994], Tyagi [1987], Mungekar [1992], Palanivel [1992], CACP and DES. It uses the graphical plot of respective series to examine their pattern of movements over

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refined methodology our results showed that during this period the terms of trade moved against agriculture from 117.8 to 101.6." (page A-181)

[37] The Kahlon and Tyagi [1980] conclusion that TOT moved against agriculture referred to the period 1967/68 to 1977/78, with triennium ending 1971/72 as base. Tyagi [1987] provided a longer series for the period 1952/53 to 1983/84, with the same base. He now demarcates the period between 1964/65 to 1974/75 with favorable agricultural TOT and the period between 1975/76 to 1982/83 with unfavorable agricultural TOT.

[38] The modified series referring to the period 1971/72 to 1991/92 has been derived by incorporating some recent data base, viz. WPI series with 1981/82 as base, CSO's National Accounts series with 1980/81 as base, and 43rd. Round of NSS survey data for 1987/88.

time.[39] For the purpose of examining the long-run movements, these series are connected to a common base (1980/81) in table 5. At a broader level, some patterns can be discerned:

> i) *agricultural NBTOT remained more or less stable till about mid-60s, if we leave aside some unfavorable shifts in specific years,*
>
> ii) *a noticeable movement in favor of agriculture can be detected for the period between mid-60 to mid-70, extending till about the beginning of 80's in some series.*
>
> iii) *agricultural NBTOT seemed to have significantly improved after the beginning of economic reforms in 1991.*

When we attempt to graph the six NBTOT series on a common scale, the picture looks full and the individual series can not be distinguished from one another. Subsequently, we attempt an individual plot of respective series, side by side with a NBTOT measure based on the ratio between the implicit price deflator (IPD) of agriculture to that of non-agriculture (provided in column 7 of table 5). We find that each of these diverse NBTOT series reveal a fair amount of resemblance with the series based on IPD over comparable periods (figure 1.a to 1.f). Although, there is no point to point correspondence among various series, their overall movements, peaks and lows indicate a pattern that is very similar to that in the ratio of sectoral IPD. The coefficient of correlation between respective series and the one based on IPD also reveals a high degree of correlation for common observations.

[39] It may be of some interest to note that Ahluwalia and Rangarajan [1989] had earlier noticed a same trend in the graphical comparison of Thamarajakshi [1977] and Kahlon and Tyagi [1980] series. Similarly, Palanivel [1999] viewed some similarity between his series (the one based on WPI) and that of the Thamarajakshi [1990] and Tyagi [1987] , after connecting all the series to a common base.

Table 5: Indices for Net Barter Terms of Trade for Indian Agriculture, base 1980/81.

	(1) Tyagi [1987] series	(2) Mungekar [1992] series	(3) Palanivel [1992] series	(4) Thamarajakshi [1994] series	(5) CACP Series	(6) DES Series (base: 1981/82)	(7) Ratio of Implicit Price Deflators (Agr.vs.Non-Agr.)	(8) Ratio of Implicit Price Deflators (Agr.vs.Economy)
1950/51	-	-	116.62	-	-	-	101.67	100.74
1951/52	-	-	110.39	96.88	-	-	98.54	99.34
1952/53	104.35	-	93.24	95.43	-	-	95.27	97.82
1953/54	98.63	92.58	93.96	99.78	-	-	94.50	97.50
1954/55	99.54	94.80	84.95	93.31	-	-	79.07	89.41
1955/56	101.60	90.14	91.97	91.19	-	-	77.82	88.27
1956/57	103.67	93.91	93.22	98.55	-	-	88.30	94.16
1957/58	102.86	90.92	91.25	94.76	-	-	87.12	93.31
1958/59	100.69	89.92	93.99	97.88	-	-	89.20	94.58
1959/60	98.40	96.46	93.67	97.88	-	-	87.37	93.39
1960/61	90.61	97.12	89.89	96.21	-	-	81.71	90.09
1961/62	92.33	94.02	89.29	96.88	-	-	83.82	91.10
1962/63	91.18	94.57	87.83	95.32	-	-	83.57	90.63
1963/64	83.51	91.69	94.87	93.76	-	-	92.49	95.81
1964/65	107.67	98.01	107.55	104.57	-	-	97.58	98.70
1965/66	117.87	106.09	114.74	110.14	-	-	103.22	101.80
1966/67	129.32	115.39	131.16	118.39	-	-	112.04	106.62
1967/68	132.42	122.92	131.03	120.29	-	-	113.22	106.88
1968/69	120.39	116.94	118.47	111.93	-	-	113.87	107.37
1969/70	116.61	116.50	115.97	120.96	-	-	112.87	106.87
1970/71	114.55	114.95	116.53	122.52	114.55	-	102.87	101.58
1971/72	111.68	110.30	114.04	115.94	111.68	-	100.69	100.39
1972/73	118.56	106.87	118.91	119.06	118.67	-	109.45	105.35
1973/74	125.54	115.17	132.32	128.99	125.54	-	119.64	110.48
1974/75	114.43	123.59	113.73	125.31	114.55	-	109.95	105.63
1975/76	96.91	120.38	97.06	113.15	96.91	-	91.91	95.19
1976/77	103.89	104.54	105.86	111.37	103.78	-	95.47	97.22
1977/78	104.01	110.30	100.75	116.50	103.89	-	97.50	98.50
1978/79	97.82	104.65	97.40	111.48	97.82	-	95.37	97.14
1979/80	101.49	94.24	103.19	106.91	101.49	-	100.13	100.08
1980/81	100.00	100.00	100.00	100.00	100.00	-	100.00	100.00
1981/82	94.96	-	95.22	100.22	94.96	100.00	94.80	96.71
1982/83	97.02	-	95.21	102.23	97.02	103.04	94.85	96.66
1983/84	98.63	-	97.14	108.14	98.85	103.27	95.04	96.83
1984/85	-	-	97.83	108.14	98.51	105.86	93.91	96.01
1985/86	-	-	92.84	102.12	94.39	105.52	93.10	95.38
1986/87	-	-	96.82	101.56	97.71	107.89	95.78	97.12
1987/88	-	-	101.26	109.81	99.54	109.81	99.68	99.78
1988/89	-	-	-	109.48	98.74	110.82	97.00	97.97
1989/90	-	-	-	105.46	99.08	112.06	98.55	99.00
1990/91	-	-	-	106.24	103.09	114.88	100.20	100.14
1991/92	-	-	-	112.82	106.19	119.05	106.27	104.31
1992/93	-	-	-	-	99.20	117.14	101.85	101.28
1993/94	-	-	-	-	104.12	116.80	104.44	103.08
1994/95	-	-	-	-	105.15	120.18	108.79	106.05
1995/96	-	-	-	-	103.32	118.60	107.80	105.65
1996/97	-	-	-	-	106.19	115.90	104.49	103.28
1997/98	-	-	-	-	101.72	115.22	-	-
1998/99	-	-	-	-	110.19	-	-	-

