6

Black Income Generation in the Sugar Industry : A Case Study

1. Introduction

The last three chapters dwelt on the scale of black income generation in the economy as a whole. In this chapter we shift our attention to a single commodity, sugar. The reasons for this shift are as follows. First, it will help illustrate the methods of black income generation deployed, some of which may be specific to sugar, while others are more generally prevalent. Second, it can throw light on the causal factors spurring black income generation. Third, the methods of estimation developed for the sugar industry may be of interest in themselves as well as examples of approaches which may be mounted for other commodities and sectors. Fourth, the chapter shows how difficult is the task of estimating black income generation, even at the level of a single, relatively homogeneous, commodity.

The choice of sugar as a case study has been influenced by a number of factors. First, as Table 6.1.1 indicates, sugar figures prominently both in the output of registered manufacturing and in private final consumption expenditure. Second, the commodity has important links with agriculture through its major input, sugar-cane. Third, the sugar industry has, since its infancy, been subject to varying degrees of

TABLE

Relative Standing of Sugar-Industry in the Economy as a whole

Year	Output of sugar (lakh tons)	Free market wholesale price of sugar (Rs/ton)	Registered manufacturing		
			Value of output of sugar (Col. 2 x Col. 3) (Rs crore)	As a percentage of value of output in food products	Standing of sugar in registered manufacturing
(1)	(2)	(3)	(4)	(5)	(6)
1970-71	37.40	1839.1	687.79	25.72	9
1971-72	31.13	2252.0	701.05	25.68	10
1972-73	38.73	3048.6	1190.98	—	--
1973-74	39.48	3900.9	1540.08	35.09	6
1974-75	47.97	4381.1	2101.57	47.27	6
1975-76	42.62	4555.0	1941.34	38.62	7
1976-77	48.40	4349.4	2104.91	39.17	7
1977-78	64.61	4279.9	2765.31	43.33	7
1978-79	58.41	2992.8	1748.21	25.59	9
1979-80	38.58	—	—	—	—
1980-81	51.48	—	—	—	—

Source: 1. Column (2) from National Federation of Co-operative Sugar Factories (1982), *Co-operative Sugar Directory and Year Book*, 1981.

2. Column (3) from Ministry of Agriculture and Irrigation, Directorate of Economics and Statistics (1980), *Indian Agriculture in Brief*.
3. Column (5) is calculated from value of output of sugar in Column 4, value of output of food-product from Government of India, CSO (1983) National Accounts Statistics 1970-71 to 1980-81.
4. Columns (6), (7), (9), (10), (11) and (12) are from Government of India, CSO (1983).
5. Column (8) calculated from value of output of sugar-cane and value of output of agriculture found in Government of India, CSO, (1983).
6. Columns (13) and (14) are from *Report on Currency and Finance (RBI)*. Various Issues.

6.1.1

Agriculture			Private final consumption expenditure			Wholesale price Index (1970-71 = 100)	
Value of out put sugar-cane (Rs crore)	As a per-centage of total value of output	Standing of sugar-cane in Agriculture	Sugar (Rs crore)	As percentage of total	Standing of sugar in total private final expenditure	Total	Sugar (including khandsari and gur
(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1036.79	6.91	4	1325	4.5	9	—	—
1235.57	6.72	3	1822	5.7	7	105.6	141.2
1681.88	8.31	3	2259	4.5	7	116.2	188.0
1851.43	6.76	4	2473	6.4	7	139.7	192.4
2028.23	6.72	3	2429	4.7	8	174.9	199.8
1948.29	6.94	3	2477	4.7	8	173.0	213.5
2127.17	7.34	4	2782	5.1	8	176.6	217.5
1998.83	6.02	4	2366	3.8	10	185.8	185.4
1788.27	5.31	4	2704	4.0	12	185.8	146.8
2540.71	7.27	4	4451	6.0	8	217.6	231.3
4075.17	9.12	3	5811	6.5	8	257.3	376.9

government regulation.[1] This holds out the possibility of investigating links, if any, between controls and black income generation at the level of an individual commodity.[2] Finally, the homogeneous character of sugar makes the very difficult task of estimatlon of a time series of black income generation a little more tractable.

The outline of this chapter is as follows. Section 2 presents a capsule history of the sugar industry in India. Section 3 gives a qualitative account of some of the mechanisms used to generate black income in the industry. The subsequent section, which is the heart of the chapter, describes the methodology for and results of estimating suppression of sugar output to generate black incomes. Section 5 deals with black income generation through the underweighment of cane. The chapter closes with a summary of estimates and conclusions. A much more detailed account, especially of the material in Sections 4 and 5, is contained in Appendix 3 to this report.

2. The Sugar Industry in India: A Capsule History

Cultivation of sugar-cane and the conversion of its juice to sugar has apparently been going on in India for over a thousand years. According to Bagchi (1975), India annually exported significant quantities of unrefined sugar upto the middle of the 19th century. The development of the beet-sugar industry in some parts of the world, together with the adoption of a policy of free trade in sugar by the British Government contributed to the decline of India's sugar exports. Even though small quantities of refined sugar were always imported, there was a sudden spurt in this activity after 1885, as foreign sugar (from both beet and sugar-cane) benefited from technical advances and export subsidies.[3] Despite rising imports of refined sugar, the cultivation of sugar-cane and its conversion to sugar continued in India. But, up until the First World War, the growth of the sugar industry was slow and the capacity of individual cane-processing units remained small. For a number of historical reasons, whatever growth occurred was concentrated in Bihar.

The advent of the First World War led to a sharp decline in sugar imports and a corresponding increase in domestic cultivation of sugar-cane and sugar production. This process of war-induced import substitution was, to some extent, constrained by the availability of the necessary machinery.

In 1919, the Indian Sugar Committee was set up to advise on all aspects of the development of the sugar industry in India. But there was little action on their recommendations until 1931. Bagchi (1975) points to several factors which militated against rapid growth of the industry during these years. First, the duty on sugar was raised sharply for revenue reasons. Second, the period witnessed a decline in world sugar prices, which undermined the competitive position of Indian sugar. This was compounded by the rising price of sugar-cane as the war-spawned sugar mills competed against each other for sugar-cane. Finally, unlike most other sugar-producing countries, the absence of worthwhile Government-backed research on development of improved varieties of sugar-cane retarded the growth of the industry.

The situation changed dramatically in 1931 when the Indian Tariff Board recommended protection of the domestic sugar industry for fifteen years, a recommendation which was enacted in the following year. Table 6.2.1 records the almost immediate impact on the output of sugar-cane and sugar. The global depression of the 1930s also helped by reducing the price of imported machinery. The relative profitability of sugar-cane cultivation was further enhanced by the generally depressed state of other agricultural prices. The ensuing boom in sugar-cane production also accelerated the diffusion of improved cane varieties, resulting in further productivity increases.

The next phase of growth of the Indian sugar industry started in the mid-1950s, with the rapid growth of the co-operative sector (with Government help) in Western and Southern India. These areas witnessed the emergence of new sugar-cane varieties with higher sugar content and higher sugar-cane yields per acre. Costs declined as a consequence and those regions (composed notably of Maharashtra, Andhra Pradesh and Karnataka) came to be known as low-cost areas, compared to the older, high-cost sugar producing areas of the North (consisting of Bihar and Uttar Pradesh).

TABLE 6.2.1

INDIAN SUGAR STATISTICS

Area, Production & Yield of Sugarcane, Factories in Operation, Duration, Crushing Capacity, Cane Crushed, Percentage of Cane Crushed by Factories, Sugar & Molasses Production From 1930-31

Year	Area under sugar cane (000 Acre)	Production of sugar cane ('000 tonnes)	Yield of cane per acre (tonnes)	No. of factories in operation	Average duration (days)	Average capacity (tonnes per day)	Total cane crushed ('000 tonnes)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1930-31	2,825	36.354	13.0	20	—	—	1,339
1931-32	3,077	44,011	14.3	31	—	—	1,814
1932-33	3,425	51,950	15.2	56	138	481	3,404
1933-34	3,422	53,297	15.6	111	103	500	5,240
1934-35	3,602	55,218	15.3	128	104	545	6,655
1935-36	4,154	62,185	15.0	135	126	644	10,045
1936-37	4,621	68,401	14.8	137	138	685	11,876
1937-38	4,043	56,533	14.0	136	112	722	10,075
1938-39	3,281	43,792	13.3	139	83	673	7,117
1939-40	3,125	40,145	12.8	145	129	778	13,342
1940-41	3,996	51,978	13.0	148	113	750	11,492
1941-42	2,956	38,515	13.0	150	85	698	8,155
1942-43	3,073	46,005	15.0	150	101	762	10,586
1943-44	3,617	52,741	14.6	151	117	762	12,333
1944-45	3,547	49,558	14.0	140	98	755	9,493
1945-46	3,210	47,273	14.7	145	93	768	9,510
1946-47	3,528	50,568	14.3	160	98	755	9,497
1947-48	4 056	58,170	14.3	134	110	815	11,014
1948-49	3,752	48,690	13.0	137	101	808	10,258
1949-50	3,624	49,380	13.6	139	92	855	10,024
1950-51	4,217	54,823	13.0	139	101	873	11,348
1951-52	4,792	59,227	12.4	140	132	938	15,889
1952-53	4,272	49,004	11.5	134	113	952	13,216
1953-54	3,485	43,182	12.4	134	86	926	9.778
1954-55	3,994	56,026	14.1	136	132	958	15,759
1955-56	4,564	58,384	12.8	143	145	980	18,642

*Provisional.

Source: National Federation of Co-operative Sugar Factories (1982), *Co-operative Sugar Directory and Year Book*, 1981.