Source: worked out from Tyagi [1987], Mungekar [1992], Palanivel [1992], Thamarajakshi [1994], GOI [1999] and various issues of CACP Reports.

Fig 1 (a) : Thamarajakshi Series & Ratio of IPDs (base: 1980/81)

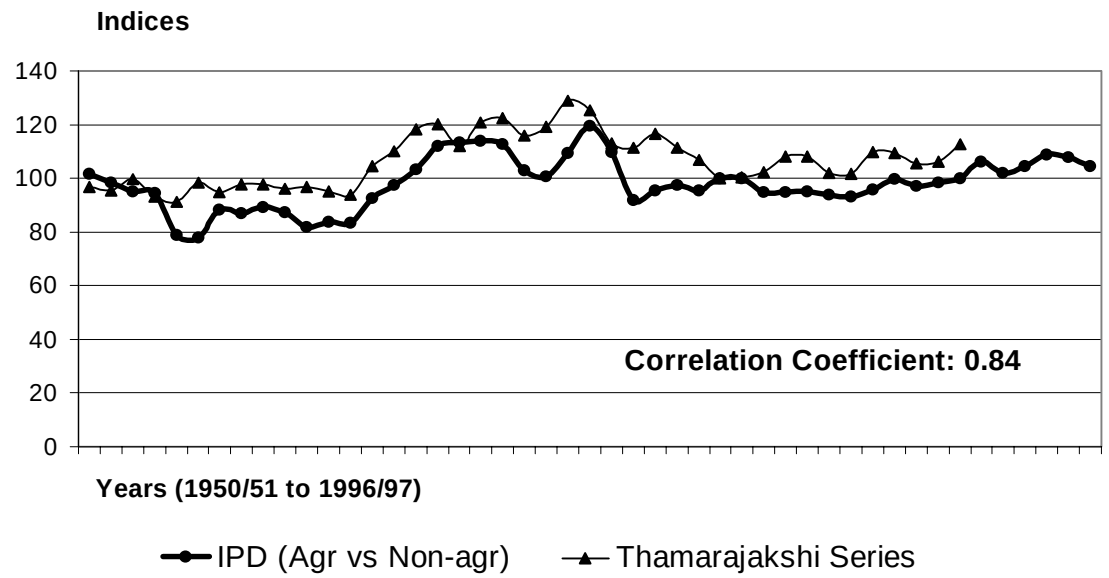
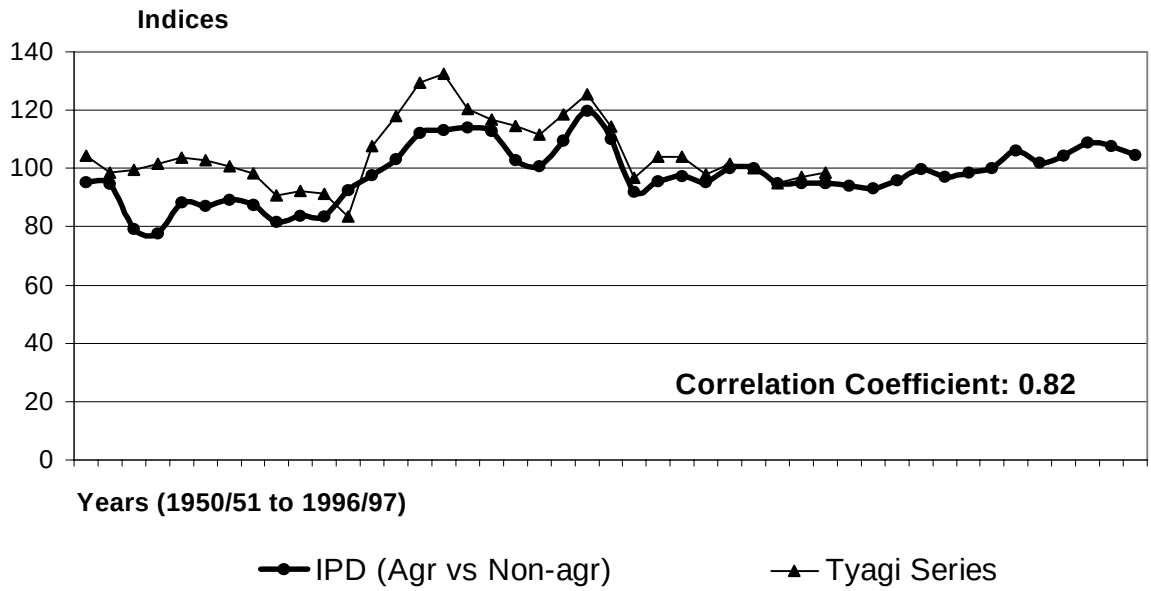


Fig 1 (b): Tyagi Series & Ratio of IPDs (base: 1980/81)



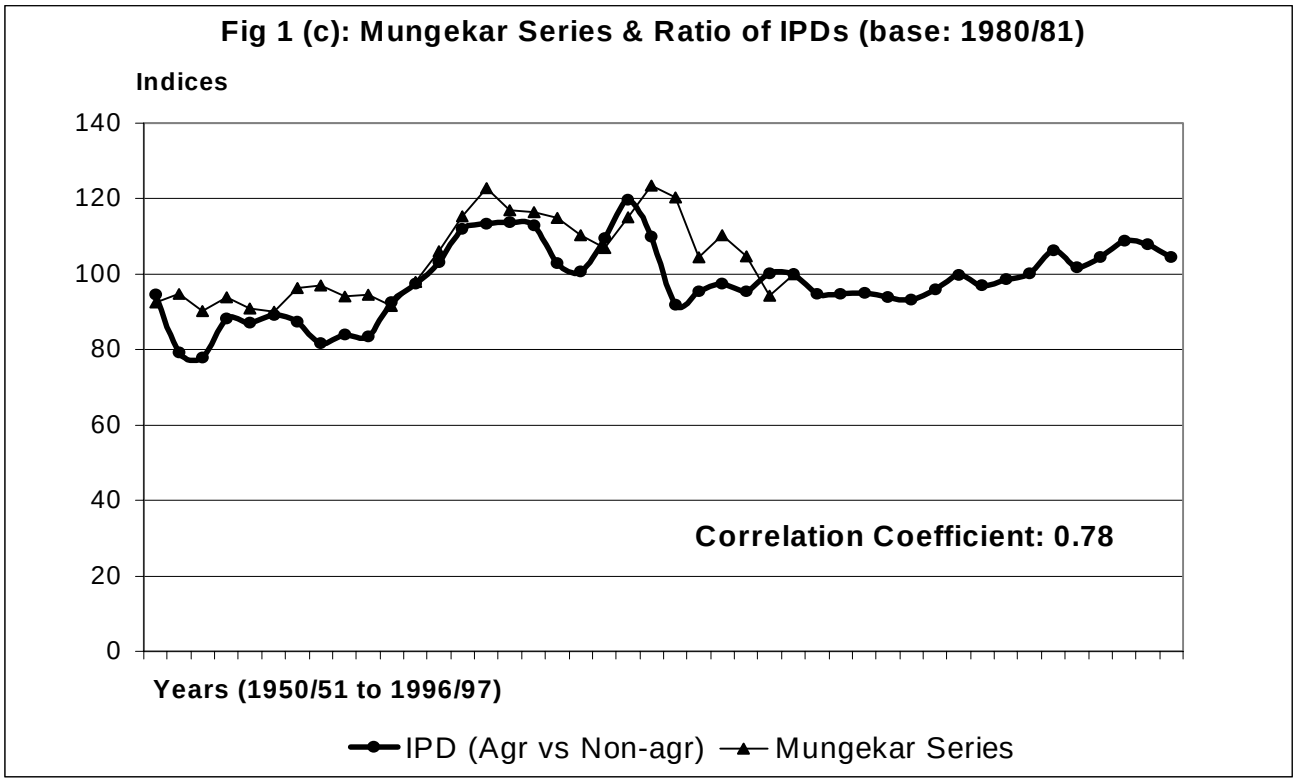


Fig 1 (c): Mungekar Series & Ratio of IPDs (base: 1980/81)
Indices
140
120
100
80
60
40
20
0
Correlation Coefficient: 0.78
Years (1950/51 to 1996/97)
IPD (Agr vs Non-agr)
Mungekar Series