%age of cane crushed by factories to total	Total sugar production ('000 tonnes)	Recovery of sugar % cane	Molasses production ('000 tonnes)	Molasses % cane	Year	Area under sugar cane (000 Acre)	Production of sugar cane ('000 tonnes)	Yield of cane per acre (tonnes)
(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
3.68	120	8.96	—	—	1956-57	5,057	65,944	13.0
4.12	161	8.63	—	3.85	1957-58	5,080	65,948	13.2
6.55	295	8.88	132	3.89	1958-59	4,803	68,346	14.5
9.83	461	8.80	193	3.68	1959-60	5,220	74,016	14.2
12.05	578	8.69	232	3.50	1960-61	5,968	110,001	18.4
16.15	934	9.29	336	3.33	1961-62	6,066	103,967	17.1
17.86	1,128	9.50	414	3.48	1962-63	5,540	91,913	16.6
17.32	946	9.39	356	3.53	1963-64	5,557	104,225	18.8
16.25	661	9.29	246	3.46	1964-65	6,432	121,909	18.9
33.23	1,242	9.31	493	3.69	1965-66	7,008	123,990	17.4
22.11	1,113	9.70	431	3.76	1966-67	5,687	92,826	19.3
21.17	790	9.69	298	3.65	1967-68	5,057	95,500	18.9
23.01	1,088	10.28	375	3.54	1968-69	6,257	124,682	19.9
22.38	1,236	10.02	446	3.61	1969-70	6,792	135,024	19.9
19.16	969	10.21	333	3.51	1970-71	6,462	126,368	19.6
20.12	959	10.09	333	3.61	1971-72	5,907	113,579	19.2
18.78	935	9.85	323	3.49	1972-73	6,058	134,866	20.6
18.93	1,092	9.91	417	3.78	1973-74	6,800	140,805	20.7
21.07	1,017	9.91	379	3.69	1974-75	7,151	144,289	20.2
20.30	995	9.93	363	3.62	1975-76	6,825	140,604	20.6
20.70	1,100	9.99	387	3.60	1976-77	7,082	153,007	21.6
26.82	1,474	9.57	598	3.91	1977-78	7,786	171,966	22.7
28.98	1,277	9.98	501	3.85	1978-79	7,630	151,655	20.3
22.64	985	10.08	338	3.46	1979-80	6,449	128,833	19.9
28.13	1,566	9.93	606	3.75	1980-81*	6,543	150,522	23.0
31.93	1,834	9.83	736	3.94				

No. of factories in operation	Average duration (days)	Average capacity (tonnes per day)	Total cane crushed ('000 tonnes)	%age of cane crushed by factories to total	Total sugar production ('000 tonnes)	Recovery sugar % cane	Molasses production ('000 tonnes)	Molasses % cane
(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
147	150	1016	20,536	31.14	1,998	9.73	768	3.73
158	129	1040	19,438		1,946	10.01	732	3.78
164	118	1082	19,187	27.67	1,889	9.84	720	3.75
168	138	1131	24,041	32.48	2,384	9.92	916	3.81
174	166	1172	31,021	28.20	3,021	9.74	1210	3.99
180	148	1144	27,946	26.88	2,729	9.76	1086	3.91
186	106	1151	20,799	22.63	2,139	10.28	749	3.63
194	22	1185	25,716	24.67	2,573	10.01	964	3.74
198	153	1204	33,454	27.44	3,222	9.66	1344	4.00
200	159	1253	36,512	29.45	3,541	9.70	1530	4.17
200	96	1229	21,637	23.81	2,151	9.94	838	3.81
200	97	1273	22,638	23.70	2,248	9.92	867	3.11
205	152	1320	37,699	30.24	3,559	9.44	1671	4.46
215	174	1333	45,701	33.85	4,262	9.33	2004	4.47
215	139	1394	38,205	30.23	3,740	9.79	1611	4.22
220	107	1437	31,015	27.31	3,113	10.03	1228	3.96
228	133	1460	40,407	32.36	3,873	9.57	1694	4.19
229	135	1491	42,278	30.03	3,948	9.34	1831	4.28
246	140	1534	48,435	33.57	4,797	9.90	2012	4.15
252	116	1563	41,880	29.79	4,262	9.83	1703	4.07
270	125	1578	48,819	31.91	4,840	9.91	2059	4.22
287	165	1551	67,329	38.05	6,461	9.59	2971	4.41
298	140	1562	59,717	37.56	5,841	9.78	2537	5.25
300	86	1651	39,050	30.31	3,858	9.88	1582	4.04
315	104	1719	51,584	34.27	5,148	9.98	2126	4.12

This brief historical sketch highlights the positive role played by government intervention at various stages of the growth of the sugar industry during the last fifty years. However, periods of rapid growth created their own problems, which then required further government intervention to protect the interests of the sugar industry. To understand this, it is necessary to first grasp some of the other complications inherent in the structure of production and sale of sweeteners as a group.

Sugar-cane, in addition to being the key input for sugar production, is also required for the production of *gur* and *khandsari*. These are inferior substitutes for sugar and compete for the sugar-cane that would otherwise go to the sugar mills. The distribution of sugar-cane among its competing uses is governed by the relative prices of sugar and its inferior substitutes. When sugar prices increase, consumers shift in favour of *gur* and *khandsari* leading to an improvement in their capacity to draw a larger share of sugar-cane output. This phenomenon is known as "diversion".

The periods of rapid growth in sugar production, noted earlier, have been associated with surges in acreage under sugar-cane. Periods of rapid growth have typically glutted the markets for sweeteners, depressed prices and included reductions in supply of both sugar and sugar-cane, which, in turn, have engendered subsequent scarcities and higher prices leading to the next cycle of fluctuations.

Until the 1970s the bulk of sugar production was in the high-cost regions. Mills in these areas found it difficult to compete with low-cost areas on the one hand and the inferior sugar substitutes on the other. This led, in the mid-1960s, to the institution of *dual pricing* in sugar in order to avoid the collapse of the sugar industry in the high-cost regions and the associated political backlash. The present policy consists of various forms of controls on output, pricing and distribution of sugar (and sugar-cane). Around these controls have evolved various mechanisms of black income generation.

3. The Anatomy of Black Income Generation in Sugar

The major activities related to the production and sale of sugar are:

a. purchase of raw material, that is, sugar-cane;
b. extraction of sugar from sugar-cane, that is, manufacture of sugar; and
c. sale of sugar.

Each of these activities is subject to controls and regulations. There are different mechanisms for the generation of black incomes at each of these stages.

a. *Black incomes via purchase of raw material.* Sugar-cane, the principal input into production of sugar, constitutes roughly 70 per cent of the cost of production of sugar. The cultivation of sugar-cane is largely confined to small farmers and this makes possible the exercise of local monopsony power by the mills. This monopsony power has been somewhat curtailed by the emergence of unions of sugar-cane suppliers. However, it is reported that unions are often controlled by the mills themselves through the rich farmers and traders.

One of the mechanisms of black income generation relating to sugar-cane stems from the fixation of a minimum price that the mills are required to pay to the farmers. The other method which is prevalent is independent of any control or regulation, namely, through under- and over-weighment of sugar-cane.

A factory cannot show on its books a price lower than the State-advised minimum. Thus, under-payment is resorted to through intermediaries/agents of the management of the mills. The difference between the amount actually paid to the farmer and the minimum price is black or unreported income. Quite clearly, a farmer would be unwilling to accept a price that he could obtain from a *gur* or a *khandsari* producer in his area and this acts as a floor to the underpayment. Underpayment may be directly made by the mills on the pretext that the cane has dry matter, etc. This amounts to cheating the farmer but not necessarily to generation of black income since this mechanism would raise the profitability of the mill and taxes would have to be paid.

Under-weighment of sugar-cane may be resorted to at the point of its entry into the mill. The Excise Department is supposed to check the weighbridges and scales. However, this is only done periodically. The under-weighment would lead to an increase in the profitability of the factory, unless, a corresponding amount of the output is also not declared. Secondly, under-weighment may be accompanied by the issue of bogus receipts of supply of sugar-cane in the names of agents of the management. In either of these cases, black incomes would be generated. The use of bogus receipts in itself would amount to over-weighment since it would tend to artificially increase the amount of sugar-cane purchased.[4]

b. *Black incomes via manufacture of sugar.* The output of sugar is monitored by the Excise Department which levies duty on production and effectively regulates the monthly release of sugar into the markets. If a certain portion of the output escapes the excise net, not only does it not pay duty but the entire proceeds of this sale becomes the management's undeclared profit (and hence black income).

Here, the motivation is not just evasion of excise duty but a skimming-off of profits from the firm's (or the cooperative's) profit-and-loss account. The cost of manufacture of the undeclared output gets loaded on to that of the declared output. Thus, if output suppression is at all possible, the gains from it may result from factors other than the rate of excise duty. In these circumstances, it is the possibility of successful evasion which may be as important as the *rate* of duty for an explanation of underreporting of output.

Output suppression in the sugar industry could result from removal of sugar from the godowns without following proper procedures and without obtaining the requisite permits for moving sugar. Other things remaining the same, this would imply a lower recorded recovery percentage of sugar from sugar-cane. For the operation to be successful, various records at the intermediate stages of production, where the sugar content of juice is measured, would have to be doctored. This may be possible since all chemical analysis is done centrally in the laboratory. However, it may be easier to just show a lower weight of input material so that the recovery percentage does not have to be fudged at various stages of production. From the point of view of the management, under-weighment also has the advantage that it does not involve them in deceiving the factory; it is the farmer who loses.

At the output stage, various other raw materials are used and by-products generated. Compared to the value of sugarcane purchased and sugar produced, these are of minor significance. However, it is generally believed that black incomes are generaed in the case of sale and purchase of each of these items. Among the by-products, molasses are the most important. The sales of molasses are governed by permits and are apparently associated with generation of significant amounts of black income. Labour is the other major input into sugar production. Since the industry is of a seasonal nature, it involves employment of much temporary labour during the season. Reportedly, these labour contracts involve pay-offs as well. It has been suggested that 5-10 per cent of all contracts may be taken as the amount of unreported incomes generated through purchases of inputs and sales of by-products.

c. Black incomes via sales of sugor. Sugar is sold through the open market as well as through the public distribution system. The government obtains supplies for the public distbution system by imposing a levy on the mills. This sugar is sold at regulated prices which are generally lower than the free market prices. Thus, diversion of sugar from the public distribution system to the free market allows a (black) profit to be earned. Either the diversion may be outright, through the use of bogus ration cards or through substitution by inferior *khandsari.* No estimate for this has been attempted here since independent data on consumption cf sweeteners and for output of inferior substitutes were not available.