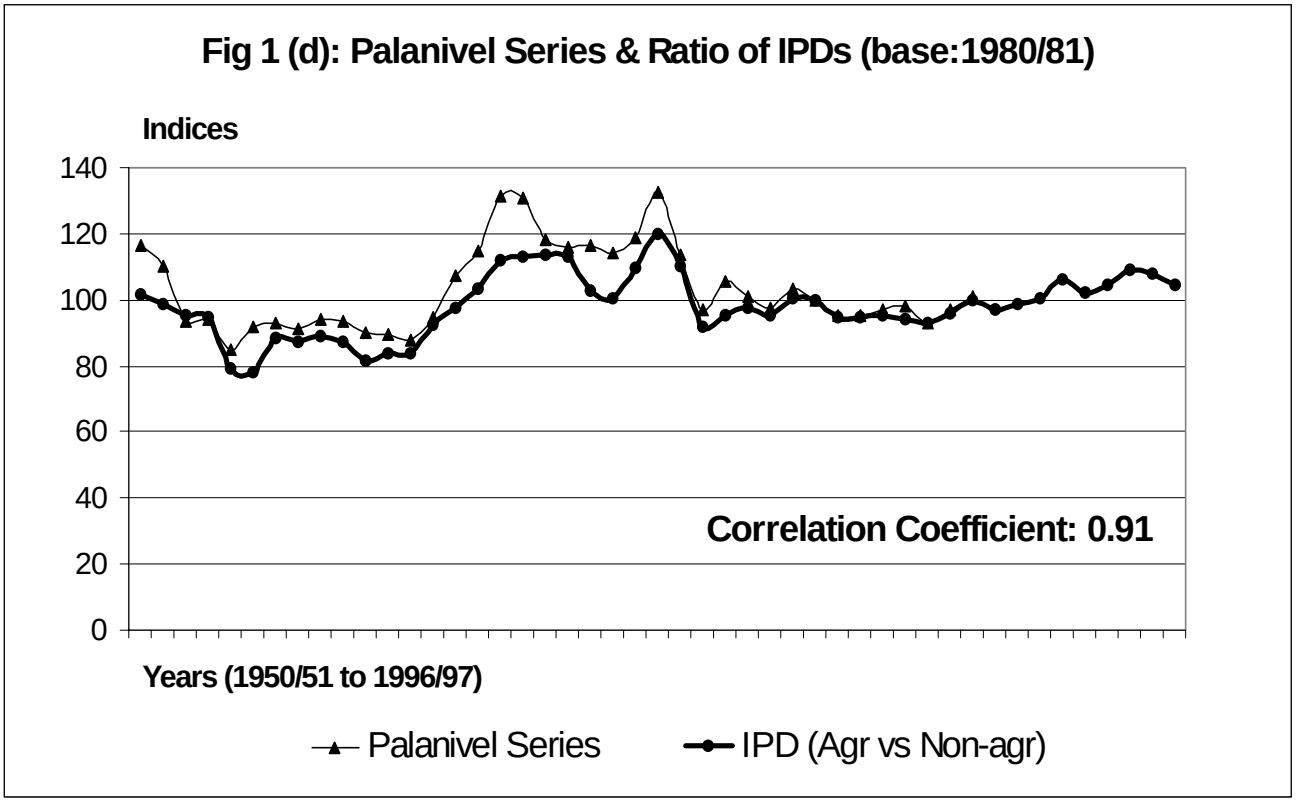


Fig 1 (d): Palanivel Series & Ratio of IPDs (base:1980/81)
Indices
140
120
100
80
60
40
20
0
Correlation Coefficient: 0.91
Years (1950/51 to 1996/97)
Palanivel Series
IPD (Agr vs Non-agr)

Fig 1 (e): CACP Series & Ratio of Sectoral IPDs (base:1980/81)

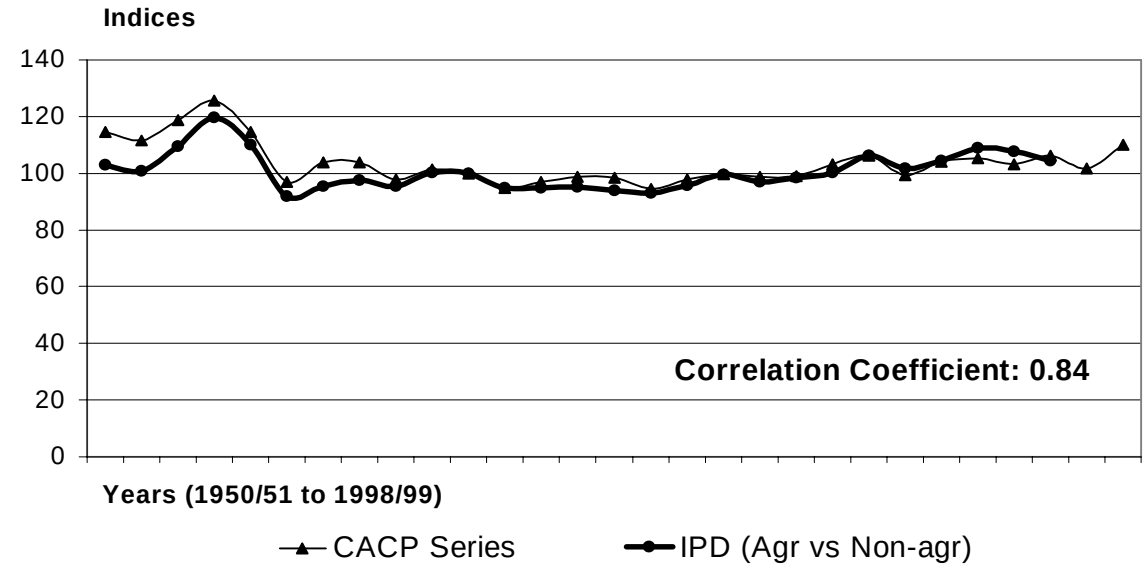
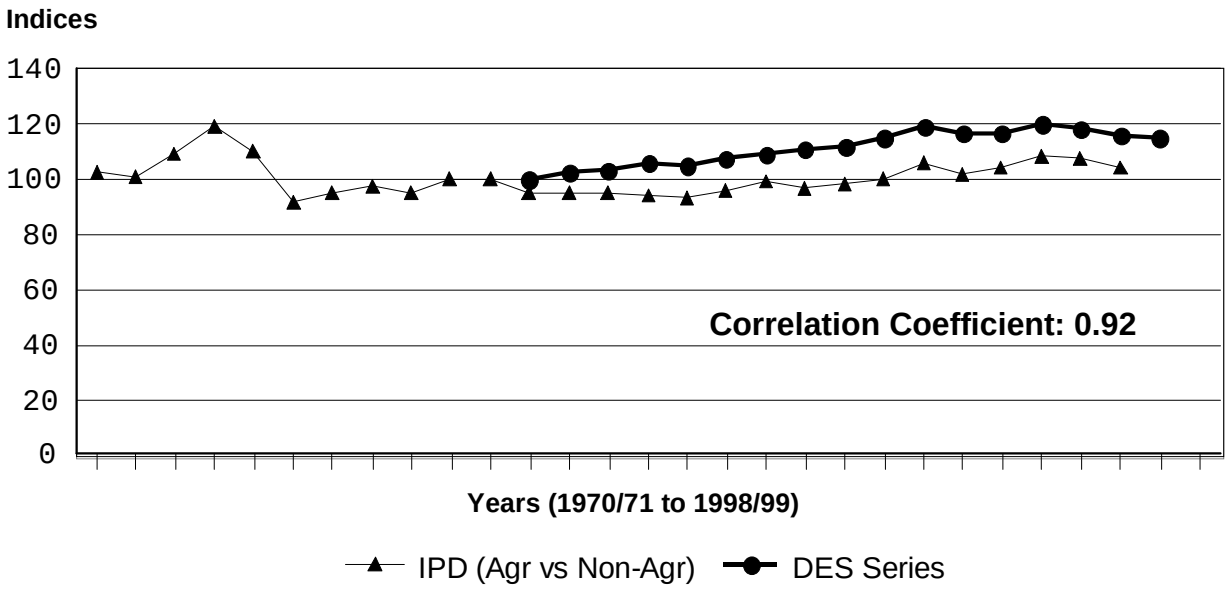


Fig 1 (f) : DES Series and Ratio of Sectoral IPDs (Base:1980/81)



Note:DES Series refers to 1981/82 base.

The similarity among different NBTOT series is somewhat contrary to our expectations. Earlier, we have observed that these series have been constructed using different commodity composition, weighting pattern and prices data. Given the methodological and data dissimilarity, one generally expects the nature of TOT movements to be different. To explore this aspect in more detail, we undertake some statistical tests, i.e. we examine the significance of difference between the population mean, variance and nature of trend to verify the symmetry among various series. We carry out this analysis by using both parametric and non-parametric (distribution free) tests. The non-parametric tests have been incorporated due to their characteristic feature of involving in less-restrictive assumptions, i.e. they allow us to relax the assumptions that the samples under study are normally distributed and have equal variance.[40]

7.2 Statistical Tests

The statistical tests are performed using the NBTOT data included in table 5. We first look at the descriptive statistics in table 6. We notice that the mean values of Thamarajakshi, Tyagi, Mungekar, Palanivel and CACP series are almost equivalent. The relative variation in Tyagi, Mungekar and Palanivel series is nearly identical, which is somewhat higher than the relative variation in Thamarajakshi series. On the other hand, the coefficient of variation in both CACP and DES series are lower than the Thamarajakshi series. A statistically significant improving trend during their respective time frame has been observed only for Thamarajakshi, Mungekar and DES series.

Subsequently, we carry out a non-parametric *sign test* to examine whether these NBTOT series revealed any pattern; i.e. indicated a favorable (or unfavorable) movement towards agriculture. Our null hypothesis is set to test whether the mean value of respective series is significantly different from the base value (=100),

[40] The materials used in performing the non-parametric tests are Conover [1980], Gibbons [1985], Sprent [1989] and Freund [1994].

Table 6 : Summary Statistics of Agricultural NBTOT Series in India

NBTOT Series	Mean	Std. Deviation	Coeff. of Variation	Linear Trend
IPDs (1951-97)	98.14	9.48	0.09	0.27*
Tyagi (1953-84)	105.35	11.71	0.11	0.12
Mungekar (1954-81)	103.82	11.00	0.11	0.78*
Palanivel (1951-88)	103.16	12.75	0.12	0.09
Thamarajakshi (1952-92)	106.62	9.82	0.09	0.34*
CACP (1971-99)	103.68	7.41	0.07	-0.30*
DES (1982-98)	111.53	6.34	0.06	1.15*

Note: * indicates significant trend at 10% level of significance.

against the alternative that it is not equal to 100. The results indicate that the null hypothesis is accepted for each and every series at 5% level of significance (table 7). Which implies that the individual series has their respective location parameters around the base value (=100). Next, a variation of the sign test, known as the Cox and Stuart's test for trend, is applied to determine the presence of a monotonic trend in each series. The results that are provided in table 8 indicate the presence of a monotonic trend only in the Mungekar series. The acceptance of null hypothesis reflects random patterns in all the other series.

Table 7: Results of Sign Test (2 tailed).

Hypothesis: H_0: mean = 100 ; H_1: mean # 100

	t	T	n-t	decision
Thamarajakshi [1994]	13.80	27	26.19	accept
Tyagi [1987]	10.04	19	20.97	accept
Mungekar [1992]	8.41	14	18.59	accept
Palanivel [1992]	12.54	17	24.46	accept
CACP series	8.81	16	19.19	accept

Notes: 1. Test statistic: t = $\frac{1}{2}\left(n - 1.96\sqrt{n}\right)$,

T = Number of observations exceeding 100,
n = total number of observations exceeding and lower than 100, observations equal to 100 are discarded.

2. H_0 is rejected if, T < t or if T > n-t.

Table 8 : Results of Cox and Stuart's Test for Trend (2 tailed).