Black incomes are also generated through sales of sugar in the open market. These sales are through auctions but it appears that traders sometimes form rings to bid down prices. Usually, prices are fixed at the level prevailing in the nearby major market (say, Bombay, Delhi, etc.) less transport margin. However, this pattern makes little sense since the sugar may be moving in the direction opposite to the market from which prices may have been compared. For instance, if sugar is to move from Kolhapur to Kerala, there is very little sense in comparing the price with Bombay and allowing for transport margin for moving the goods to Bombay. Apparenly, cuts are obtained by the managements for sales to the traders' rings.

In the above discussion, some of the mechanisms of generation of black incomes depend not so much on any controls or regulations as on the possibility of getting away with business malpractices. Amongst the various ways of generating black incomes in sugar industry, suppression of output is likely to be the major one. In what follows, an attempt is made to estimate this for the period 1961-62 to 1980-81 and then to analyse the results in the context of controls and regulations to understand if any links exist between them and the generation of black incomes.

4. Estimating Suppression of Sugar Output: A Physical Input-Output Approach

In principle, output suppression may be estimated either directly or indirectly. Direct estimates would require the use of Excise Department data on the extent of evasion detected. Reliable evidence of this nature is unavailable. Hence one is obliged to use indirect approaches. The most promising indirect approach is to focus on a key input used in sugar production, observe the inter-temporal profile of the input-output ratio, estimate the input-output norm that ought to prevail in the light of objective, technical and economic factors, and attribute departures from this norm to output suppression.

The most obvious candidate for such an input-based approach is sugar-cane, with the sugar recovery percentage as the key ratio. However, as noted earlier, sugar-cane is not only an input for sugar production but also for the inferior substitutes *gur and khandsari*. Furthermore, a certain portion of sugar-cane is used for seed, for feed and chewing; there are no reliable estimates of these. Generally, a norm of 11 per cent is used to estimate sugar-cane used for seed, feed and chewing, while the amounts used for *gur* and *khandsari* production are estimated as a residual: In effect, no independent estimate of how much sugar-cane is used by sugar factories is available. Thus, the application of the observed recovery percentage to the factory-reported in put of sugar-cane will not reveal evasion.

Alternatively, if an independent estimate of the recovery percentage could be obtained, then, accepting factory records on sugar-cane input to be correct could yield alternative estimates of sugar output. Unfortunately, no standard recovery percentage can be credibly computed. This is because recovery percentages vary from factory to factory, season to season and month to month.

After a careful consideration of a variety of inputs, it was decided to focus on the use of energy as an input, especially electricity, for sugar production to estimate associated input-output norms, actual sugar output and, hence, the extent of of sugar suppression.

a. *The logic of the exercise.* In summary, the application of a physical input-output approach, based on energy use, to estimating the extent of sugar output suppression involves the following steps.

We first hypothesise that, in any given year, recorded electricity use per unit of recorded sugar output depends on a number of factors:

i. the technology of sugar production;
ii. the substitution of electrical for thermal energy in sugar production;
iii. the changes in machine energy requirements due to aging of plants;
i . the changes in recovery percentage of sugar from sugar-cane;
v. the duration of the sugar-cane crushing season;
vi. stoppages of plant and machinery;
vii. the suppression of figures for electricity consumption; and

vii. the suppression of sugar output.

We then proceed to systematically allow for the first seven factors and thus isolate the changes in recorded electricity consumption per unit of recorded sugar output, which are attributable to varying levels of suppression of sugar output. This, in turn, allows us to estimate the quantum of output suppression in each of the years of our sample period, 1961-62 to 1980-81.

In this section we present a summary account of our methodology and results. A much more detailed treatment is available in Appendix 3 to this report. We begin with a brief discussion of energy use in sugar production.

b. *Energy use in sugar production.* Energy is required for production and sugar is no exception. Energy is used for a variety of purposes and in a variety of forms. Thus, a small amount of man-supplied mechanical energy is used for controlling and directing operations. Energy is also used for transporting sugar-cane. However, our focus here is on the direct energy requirements of the machines for converting sugar-cane into sugar (this excludes losses incurred in transferring energy from one part of the factory to another).

Machine energy requirements can be met either through thermal or electrical energy. In the older sugar mills steam was produced by burning bagasse (thermal energy) and then used for driving crushers (creating motion, that is, mechanical energy) to obtain juice from sugar-cane. In the more modern mills the steam is first used to run turbines (mechanical energy), which then drive generators to produce electricity (electrical energy) and this is used to drive motors to drive the crushers (mechanical energy).

In both cases thermal energy, obtained by burning bagasse, is converted into mechanical energy to drive crushers. The intermediate conversion into electrical energy in the modern mills is dictated by efficiency gains to be reaped from using the steam to run a large turbine to generate electricity in bulk instead of using it to run a number of smaller turbines to drive the rollers of the crushers.

In all this, assuming that the crushing technology remains more or less unchanged, the total energy requirement of machines per unit of sugar output remains unchanged. What does happen is that the energy requirement of the machines is met, in the more modern mills, by a smaller proportion of energy input from outside the factory. In other words, energy carried by steam is more fully utilised and the purchases of energy from outside (in the form of coal, fuel oil and electricity) are correspondingly reduced.

Incidentally, electricity generated by the factories is sometimes also supplied to local townships for lighting. The data on this are separately available and can be subtracted from the total generation of electricity to obtain the figures for electricity consumption in the factory for the production of sugar.

We turn now to a discussion, seriatim, of the principal factors influencing the consumption of electricity per unit of sugar output, which were listed on an earlier page. Electricity consumption and output of sugar are presented in Figure VI.1.

c. *Technological change in the sugar industry.* Our working assumption is that, measured in terms of machine energy requirements per unit of sugar output, technical change in the sugar industry in India in the period 1961-62 to 1980-81 was negligible. The basis for this assumption is as follows.

Table 6.2.1 indicates that the number of factories operating changed little between 1935-36 and 1956-57. However, in this period, installed capacity per factory increased considerably, from 644 tons per day (tpd) in 1935-36 to 1016 tpd in 1956-57[5]. This increase resulted mainly from increases in plant sizes through addition of machinery. As Bagchi (1975) points out, most of the plant and machinery put in place during this period was imported.

During the 1950s, when manufacture of indigenous machinery was taken up, the Government asked the manufacturers to standardise plant size at 1,000 tpd. This was subsequently raised to 1, 250 tpd. As a consequence, if we examine the plant sizes of new factories commissioned during 1955-56 to 1980-81, we find that up until 1964-65 plant sizes varied between 813 tpd and 1270 tpd[6]. After 1964-65 an overwhelming majority of plants were scaled at 1250 tpd. Furthermore,

Figure 6.1

Electricity Consumption and Output

Scale :

X axis: 10 divisions = 1 Year

Y axis :

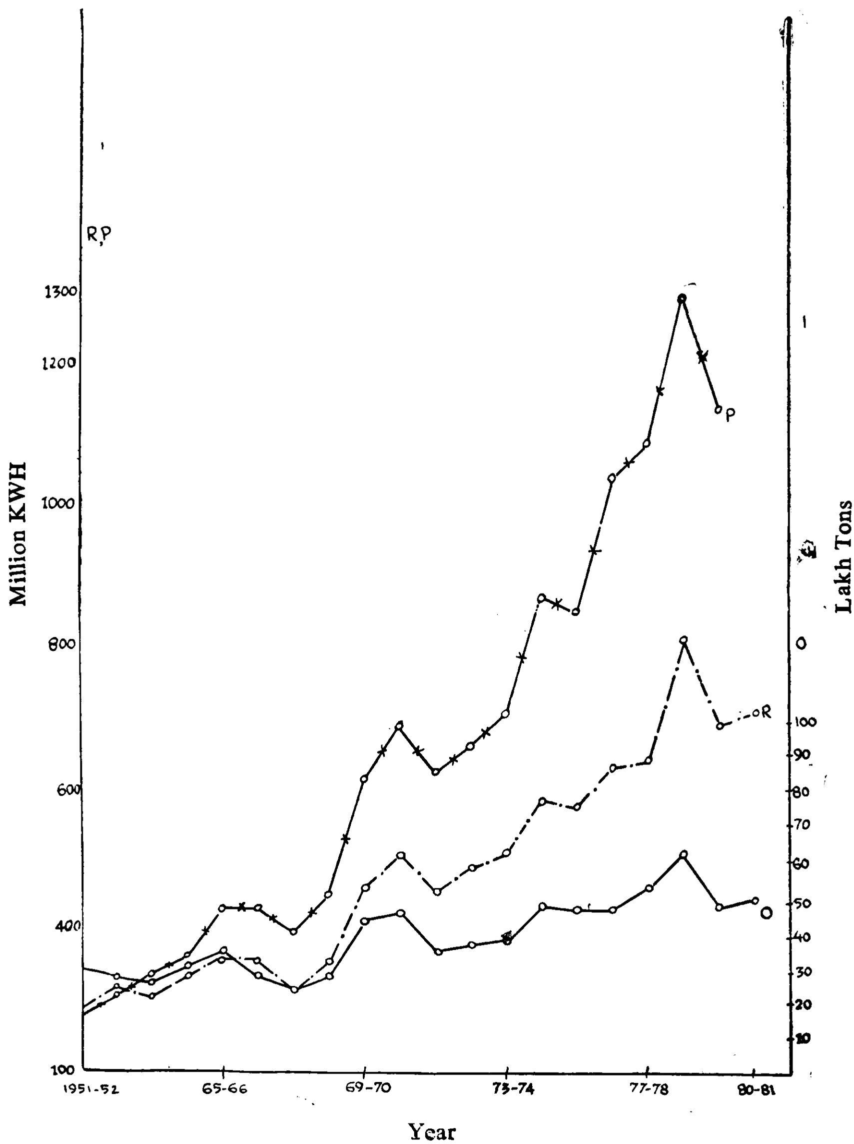
(a) 1 division = 5 million Kwh

(b) 1 division = 1 lakh tons

P—Total electricity consumption by Industry (adjusted for non-reporting). Given as x

R—Total electricity consumption adjusted for substituted Given as—. —

O—Output of Sugar. Given as o-e



many smaller size, older plants were modernised by adding machinery and upgraded to 1,250 tpd capacity. In addition, many factories of larger size were set up by erection of plants in multiples of 1,250 tpd capacity. Thns, for the period under consideration, plant size was largely standardised.