Hypothesis: H_0: no trend exists; H_1: there is either an upward or downward trend

	n –T	Pr(T < n - T)	decision
Thamarajakshi [1994]	7	0.13	accept
Tyagi [1987]	5	0.11	accept
Mungekar [1992]	2	0.01	reject
Palanivel [1992]	6	1.00	accept
CACP series	6	0.39	accept

Note: 1. H_0 is rejected if Pr (T < n - T) is smaller than 0.025.

2. T = number of + signs after arranging each series in the paired observations form as:
(x_1, x_{1+c}), (x_2, x_{2+c}), . . ., (x_{n-c}, x_n), where c = n/2 if n is even and c = (n+1)/2, if n is odd.
n = sum of + and - sign, zero differences are discarded.

Subsequently, we test whether the populations sampled in various TOT series have equal means. To examine the significance of difference between population means, we apply the sign test in paired samples. This paired sample sign test is performed using the Thamarajakshi [1994] series as benchmark. The comparison between two government series is made by using the CACP series as benchmark. The results reveal that the mean value of all the series, except for Tyagi's are significantly different from the Thamarajakshi series (table 9). The population mean of the CACP series also turns out to be significantly different from the series provided by DES. The similarity between Tyagi and Thamarajakshi series in terms of having equal mean has also been confirmed by the signed rank test results (table 10). A similar picture emerges when the significance of difference between population means is examined by parametric tests, such as paired sample t-test. These results given in table 11 also bring out the symmetry between the Tyagi [1987] and Thamarajakshi [1994] series in terms of having equal means.

Among non-parametric alternatives, the Wilcoxon-Mann-Whitney test is considered more reliable, since unlike the sign test it also utilizes the magnitude of difference between samples. We applied this test in paired series to examine

Table 9 : Results of Paired Sample Sign Test (2 tailed).

Hypothesis: H_0: E (x_i) = E (y_i), for all i, ; H_1: E (x_i) E (y_i)

	n	x	Z	decision
Thamarajakshi and Tyagi	31	19	1.44	accept
Thamarajakshi and Mungekar	27	22	3.46	reject
Thamarajakshi and Palanivel	36	27	3.16	reject
Thamarajakshi and CACP	21	21	4.80	reject
CACP and DES	17	17	4.37	reject

Note: 1) test statistic: $Z = \{(x+ ½) - n\theta\} / n\theta (1-\theta)$, where, x = no. of times obs. in first series exceeds corresponding obs. in second series.
n = total no. of obs., discarding those where the difference is zero.
2) H_0 is rejected at 5% level of significance if |z| > 1.96.

Table 10 : Results of Signed Rank Test (2 tailed).

Hypothesis: H_0: E (x_i) = E (y_i), for all i, H_1: E (x_i) # E (y_i)

	n	T^+	Z	decision
Thamarajakshi and Tyagi	31	297.5	0.97	accept
Thamarajakshi and Mungekar	27	320.0	3.15	reject
Thamarajakshi and Palanivel	36	521	2.95	reject
Thamarajakshi and CACP	21	231.0	4.01	reject
CACP and DES	17	153.0	3.62	reject

Note: 1. Test statistic: $Z = \{T^+ - E(T^+)\} / Var(T^+)$, where, T^+ = sum of ranks assigned to the positive difference between the obs. in two series. $E(T^+) = \{n(n+1)/2\}$, $Var(T^+) = \{n(n+1)(2n+1)/24\}$,
2. H_0 is rejected at 5% level of significance if |z| > 1.96.

Table 11 : Results of Paired Sample t-test (2 tailed).

Hypothesis: H_0: E (x_i) = E (y_i), for all i ; H_1: E (x_i) # E (y_i)

	T	decision
Thamarajakshi and Tyagi	t_{31} = 1.08	accept
Thamarajakshi and Mungekar	t_{27}= 4.04	reject
Thamarajakshi and Palanivel	t_{36}= 3.14	reject
Thamarajakshi and CACP	t_{21}= 9.18	reject
CACP and DES	t_{17}= -12.30	reject

Note: Test statistic: $t = \{(m_1 - m_2) / s/n^{1/2}\}$, where, s^2 = variance of the differences formed for each pair of observations, m_1, m_2 = sample means from the two populations.

whether the two populations are identical. In table 12, we provide two set of results based on this test, viz. one by keeping the Thamarajakshi [1994] series as the benchmark and the other considering ratio of IPD between agriculture and non-agriculture as benchmark for rest of the series. We find the null hypothesis concerning the equality of mean with Thamarajakshi series is accepted for the Tyagi, Mungekar, Palanivel and CACP series in the Wilcoxon-Mann-Whitney test. Correspondingly, this test also revealed that both Mungekar and Palanivel series are similar with the one based on IPD in terms of having equal means. On the contrary, the population mean between the two government series (CACP and DES) reflected a significant difference.

Table 12 : Results of Wilcoxon-Mann-Whitney Test (2 tailed).
Hypothesis: H_0: E (x_i) = E (y_i), for all i ; H_1: E (x_i) # E (y_i)

	w_1	n_1	n_2	Z	decision
Thamarajakshi and Tyagi	1568	41	32	0.57	accept
Thamarajakshi and Mungekar	1540	41	28	1.28	accept
Thamarajakshi and Palanivel	1830	41	38	1.86	accept
Thamarajakshi and CACP	1547	41	29	1.09	accept
CACP and DES	530	29	17	-3.45	reject
IPD and Thamarajakshi	1669.9	47	41	-3.53	reject
IPD and Tyagi	1625.0	47	32	-2.55	reject
IPD and Mungekar	1631.0	47	28	-1.70	accept
IPD and Palanivel	1882.0	47	38	-1.23	accept
IPD and CACP	1573.0	47	29	-2.53	reject
IPD and DES	1223.0	47	17	-4.60	reject

Note: 1. Test statistic: $Z = \{U_1 - E(U_1)\} / Var(U_1)$, where, $U_1 = \{w_1 - n_1 (n_1+1)/2)\}$, $E(U_1) = (n_1n_2/2)$, $Var (U_1) = \{n_1n_2 (n_1 + n_2 +1)/12\}$, where, n_1, n_2 = no. of observations in the 1st & 2nd sample.