It could be argued that even if plant size remained largely unchanged, machinery of different makes and varying efficiencies might have been involved. Thus we have to look at the relative efficiency of plants of different brands. An analysis of the data suggests that machines of different makes gave roughly the same efficiency of extraction[7].

Hence we can deem technology to have remained approximately invariant during the period in question, not only because plant sizes were largely standardised, but also because the efficiency of plants of different makes were more or less the same. With this meaning of a stable technology in the sugar industry, we can now discuss the other factors that influence electricity consumption per unit of sugar output[8].

d. *Substitution of electricity for thermal energy.* We argued above that technology has remained stable as indicated by machine energy requirements per unit of sugar output. But the period 1961-62 to 1980-81 witnessed substantial *substitution* of electricity for thermal energy in sugar production. This occurred because the newer plants found it profitable to convert the thermal energy associated with steam from bagasse burning into electricity before driving the sugar-cane crushers. Thus, the series for (recorded) electricity consumption per unit of (recorded) output of sugar shows an increasing trend and so does the series for installed generation capacity per unit of installed sugar-cane crushing capacity (see Table 6.4.1).

If, as we have argued, the machine requirement of energy per unit of sugar output has remained constant, and electricity consumption per unit of sugar output has increased as a result of substitution, then (other things being equal), subtraction of the increased consumption of electricity (*on account of substitution*) from the total consumption of electricity should yield a constant figure for the remaining consumption of electricity per unit of sugar output. The

TABLE 6·4.1.

Corrected Electricity Consumption per Unit of Output

Year	Total number of factories reporting	Total installed capacity (KW)	Number of factories working in the year	Proportionate installed generating capacity (KW)	Installed super-cane crushing capacity (tons/day)
(1)	(2)	(3)	(4)	(5)	(6)
1960-61	—	—	—	—	203926
1961-62	99	70134	160	163687	205920
1962-63	98	80080	186	169070	214086
1963-64	95	99311	194	202803	229690
1964-65	100	102229	198	202413	238392
1965-66	109	119104	200	238208	250600
1966-67	141	166723	200	236557	245800
1967-68	134	172145	200	256733	254600
1968-69	136	183345	205	276322	270600
1969-70	140	195298	213	299922	286595
1970-71	140	201511	215	320213	299710
1971-72	136	215531	220	344078	316140
1972-73	145	224202	228	352538	332680
1973-74	143	236027	229	377973	341457
1974-75	149	270213	246	446123	377364
1975-76	163	300636	252	465087	393876
1976-77	178	364640	270	553106	426060
1977-78	209	435254	287	597693	445237
1978-79	274	425863	298	593998	465476
1979-80	216	470518	200	653497	495300
1980-81	227	496314	318	688718	541485

Source: 1. Columns (4), from Table 6..2.1.

2. Column (5), calculated using columns (2), (3) and (4); col. (5) $= \frac{\text{col. 4}}{\text{col. 2}} \times \text{Col. (3)}$

3. Column (6), calculated from Table 6. 2.1.

4. Column (11), from Central Excise and Customs, Directorate of Statistics, and Intelligence, *Statistical Year Book* Central Excise, Vol. 1, Various issues from 1970–71 to 1980-81.

5. Column (2), (3) & (9), from Public Electricity Supply, All India, State General Review for Relevant Years.

Ig (col. 5. /col. 6.)	Index of Ig 1961-62 = 100)	Total electricity consump-tion in industry (P_1) (million (KWH)	P_1/I_g–P col.2 ÷ col. 3) million (KWH)	Output in the fiscal year (O) (lakh tons)	P/o col 10÷ col. 11.
(7)	(8)	(9)	(10)	(11)	(12)
—	—	—	—	—	--
0.7059	1.000	287.960	287.96	28.36	10.157
0.7897	0.992	312.285	314.74	25-67	12.261
0.8822	1.108	339.267	306.19	25.05	12.223
0.8491	1.064	360.174	337.55	29.00	11.640
0.9506	1.194	430.632	360.63	33.99	10.611
0.9624	1.209	428.350	354.25	27.43	12.918
1.0092	1.268	395.035	311.64	22.40	13.908
1.0211	1.283	459.700	350.30	27.19	13.170
1.0465	1.318	612.440	465.73	40.31	11.501
1.0684	1.342	679.890	806.62	45.23	11.201
1.0884	1.367	623.423	456.08	34.41	13.283
1.0591	1.331	660.832	496.49	36.68	13.536
1.1078	13.91	706.760	508.07	37.36	13.603
1.1822	1.486	866.163	583.27	47.26	12.337
1.1808	1.454	849.851	572.67	46.32	12.337
1.2982	1.631	1042.602	639.26	46.67	13.697
1.3427	1.687	1091.247	646.98	51.80	12.487
1.276i	1.603	1299.458	810.64	62.31	13.010
1.3194	1.658	1144.417	690.23	47.06	14.606
1.2719	1.598	1131.738	708.22	49.73	14.241

subtraction of the substitution-related electricity consumption is done in the calculations shown in Table 6.4.1, on the assumption that this amount is proportional to the increased installed electricity generation per unit of installed sugar-cane crushing capacity. In other words, if the figures are deflated by the index (I_g) of the ratio of installed generating capacity in the industry to the installed sugar-cane crushing capacity in the industry, then the resulting, "modified" series for electricity consumption per unit of output ought to be constant, provided other things remained unchanged.

Other things, of course, changed during this period. And we turn now to gauging and "netting out" the influence of other factors on electricity consumption per unit of output.

e. *The influence of aging of sugar plants,* The average age of sugar machinery is a factor that can affect the efficiency of plants. As machinery ages, and in spite of maintenance, efficiency usually declines as a result of wear and tear, cumulative small changes in tolerances and increased breakdowns. In sugar this would be reflected in increased consumption of machine energy per unit of output. Table 6.4.2 gives the data on the number of factories in operation and their averaae installed crushing capacity per day in each of the years. Thus we know how much new crushing capacity was brought into operation each year. We noted earlier that there was an upsurge in the number of sugar factories in the period 1930-31 to 1934-35. From this we deduce that in 1950-51 the average age of sugar plants was about 17 years. In each succeeding year the new crushing capacitv added is taken to be one year old, while the average age of the already existing crushing capacity is advanced by a year. A weighted average of the age of the crushing capacity is presented in Table 6.4.2 both in absolute terms as well as in index-form (I_A).

f. *Recovery of sugar from sugar-cane.* The sugar content of sugar-cane varies for a number of reasons including different varieties of cane and weather conditions. If there is more sugar content in the juice extracted from cane, then with the same expenditure of energy more sugar would be recovered—other things equal. In other words, energy consumption per unit of sugar output would be lower. The data

TABLE 6.4.2

Age Profile of Sugar Mills Crushing Capacity

Fiscal year	Number of factories in operation	Average capacity (tons per day)	Total crushing capacity (per day) col. 2 × col. 3)	Age profile (years)	Age index I_A (1960-61 = 1.0)
(1)	(2)	(3)	(4)	(5)	(6)
1950-51	139	873	121347	17.00	—
1951-52	140	938	131320	16.70	—
1952-53	134	952	127568	17.67	—
1953-54	134	926	124084	18.63	—
1954-55	136	958	130288	18.69	—
1955-56	143	980	140140	18.19	—
1956-57	147	1016	149352	17.91	—
1957-58	158	1040	164320	17.11	—
1958-59	164	1082	177448	15.74	—
1959 60	168	1131	190008	15.63	—
1960-61	174	1172	20 928	15.53	1.000
1961-62	180	1144	205920	16-37	1.054
1962-63	186	1151	214086	16.71	1.076
1963-64	194	1185	229890	16.54	1.065
1964-65	198	1204	238392	16.87	1.086
1965-66	200	1253	250600	17.02	1.096
1966-67	200	1229	245800	18.19	1.171
1967-68	200	1273	254600	18.46	1.189
1868-69	205	1320	270600	18.35	1.182
1969-70	215	1333	286595	18.25	1.175
1970-71	215	1394	299710	18.33	1.180
1971-72	220	1437	316140	18.23	1.174
1972-73	228	1460	332880	18.13	1.167
1973-74	229	1491	341439	18.67	1.202
1974-75	246	1634	377364	17.89	1.152
1975-76	252	1563	393876	18.14	1.168
1976-77	270	1578	426060	17 77	1.144
1977-78	287	1551	445137	18.01	1.160
1978-79	298	1562	465476	18.22	1.173
1979-80	300	1651	495300	18.12	1.167
1980-81	315	1719	541485	17.57	1.131

Source: 1. Columns (2) and (3), refer to Table 6.2.
2. Column (5), calculated as per the text.

on recovery percentages is given in Table 6.2.1 From this we derived an index of recovery percentage (I_r).

g. *Duration of the sugar-cane crushing season.* The duration of the crushing season of sugar industry also influences energy consumption. These data also appear in Table 6.2.1. However, the data refer to the standardised day of 22 hours and not to the actual number of days for which the factories operated. For this, data were collected on the All India average hours lost as a percentage of total hours available (see Table 6.4.3). The data from Table 6.2.1 on the average number of days of factory operations were corrected by the figures for percentage hours lost to obtain the average uumber of days of actual factory running during the year, Given that the sugar industry has a seasonal character, plant and machinery is designed for a certain optimum number of days of operations. If the plant is run for either a shorter or a longer duration than the optimum, then the energy consumption per unit of output is likely to increase. In the former case, this would be the result of (a) overheads being spread over a smaller amount of output, and (b) factory operation over the coldest parts of the crushing season. In the latter case, the reason would be overloading of plants and the consequent higher wear and tear of machinery which would cumulatively add up during the later part of the season to cause larger numbers of plant breakdowns. Such breakdown are distinct from any stoppages due either to shortage of raw material or breakdown on account of the age of machinery.

If an index of the actual number of days of factory operations (I_N) is constructed, then energy consumption per unit of output would be minimum at the I_N corresponding to the optimum. This has been taken to be the average number of days of factory running (162.5 days) in the period 1960-61 to 1980-81 and normalised at unity. Then energy consumption per unit of output may be taken to be an increasing function of $(1 + I_N - 1)$. This is given in Table 6.4.3.

h. *Stoppages of machinery and plant.* The hours lost as a percentage of hours available (in index form, I_h) would be

TABLE 6.4.3

Number of days of Factory Running Corrected for Hours Lost—Converted to Fiscal Year

Year	Sugar year number of days of effective running	Per cent hours lost in sugar year	Corrected for hours lost (actual days	Days of running upto March 31	Extra after March 31 (Col. 4 – col 5)	Fiscal year days of operations (N)	Index of In col. 5) (	1÷/ $I_4-1/$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1960-61	166	—	—	135	—	—	—	—
1961-62	148	17.20*	178	135	43	—	—	—
1962-63	106	16.70	I27	127	0	170	1.049	1.049
1963-64	122	16.67	146	135	11	135	0.833	1.167
1964-65	153	17.39	185	135	50	146	0.901	1.099
1965-66	159	15.89	189	135	54	185	1.242	1.142
1966-67	96	20.00	120	120	0	174	1.074	1.074
1967-68	97	24.10	128	128	0	128	0.790	1.210
1968-69	152	19.00	188	135	53	135	0·833	1.167
1969-70	174	17.18	210	135	75	188	1.160	1.160
1970-71	139	18.20	170	135	35	210	1.296	1.296
1971-72	107	18.90	132	132	0	167	1.031	1,031
1972-73	133	17.80	162	135	27	135	0.833	1.167
1973-74	135	17.80	164	135	29	162	1.000	1.000
1974-75	140	17.20	169	135	34	164	1.012	1.012
1975-76	116	17.00	148	135	5	169	1.043	1.043
1976-77	125	17.60	152	135	17	140	0.864	1.136
1977-78	165	19.30	204	135	69	152	0.944	1 056
1978-79	140	21.00	177	135	42	204	1.259	1.259
1979-80	86	36.75	136	135	1	177	1.093	1.093
1980-81	104	28.71	146	135	11	136	0.840	1.160

Notes: * Approximate

Source: 1. Column (2), from Table 6. 2.1
2. Column (3), Indian Sugar Mills Association, *India Sugar Year Book*. Various Issues.
3. Column (4), calculated using Columns (2) and (3).
4. Column (5), as in the text.
5. Column (7), calculated by using column (6) and column (5) [col. 7 = (6) for year t + col. (5) for year (t +1)].
6. Column (10), refers to Table 6.2.1.
7. Columns (11) and (12) are calculated using columns (5), (6), and column (10).
8. Column (13), calculated using columns (5), (6), (11) and (12).
9. Column (15), calculated using columns (3), (5) and (6).
10. Column (17), refer Table 6. 2.1

Recovery per cent in sugar year	Recovery per cent upto March 31 (X)	Recovery per cent after March 31 (.9X)	Fiscal year recovery per cent	Index of recovery per cent $[(I_r)_{sin} = I_r]$	Per cent hours lost in fiscal year	Index of hours lost in fiscal year in 16.3 % In=1.000	IA In fiscal year
(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
9.74	—	—	—	—	—	—	—
9.76	10.00	9.00	—	—	—	—	—
10.28	10.28	0.00	9.96	1.061	16.78	1.029	1.029
10.01	10.09	9.08	10.09	1.075	16.67	1.023	1.023
9.66	9.93	8.94	9.87	1.051	17.34	1.064	1.063
9.70	9.99	8.99	9.71	1.033	16.30	1.000	1.000
9.94	9.94	0.00	9.65	1.026	18.72	1.148	1.148
9.92	9.92	0.00	9.92	1.056	24.10	1.479	1.479
9.57	9.85	8.86	9.85	1.049	19.00	1.166	1.166
9.56	9.91	8.92	9.61	1.023	17.64	1.082	1.052
9.84	10.05	9.04	9.65	1.028	17.81	1.093	1.093
10.03	10.03	0.00	9.82	1.046	18.75	1.150	1.150
9.57	9.73	8.76	9.73	1.036	17.80	1.092	1.092
9.34	9.51	8.56	9.39	1.000	17.80	1.092	1.092
9.94	10.10	4.13	9.86	1.050	17.31	1.062	1.062
9.83	9.87	1.88	9.72	1.035	17.04	1.045	1.045
9.91	10.02	9.02	9.98	1.063	17.58	1.079	1.079
9.59	9.93	8.93	9.63	1.047	19.11	1.172	1.172
9.78	10.02	9.02	9.65	1.028	20.43	1.253	1.253
9.88	9.89	8.90	9.68	1.031	33:01	2.025	2.025
9.98	10.08	9.05	10.05	1.070	28.77	1.765	1.765

another factor affecting input of energy per unit of output. The reason is that most new plants have teething troubles and have to stop for reasons other than wear and tear. Further, plant may also be stopped due to shortages of raw materials. Each stoppage implies loss of heat because boilers and generators have to be maintained at a minimum level of functioning and other machinery has to be allowed to cool or to stop for repairs, etc. Stoppages may lead to loss of material in process or may require extra expenditure of energy to maintain the temperatures in different parts of the plant. Lastly, energy is also required to heat the plants back to optimum temperatures before starting the process after a stoppage. In all these cases, the energy consumption per unit of output would go up.

i. *Doctoring of data on electricity consumption.* Earlier in this chapter we listed eight factors which influence the reported electricity consumption per unit of recorded sugar output. The six factors discussed thus far have been of a technical nature, while the remaining two depend on manipulations, if any, resorted to by the industry.

Electricity consumption in sugar production is the sum of own generation by the industry and purchases from the State Electricity Board. In either case, if purchases/uses are suppressed, then it would have to be done systematically by adjusting the relevant counters and meters. In neither case is such doctoring likely to be seasonally adjusted. So, it would simply that in both cases estimates of sugar output suppresion based on recorded electricity consumption would be biased downward.

However, the doctoring of electricty consumption data is unlikely to be widespread for two reasons. First, the value of electricity purchased from the State Electricty Boards is a tiny fraction of the total value of inputs into sugar production. Data from the 1973-74 *Annual Survey of Industries* suggest that such purchases amounted to less than 0.1 per cent of the average value of output per factory. Thus the monetary gain to owners and managers from doctoring the meters in connivance with ultility officials appears to be too small to be worth the risk. Second, most of the industry's electricity needs are met from self generation. Since this is a by-product, no valuation or payment is required. Thus, suppression of these figures leads to no direct monetary gain.

It might be argued that from 1978-79 an electricity generation duty was imposed by the Centre (on behalf of State Governments) and this could have induced tampering with the electricity data. But, in most cases, this duty amounted to a few thousand rupees per factory and was not a credible reason for doctoring electricity consumption.

Finally, we could entertain a collusive theory of deliberately doctoring electricity consumption figures to show an unchanged input-output relationship. However, in the absence of well-established and recongnised electricity input norms for the industry, the trouble of suppressing electricity consumption, in a manner which is systematically related to sugar output suppression, seems to be hardly worth the effort.

So, we assume that the our electricity consumption data are not doctored by the industry.

j. *Suppression of sugar output.* Finally, if there is evasion of output, then the consumption of energy per unit of *reported* output would be higher. There is no direct evidence on this. Indeed, the purpose of this entire exercise is to estimate such evasion. We hypothesise that each of the technical factors (discussed above) affecting the machine energy consumption per unit of sugar output is largely independent of each other. Fvrther, the extent of sugar output suppression is unlikely to depend on these technical factors. Instead, it is likely to be governed by prices, profitability, ease of evasion and so forth. Thus, evasion is unlikely to depend on the variables I_A, I_r, I_h, and I_N. So, if the relationship of these factors with electricity consumption (corrected for substitution of thermal energy) per unit of output, P/O, is estimated, then, by hypothesis, fluctuations in P/O may be attributed to output suppression.

k. *The model : a summary*[9]. As discussed in previous sub-sections, the machine requirement of energy (E) for sugar production (O) can be split up into two components, thermal (T) and electrical (P). Recall that I_A is the index of average age of plants, I_r is the average recovery percentage, I_N is the index number of days of factory operation and I_h is the index of hours lost as a percentage of hours available. On the basis of our earlier discussion we can then write

$$E = F(O, I_N, I_r, I_N, I_h) \quad \ldots\ldots\ldots\ldots \quad (6.1)$$

and

$$E = T + P. \quad \ldots\ldots\ldots\ldots \quad (6.2)$$

For simplicity, we choose a multiplicative form of the function F, so that

$$E = C.0\ \alpha^1.\ I_A\ \alpha^2.I_r\ \alpha^3.\ (+\ /I_N - 1/)\ \alpha^4.I_h\alpha\ 5 \ \ldots\ldots \quad (6.3)$$

where C is a constant term.

Now, our assumption that sugar production technology is constant implies that $\alpha_1 = 1$.