2. H_0 is rejected at 5% level of significance if $|z| > 1.96$

We also inquire whether the different NBTOT series could have come from populations having equal variances. The parametric test examining the significance of difference between two population variances is performed by the usual F-test (variance ratio test). As before, these tests have been undertaken in paired samples, viz, by alternatively considering the Thamarajakshi and IPD series as benchmarks. Likewise, the comparison on government series has been made by using the CACP series as benchmark. The results indicate that population variances in each and every series are not significantly different from the variance observed in Thamarajakshi [1994] series (table 13). The population variances in two government series also do not turn out to be significantly unrelated from each other. When the equality between variance is compared with the IPD series, again all except the DES series indicated no significant difference in variability.

The non-parametric test of equality in variance has been undertaken using Sigel-Tukey's rank sum dispersion test. The results reveal equal variability in both Tyagi and Mungekar series with the Thamarajakshi series (table 14). Similarly, the variances in CACP and DES series are not significantly disparate from each other. On the other hand, the null hypothesis is rejected for both Palanivel and CACP

Table 13: Results of F-test on Population Variances (2 tailed)
(Variance Ratio Test) Hypothesis: $H_0: s_1^2 = s_2^2$; $H_1: s_1^2 \# s_2^2$

	F			decision
Thamarajakshi and Tyagi	$F_{40,31}$	=	0.70	accept
Thamarajakshi and Mungekar	$F_{40,27}$	=	0.79	accept
Thamarajakshi and Palanivel	$F_{40,37}$	=	0.59	accept
Thamarajakshi and CACP	$F_{40,28}$	=	1.76	accept
CACP and DES	$F_{28,16}$	=	1.37	accept
IPD and Thamarajakshi	$F_{46,41}$	=	0.93	accept
IPD and Tyagi	$F_{46,31}$	=	0.66	accept
IPD and Mungekar	$F_{46,27}$	=	0.74	accept
IPD and Palanivel	$F_{46,37}$	=	0.55	accept
IPD and CACP	$F_{46,28}$	=	1.64	accept
IPD and DES	$F_{46,16}$	=	*2.24*	reject

Note: Test statistic: $F = s_1^2 / s_2^2$, where, s_1^2 and s_2^2 are the variances of x and y sample with n_1 and n_2 sample size.

Table 14 : Results of Siegel-Tukey's Rank Sum Dispersion Test

Hypothesis: $H_0: s_1^2 = s_2^2$, $H_1: s_1^2 \# s_2^2$ (2 tailed)

	R_1	n_1	n_2	Z	decision
Thamarajakshi and Tyagi	1532	41	32	0.17	accept
Thamarajakshi and Mungekar	1539	41	28	1.27	accept
Thamarajakshi and Palanivel	1889	41	38	2.45	reject
Thamarajakshi and CACP	1279	41	29	-2.09	reject
CACP and DES	631	29	17	-1.14	accept
IPD and Thamarajakshi	2009.0	47	41	-0.69	accept
IPD and Tyagi	1810.0	47	32	-0.69	accept
IPD and Mungekar	1934.0	47	28	1.63	accept
IPD and Palanivel	2151.0	47	38	1.15	accept
IPD and CACP	1620.0	47	29	-2.02	reject
IPD and DES	1542.0	47	17	0.23	accept

Note: 1. Test statistic: $Z = \dfrac{R_1 - n_1(n_1 + n_2 + 1)/2 + 1/2}{\sqrt{n_1 n_2 (n_1 + n_2 + 1)/12}}$, where, n_1 and n_2 denote the sample size, and R_1 is the rank sum of the series of size n_1.

2. H_0 is rejected at 5% level of significance if $|z| > 1.96$.

series in having equal variances with Thamarajakshi [1994] series. When we make comparisons with the IPD series, we find that all except the CACP series indicated that the respective samples could have come from populations having equal variability.

The overall result of these tests indicate that the mean and variance of most of the NBTOT series is similar to that of a standard measure based on IPD. The evidence of similarity is very strong between the Tyagi [1987] and Thamarajakshi [1994] series, since the hypothesis of having similar mean and variance between the two series is consistently indicated by all the tests. We therefore infer that although the empirical estimation of agricultural NBTOT in India is subjected to an extensive debate, the underlying nature of the various series does not look too different.

8. Summary

The empirical estimation of sectoral TOT in India has primarily focused on the construction of agricultural NBTOT indices, worked out on the basis of defining composite price indices of prices received and prices paid for the goods traded by agriculture. The composite price indices have been constructed by aggregating over individual prices that agriculture receives and pays for the tradable. The studies by Thamarajakshi [1969], Kahlon and Tyagi [1980], Tyagi [1987], Mungekar [1992], Palanivel [1992] as also the agricultural NBTOT series currently being compiled by two government departments, viz. the Commission for Agricultural Costs and Prices (CACP) and the Directorate of Economics and Statistics (DES) conform to this design. This did not however prevent a vigorous debate on the TOT trends reported by different studies.