And holding other variables constant, we obtain

$$\frac{\partial E}{\partial O} = \frac{\partial (T + P)}{\partial \quad O} = \text{constant} \quad \ldots\ldots\ldots \quad (6.4)$$

Furthermore, it is shown in Appendix 3 that under these assumptions,

$$\frac{P}{O} = \frac{(\bar{P})}{\bar{O}} \cdot I_g, \quad \ldots\ldots\ldots \quad (6.5)$$

where $\left(\frac{\bar{P}}{\bar{O}}\right)$ is electricity consumption per unit of sugar output in the base year (taken as 1961-62) and I_g is the index of g, with $I_g = 1$ in the base year and with g defined as;

$$g = \frac{\text{installed electricity generation capacity in the industry}}{\text{installed sugar-cane crushing capacity in the industry}} \quad \ldots \quad (6.6)$$

Using (6.2), (6.4) and (6.5) we can show that,

$$E \ \alpha \ \frac{P}{I_g} \quad \ldots\ldots\ldots\ldots \quad (6.7)$$

Now, allowing the other factors in (6.3) to vary, and combining (6.3) and (6.7), we get:

$$\frac{P}{(0.I_g)} = C'\ .I_A^{\alpha 2}\ .I_r^{\alpha 3}\ .\ (1 + /\ I_N\ - 1/\ )^{\alpha\ 4}.\ I_h^{\alpha^5} \ \ldots\ldots \quad (6.8)$$

where C' is a new constant term.

Now let us define,

$$P_c = P/\left(I_g.\ I_A^{\alpha 2}.\ I_r^{\alpha 3}.\ (1 + /I_N - 1/)^{\alpha 4}\ I_h^{\alpha 5}\right) \quad \ldots\ldots \quad (6.9)$$

and

$$O = O_e + O_d \quad \ldots\ldots\ldots\ldots \quad (6.10)$$

where $O_e + O_d$ is evaded (or suppressed) output and O_d is declared output.

Then, we can show (as we do in Appendix 3) that

$$\frac{P_c}{O_d} = (1 + \frac{O_e}{O_d}) \left(\frac{P_c}{O_d}\right)_O \quad \ldots\ldots\ldots \quad (6.11)$$

where $\left(\frac{P_c}{O_d}\right)_o$ gives the value of the ratio when O_e is zero, that is, when there is no evasion.

Now O_d is known and P_c can be estimated. If a graph of $\frac{P_c}{O_d}$ is plotted against time, then equation (6.11) can be used to calculate evasion. The ratio $\left(\frac{P_c}{O_d}\right)_o$ can be used as a first approximation. This would bias downwards the results obtained for output evasion in other years.

1. *Estimation of evaded output*[1]. We noted above that, with certain assumptions, the ratio $\frac{P_c}{O_d}$ can be examined to deduce the extent of output suppression in each year in our sample period. Estimation of the annual values of P_c requires knowledge of the α_i parameters. To estimate the α_i an ordinary least squares regression was run on the logarithmic form of equation (6.7), with the approximation involved in using O_d in place of O, the latter being unobservable. It yielded the following results:

$$\log\left(\frac{P}{I_g\ O_d}\right) = 2.42 + \underset{(1.43)^{*}}{0.67}\log I_A - \underset{(-0.32)}{0.37}\log I_r$$

$$- \underset{(-2.23)^{**}}{0.28}\log(1 + /I_N - 1/) + \underset{(3.72)^{***}}{0.25}\log I_h, \quad \ldots\ldots \quad (6.11$$

where t – statistics are indicated in parentheses below the coefficients[10] and

$$\bar{R}^2 = 0.68;\ F = 10.43;\ DW = 1.77.$$

The regression coefficients (the α_i s) have the expected signs and are also significant. except for that of I_r. The estimates of α_i from equation (6 11) were substituted in equation (6.8), together with the observed values of the other variables to yield an estimated time series for P_c. Knowing the annual values of O_d and P_c, and hence the ratio $\frac{P_c}{O_d}$ for each year, the percentage of sugar output suppression was calculated for each year along the lines indicated in the preceding sub-section. The results are shown in Table 6.4.4 and Figure 6.2.

The estimates of output evasion obtained by the above method relate to evasion during the financial year. Each financial year spans two "sugar years" and the factors which may cause or influence evasion—such as, prices, the market situation, government policy and so forth—usually vary with sugar years. So, the estimates of evasion by financial year were converted to estimates of evasion by sugar years by allocating the number of days of operation of factories over the different financial years and by assuming uniform rates of output suppression over the year. The results are shown in Table 6.4.4. This conversion was also necessary to test whether evasion of output was resorted to by underreporting of sugar-cane crushed or by suppression of the recovery percentage.

m. *Interpretation of the results.* As noted earlier, evasion of sugar output may be associated either with reporting the correct amount of sugar-cane purchased for crushing and suppressing the recovery percentage, or by underreporting the amount of sugar-cane purchased and leaving unchanged the figure for recovery percentage, or a combination of the two. We indicated earlier that under Excise Department rules, various registers have to be maintained at different stages of production for checking the recovery percentages. Thus, distortion of the data may involve active collusion with a number of people. For underreporting of sugar-cane, only the point of its weighment if crucial.

To investigate this issue, the implications of output evasion for underreporting of sugar-cane was compared with capacity utilisation data for industry.[11] Table 6.4.5 and Figure 6.3 show that in almost all cases the evasion-implied

TABLE 6.4.4

Conversion of Evasion of Output from Fiscal Year to Sugar Year

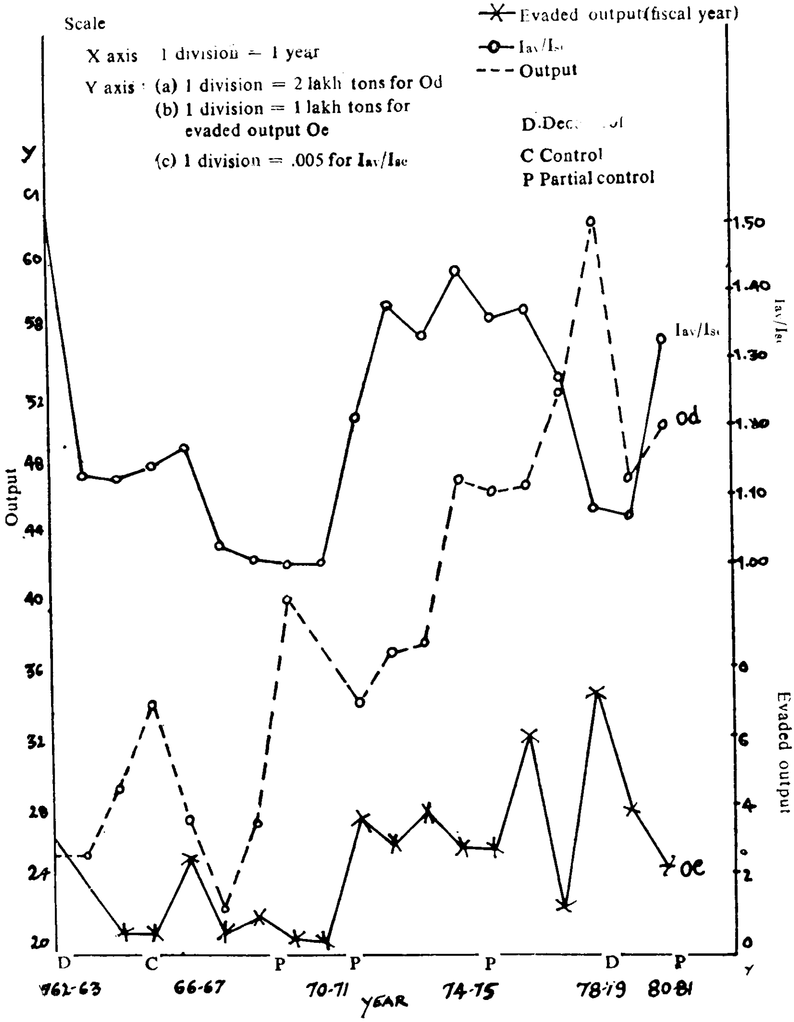
Year	Fiscal year output (lakh tones)	Sugar year output (lakh tons)	Evasion in fisical year (lakh tons)	Number of days of running in fiscal year
(1)	(2)	(3)	(4)	(5)
1961-62	28.35	27.29	—	--
1962-63	25.67	21.39	3.23	170
1963-64	25.05	25.73	1.63	135
1964-65	29.00	32.22	0.17	146
1965-66	33.99	35.41	0.24	185
1966-67	27.43	21.51	2.36	174
1967-68	22.40	22.48	0.16	128
1968-69	27.19	35.59	0.76	135
1969-70	40.31	42.62	0.12	188
1970-71	45.23	37.40	0.00	210
1971-72	34.41	31.13	3.65	167
1972-73	36.68	38.73	2.90	135
1973-74	37.35	39.48	3.85	162
1974-75	47.28	47.97	2.79	164
1975-76	46.42	42.62	2.65	169
1976-77	45.67	48.40	6.07	140
1977-78	51.90	64.61	1.04	152
1978-79	62.31	58.41	7.35	204
1979-80	47.00	38.58	3.90	177
1980-81	49.73	51.48	2.19	136

Source : Column (2), refer to Table 6.4.1.
Column (3), refer to Table 6.2.1.
Column (4), calculated from the regression analysis mentioned in the text.
Column (5), refer to Table 6.4.2.
Columns (7), (8) and (9), refer to Table 6.4.3.
Column (10), calculated using columns (6), (8) and (9).

Evasion per day (col. 4 ÷ col. 5 lakh tons)	Days of running sugar year	Days upto March 31	Days after March 31	Evasion in the sugar year (lakh tons)	Percentage evasion in the sugar year (col. 10 as per-cent of col. 3)
(6)	(7)	(8)	(9)	(10)	(11)
—	178	135	43	—	—
0.019	127	127	0	2.413	11.28
0.012	146	135	11	1.631	6.34
0.001	185	135	50	0.185	0.57
0.001	189	135	54	0.891	2.52
0.014	120	120	0	1.680	7.81
0.001	128	128	0	0.128	0.57
0.006	188	135	53	0.863	2.42
0.001	210	135	75	0.135	0.32
0.000	170	135	35	0.770	2.06
0.022	132	132	0	2.904	9.33
0.021	162	135	27	3.483	8.99
0-024	164	135	29	3.733	9.46
0.017	169	135	34	2.839	5.92
0.016	140	135	5	2.375	5.57
0.043	152	135	17	5.924	12.24
0.007	204	135	69	3.429	5.31
0.036	177	135	42	5.784	9.90
0.022	136	135	1	2.986	7.74
0.016	146	138	11	—	—

Figure VI.2

Evasion : Relationship with Other Variables



underreporting of cane purchased was less than or equal to the unutilised capacity in that year. Thus, only in a few years of unusually high output evasion is it necessary to invoke suppression of the sugar recovery percentage. Then too, the suppression of this ratio is never more than five per cent in the period considered.

We turn now to a heuristic exploration of some of the factors that might explain the time-profile of sugar output evasion estimated by our method.[12] Figure 6.2 plots against time (financial years) the following variables: evaded sugar output (O_E), declared sugar output (O_d) and the ratio of indices of average sugar prices (Iav/Iac). Further, segmentation of the horizontal axis indicates, broadly, different phases of government control over marketing and prices of sugar.

Inspection of Figure 6.2 yields some tentative judgements. First, there does not appear to be any clear-cut relationship between the extent of control and the degree of output evasion. Second, with the conspicuous exception of 1978-79, evasion seems to be lower in periods of rapidly rising sugar output. Third, until 1977-78, the time-path of evasion appears to display a trend similar to that of (Iav/Iac). The latter roughly indicates mark-up on prime costs and can be viewed as a rough index of profitability. A possible interpretation of this result can be that when profitability increases, the industry is induced to skim off profits through output suppression. But this relationship breaks down completely after 1977-78. Fourth, the evasion results in Table 6.4.4 indicate that the average percentage of output suppression seems to be significantly higher in the 1970s, averaging nearly 8 per cent of the declared output, than in the 1960s, when it averaged at about 4 per cent. But this observation must be qualified by the presence of a higher amplitude of fluctuations in the degree of evasion in the 1970s as compared to the earlier decade.

Finally, we should emphasise that given the complex and indirect methodology we adopted to estimate sugar output suppression and the attendant range of uncertainty regarding the results, we thought it best to eschew more "rigorous" multivariate approaches to explaining the time-profile of evasion.

Figure 6.3

Evasion of Output and Implication for Recovery Percentage and Cane Underreportion

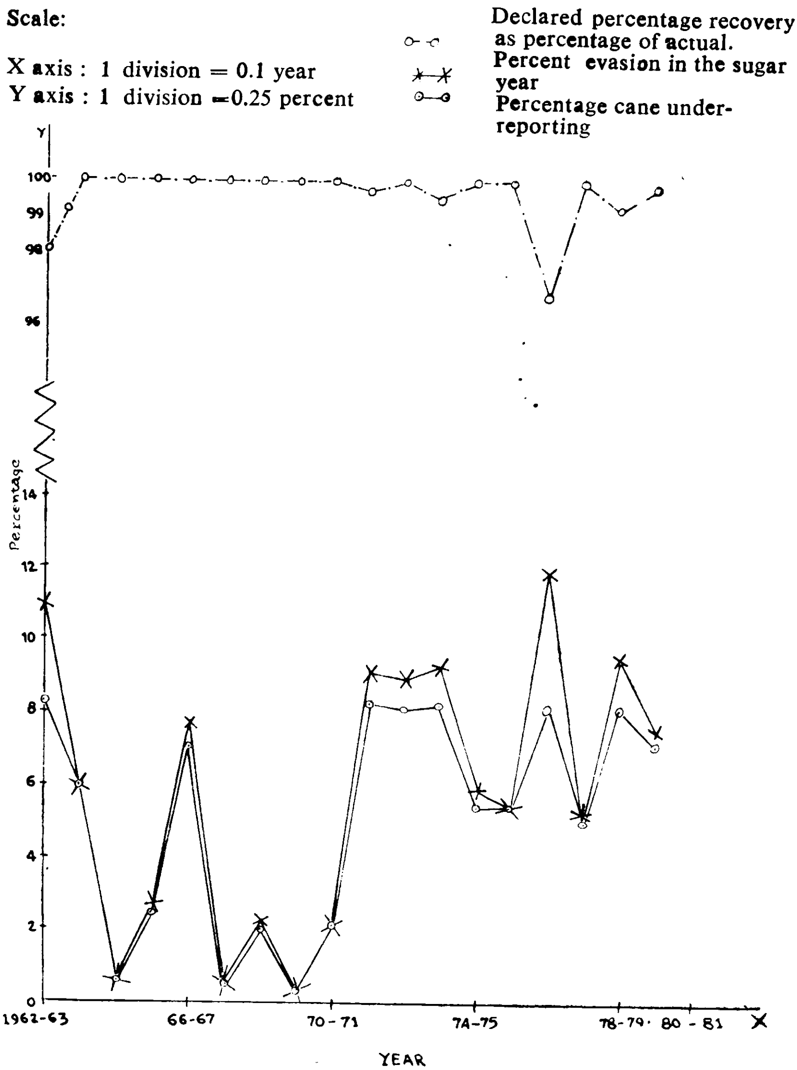


TABLE 6.4.5

Evasion: Implication For Underreporting of Sugar-cane Crushed and Percentage Recovery (Partitioning)

Year	Available crushing capacity (lakh tons)	Actual sugar-cane crushing (lakh tons)	Additional capacity available (col.2 – col.3) (lakh tons)	Additional sugar-cane implied by evasion (lakh tons)	Additional sugar production explained by under-reporting of cane crushed (lakh tons)
(1)	(2)	(3)	(4)	(5)	(6)
1961-62	304.76	279.46	25.30	—	—
1962-63	226.93	207.99	18.94	23.46	1.95
1963-64	260.47	257.16	23.31	16.30	1.63
1964-65	364.74	334.54	30.20	1.91	0.18
1965-66	398.45	365.12	33.33	9.20	0.89
1966-67	235.97	216.37	19.60	16.90	1.68
1967-68	240.96	226.38	20.58	1.29	0.13
1968-69	411.31	376.99	34.32	9.12	0.86
1969-70	498.68	457.01	41.67	1.46	0.14
1970-71	416.60	382.05	34.55	7.87	0.77
1971-72	338.27	310.15	28.12	28.94	2.82
1972-73	412.73	404.07	38.66	36.33	3.48
1973-74	460.94	422.78	38.16	39.99	3.54
1974-75	526.31	484.35	43.96	28.67	2.85
1975-76	456.50	418.80	38.10	23.33	2.29
1976-77	532.50	488.19	43.39	59.75	4.30
1977-78	734.48	673.29	61.19	35.75	3.43
1978-79	651.57	597·17	54.50	59.12	5.33
1979-80	425.96	390.50	35.46	30.22	2.99
1980-81	563.14	515.84	—	—	—

Note :* $\frac{42.62}{418.80} = 1018$

In the source (Table 6.2.1) the figure is given at 9.83% However, the output of sugar is given as 42.62 lakh tons and sugarcane crushed as 418.8 lakh tons. The recovery percentage has correspondingly been changed to 10. 18. It may be noted that the figures have been cross-checked with those in other tables as well.

Source: 1. Col. (2), calculated using Table 6. 4.2 for crushing capacity per day and Table 2.1 for average number of days of operation of factories.

Reported percentage of sugar recovery	Actual sugar-cane crushed implied by reported + undereported cane [col.3+ or = (col 4, col.5)] (lakh tons)	Actual sugar output (lakh tons)	Actual percentage recovery (col.9 as % of col.8	percentage sugar cane under-reported (col.4) $\frac{col.5}{col.2} \times 100$	Declared percentage recovery as percentage of actual (col.7 as% of col.10)
(7)	(8)	(9)	(10)	(11)	(12)
9.76	—	—	—	—	—
10.29	226.93	23.803	10.41	8.38	98.00
10.01	273.46	27.361	10.04	5.96	100.00
9.63	336.45	32.405	9.63	0.57	100.00
9.70	374.32	36.301	9.70	2 46	100.00
9.94	233.27	23.190	9.94	7.25	100.00
9.92	227.67	22.608	9.93	0.57	100.00
9.44	386.11	36.453	9.44	2.36	100.00
9.33	458.47	42.755	9.33	0.32	100.00
9.79	389.92	38.170	9.79	2.02	100.00
10.03	338.27	38.034	10.06	0.31	99.70
9.57	440.40	42.213	9.56	0.25	100.00
9.34	460.91	43.213	9.30	8.20	99.57
9.94	513.02	50.809	9.90	5.59	100.00
10.10*	442.13	44.993	10.18	5.20	100.00
9.91	531.58	54.324	10.22	0.16	96.97
9.59	709.04	68.039	9.60	5.04	100.00
9.70	651.67	64.194	9.83	8.36	99.29
9.80	420.72	41.568	9.00	7.18	100.00
9.98	—	—	—	—	—

2. Col. (3), refer to Table 6.2.1.
3. Col. (5), derived from evasion in the sugar year from Table 6.7 and reported percentage recovery from Table 6. 2.1
4. Col. (6), min. [Col.3, Col4] × Col.(7).
5. Col. (7), refer to Table 6.2.1
6. Col. (9), col.(9) + col.(2) of Table 6.4.4.
7. Col. (12), from Table 6.2.1.

5. Underpayment for Sugar-cane

The Government fixes the minimum prices that sugar factories are required to pay to farmers for their sugar-cane.[13] Farmers frequently complain that they are paid less. This is more likely to be the case in those years when there is a bumper crop of cane and prices of sugar and its substitutes slump, with the *gur* and *khandsari* manufacturers paying cane prices below the minimum fixed for the sugar factories. In years when the manufacturers of sugar substitutes purchase their cane at prices above the State-advised minima (for the sugar factories), underpayment by sugar factories is unlikely, since they would then not be able to secure the necessary supplies.