Much of the methodological debate on TOT estimation can be traced to disagreements on the sampling design used in the selection of representative price and quantity information, as well as the method of aggregation. A major feature of the constructed NBTOT indices has been the use of a joint application of aggregate and disaggregated level data, at different stages of empirical estimation. In this connection, we discuss how complications arising from the *aggregation error* and *aggregation problems* could result in the NBTOT measure from being a good macro indicator of sectoral TOT. In part, due to these limitations, the NBTOT approach might not be suitable to work out macro estimates of sectoral TOT shifts. Nevertheless, a particular useful feature of the NBTOT concept is the ability to apply the measure at a fairly disaggregated level, as distinct from the overall agricultural

sector as a whole. Thus, this measure can be fruitfully utilized at the disaggregated level to analyze the differential impact of TOT across crops or on different income and household groups - as has been the case in some work undertaken by Rahman [1981], in which he studied the impact of TOT on various household categories in Bangladesh.

In reviewing the studies on India, we expected the movements in alternate TOT series to be different given the differences in commodity composition, weighting pattern and price data used in agricultural NBTOT construction. However, we find that in spite of numerous methodological differences, the fundamental nature of different NBTOT indices reflected similar attributes over comparable time periods. For instance, all the tests consistently indicate that the Tyagi [1987] and Thamarajakshi [1994] series have a similar mean and variance. Similarly, there is an indication that the mean and variance of most of the constructed agricultural NBTOT series in India are similar to the standard measure of NBTOT that is based on ratio of implicit price deflators.

Appendix Table: A-1: Indices of Net Barter Terms of Trade for Indian Agriculture (all uses)

	Thamarajakshi [1977] (base:1960-61)	Kahlon & Tyagi [1980] (base:1969 -72)	Tyagi [1987] (base:1969 -72)	Mungekar [1992] (base: 1961-62 & 1971-72)	Palanivel [1992] (base: 1969-72)	Thamarajakshi [1994] (base:1978-79)	CACP Series (base: 1969-72)	DES Series (base: 1988-91)	Thamarajakshi [2000] (base: 1993-94
1950/51					100.98				
1951/52	100.72				95.59	86.90			
1952/53	99.13		91.10	99.49	80.74	85.60			
1953/54	103.74		86.10	101.90	81.36	89.50			
1954/55	97.02		86.90	96.86	73.56	83.70			
1955/56	94.78		88.70	100.90	79.64	81.80			
1956/57	102.46		90.50	97.69	80.72	88.40			
1957/58	98.46		89.80	96.67	79.01	85.00			
1958/59	101.66		87.90	103.85	81.39	87.80			
1959/60	101.68		85.90	104.37	81.11	87.80			
1960/61	100.00		79.10	101.07	77.84	86.30			
1961/62	100.69		80.60	101.67	77.32	86.90			
1962/63	99.09		79.60	98.61	76.05	85.50			
1963/64	97.39		72.90	105.40	82.15	84.10			
1964/65	108.66		94.00	114.00	93.13	93.80			
1965/66	114.47		102.90	124.00	99.35	98.80			
1966/67	123.07		112.90	132.11	113.57	106.20			
1967/68	125.02	117.80	115.60	108.76*	113.46	107.90			
1968/69	116.27	105.80	105.10	109.14*	102.58	100.40			
1969/70	125.72	102.00	101.80	107.03*	100.42	108.50			
1970/71	127.32	99.60	100.00	103.68*	100.90	109.90	100.00		
1971/72	120.08	97.70	97.50	99.98*	98.75	104.00	97.50		
1972/73	118.90	103.50	103.50	104.71*	102.96	106.80	103.60		
1973/74	136.98	108.60	109.60	111.91*	114.58	115.70	109.60		
1974/75	133.92	101.60	99.90	104.72*	98.48	112.40	100.00		
1975/76		86.70	84.60	85.20*	84.04	101.50	84.60		
1976/77		90.40	90.70	93.00*	91.66	99.90	90.60		
1977/78		90.30	90.80	95.32*	87.24	104.50	90.70		
1978/79			85.40	90.75*	84.34	100.00	85.40		
1979/80			88.60	94.91*	89.35	95.90	88.60		
1980/81			87.30	88.74*	86.59	89.70	87.30		
1981/82			82.90	87.03*	82.45	89.90	82.90	88.70	
1982/83			84.70	89.02*	82.44	91.70	84.70	91.40	
1983/84			86.10	96.97*	84.11	97.00	86.30	91.60	
1984/85				94.20*	84.71	97.00	86.00	93.90	
1985/86				92.95*	80.39	91.60	82.40	93.60	
1986/87				95.47*	83.84	91.10	85.30	95.70	
1987/88					87.68	98.50	86.90	97.40	
1988/89						98.20	86.20	98.30	
1989/90						94.60	86.50	99.40	
1990/91						95.30	90.00	101.90	98.50
1991/92						101.20	92.70	105.60	104.60
1992/93							86.60	103.90	103.30
1993/94							90.90	103.60	100.00
1994/95							91.80	106.60	103.30
1995/96							90.20	105.20	103.60
1996/97							92.70	102.80	104.80
1997/98							88.80	102.20	101.50
1998/99							96.20		106.30

Source: *Thamarajakshi [1977, 1994, 2000], Kahlon and Tyagi [1980], Tyagi [1987], Mungekar [1992], Palanivel [1992], GOI [1999] and various issues of the CACP Report.*

Note: *The starred entries in Mungekar [1992] series refer to 1971/72 as base.*

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