We further assume that underpayment can only be resorted to at the margin. Large farmers, who regularly supply sugar-cane to their local mills, are likely to possess sufficient economic clout to ensure receipt of the stipulated minimum prices. It is the smaller farmers, particularly those who switch in and out of cane cultivation, and who have the weakest bargaining position with respect to the sugar mills, that are most likely to be victims of underpayment.

It is, therefore, necessary to identify the quantum of sugar-cane supplied by this category of farmers and to estimate the associated underpayment. The calculations and results are shown in Table 6.5.1. Since the minimum price of sugar-cane and the price of *gur* (taken as a proxy for substitutes of sugar) vary across regions, the country was treated as comprising three major zones, namely, Northern, Western and Southern. The zone-wise averages of the stipulated price minima, the recorded cane prices and the average wholesale price of gur at the *mandis* were obtained Assuming that for *gur* the conversion and transportation charges can be taken into account by a 20 per cent margin on the wholesale prices and using a 10 per cent recovery percentage of *gur* from sugar-cane, the prices likely to be offered by *gur* manufacturers to sugar-cane growers were estimated.[14]

The difference between this price and the recorded sugar-cane price paid by the factories was taken as an indicator of underpayment. We further assumed that if the former was less than the latter then half the difference constituted underpayment. To estimate the amount of sugar-cane subject to such underpayment, we computed the region-wise totals of sugar-cane crushed and compared these with the averages for the preceding three years.[15] The excess of cane crushed over the preceding three-year average was treated as an estimate of the amount on which underpayment occurred.

The total amount of underpayment on sugar-cane purchases by sugar factories was then computed, zone-wise, by multiplying the relevant estimate of underpayment per unit by the corresponding estimate of the amount of sugar-cane as calculated above. Needless to say, the estimates presented here are rough and reflect the crude assumption deployed. On the whole, the estimates are likely to be biased downwards.[16]

6. Black Income Generation in Sugar: A Summary of Estimates

The entire underpayment for sugar-cane constitutes black income in the hands of the mill managers/agents.

Quantitatively more significant are the proceeds (black) from the sale of sugar output suppressed from the formal accounts. Since this sugar is sold in the free market an estimate of the associated black incomes is obtained by multiplying, in each year, the estimate of output evaded by the average free market price of sugar (adjusted downwards by 10 per cent to allow for transportation and marketing charges). The results are shown in Table 6 6.1.

The amount of excise duty evaded by the sugar industry is estimated by assuming that the effective average rate of duty on the evaded output would have been the same as that recorded for declared clearances of sugar.[17] Table 6.6.1 shows the results.

The underweighment of cane implied by sugar output evasion entails a loss to the cane growers. In Table 6.6.1 the annual amount of this loss is estimated by multiplying the estimated net under-weighment by the average minimum price of sugar-cane in that year. The latter is taken as the price the industry would have to pay as per the formula for the State-advised minimum price.

TABLE 6.5.1

Underpayment in Cane Purchase during Sugar Year

Year	Zone	Minimum sugar-cane price (Rs/ qntl.)	Actual average cane price paid (Rs/ qntl.)	Gur price* (Rs./ qntl)	Col. (5)—20 per cent
(1)	(2)	(3)	(4)	(5)	(6)
1973-74	Northern	9.21	12.64	139.63	111.70
	Western	9.87	11.76	181.25	145.00
	Southern	8.80	11.32	143.75	115.00
1974-75	Northern	9.25	14.10	150.88	120.70
	Western	10.75	12.75	185.00	148.00
	Southern	9.66	12.83	147.25	117.80
1975-76	Northern	9.65	13.01	129.25	103.20
	Western	10.82	14.55	133.76	107.00
	Southern	10.08	12.70	147.50	118.00
1976-77	Northern	9.56	13.02	144.13	115.30
	Western	11.01	12.93	189.25	151.40
	Southern	10.10	11.80	147.50	118.00
1977-78	Northern	9.84	13.17	122.63	98.10
	Western	10.70	12.16	135.25	108.20
	Southern	9.48	12.60	97.52	78.02
1978-79	Northern	11.46	11.21	104.00	83.00
	Western	12.70	10.61	111.00	88.80
	Southern	11.30	10.97	97.00	77.60
1979-80	Northern	14.12	14.54	256.88	205.50
	Western	16.26	14.08	266.25	213.00
	Southern	14.15	14.11	212.00	169.60
1980-81	Northern	15.20	23.25	274.38	219.50
	Western	16.08	19.30	342.50	274.00
	Southern	14.37	29.54	258.50	206.80

* Calculated as average of wholesale prices at important mandis in the region; the average wholesale prices were calculated by averaging over the prices prevailing during the 4 important months of gur production.

Source: 1. Columns 3,4 and 7, from Indian Sugar Mills Association, *India Sugar Year Book*, Various issues.
2. Column 5, from National Federation of Co-operative Sugar Factories (1982)

Col. 4 - col. 6/10) (Rs/ qntl.)	1/2 (Col. (7)) (Rs./ qntl.)	Sugar-cane crushed (lakh tons)	3-year past moving average	Excess cane crushed (Col. 9— col. 10) (lakh tons)	Under-payment (Col. 8 × col. 11) (Rs lakh)
(7)	(8)	(9)	(10)	(11)	(12)
1.47	0.74	189.72	161.93	27.79	205.65
—2.74	—	107.18	107.54	0.00	—
—0.18	—	114.16	100.56	—	—
2.03	1.02	197.53	143.44	64.09	55.72
—2.05	—	151.44	124.72	—	
1.05	0.53	118.92	111.00	7.92	41.98
2.69	1.35	162.92	137.88	26.04	338.04
3.85	1.93	153.36	137.32	16.04	309.57
0.90	0.45	88.28	107.12	—14.84	0.00
1.49	0.75	193.28	139.08	54.20	406.50
—2.21	—	166.62	157.14	—	—
0.00	0.00	113.36	106.84	—	—
3.36	1.68	266.68	207.60	59.08	992.54
1.34	0.67	224.06	181.34	42.72	286.22
4.80	2.40	161.64	121.08	40.56	973.44
2.89	1.45	212.08	224.00	—11.92	0.00
1.73	0.87	221.68	204.12	17.56	152.77
3.21	1.61	143.32	139.44	3.88	62.47
— 6.01	—	135.04	204.60	—	—
—7.22	—	152.46	199.40	—	—
—2.85	—	93.24	132.72	—	—
1,30	0.65	168.40	171.84	—3.44	0.00
—8.10	—	222.20	198.78	—	—
—0.14	—	116.72	117.76	—	—

TABLE 6.6.1

Evasion of Excise, Income and Underpayment for Underweighed Cane

Year	Evasion in fiscal year (lakh tons)	Free market price of sugar (Rs/ton)	(Col.3)—10 per cent (Rs/tons)	Income evaded (Col.2x col.4) (Rs. lakh)	Price of sugar-cane in sugar year (Rs/tons)
(1)	(2)	(3)	(4)	(5)	(6)
1961-62	—	—	—	—	—
1962-63	3.23	—	—	—	—
1953-64	1.63	—	—	—	—
1964-65	1.17	—	—	—	—
1965-66	0.24	—	—	—	—
1966-67	2.36	—	—	—	—
1967-68	0.16	—	—	—	—
1968-69	0.76	1775.87	1898.28	1214.69	73.00
1969-70	0.12	1749.27	1574.34	188.92	73.70
1970-71	0.00	1740.85	1566.77	0.00	76.30
1971-72	3.65	2076.08	1868.47	6819.92	77.90
1972-73	2.90	3213.10	2891 70	8385.93	90.10
1973-74	3.85	3740.50	3366.45	12960.83	87.90
1974-75	2.79	4487.50	4038.75	11268.11	99.00
1975-76	2.65	4422 80	3980.52	10548.38	98.30
1976-77	6.07	4551.40	4096.26	24864.30	99.10
1977-78	1.04	3829.30	3446.37	3584.22	95.90
1978-79	7.35	2378.40	2140.56	15633.12	100.10
1979-80	3.90	3117.70	2805.93	10943.13	145.30
1980-81	2.19	6190.10	5571.09	12200.69	—

Source: 1. Col. (2), refer Table 6.4.4.

2. Col. (3), from Ministry of Agriculture and Irrigation, Directorate of Economics and Statistics (1980), *Indian Agriculture in Brief.*
3. Col. (6) from National Federation of Co-operative Sugar Factories Ltd. (1982), *Co-operative Sugar Directory and Year Book, 1981.*
4. Col. (7), refer to Table 6.4.2 (Min. col.4, col.5).
5. Col. (9) and col. (10) from Central Excise and Customs, Directorate of Statiatics and intelligence, *Statistical Year Book, Central Excise, Vol. 1,* various issues from 1970-71 to 1980-81.

Under-reporting of cane crushed (lakh tons)	Under-payment for cane under weighment sugar year (Col.6× col.7) (Rs lakh)	Total excise duty collected from V P S (Rs lakh)	Clearance of sugar (lakh qtls.)	Average excise duty (Rs/ qtls.) (Col.9÷ col.10)	Duty evaded (Col.2 x Col. 11) (Rs lakh)
(7)	(8)	(9)	(10)	(11)	(12)
—	—	5842	222.76	26.23	—
18.94	—	7498	269.72	27.80	897.9
16.72	—	6617	234.85	28.18	459.3
2.01	—	6518	230.56	28.27	330.8
2.56	—	7500	261.20	28.71	68.9
18.61	—	11012	298.08	36.94	871.8
1.58	—	7396	212.54	34.80	55.7
10.56	780.39	6655	226.63	29.37	223,2
1.37	100.97	10215	305.65	33.42	40.1
0.00	0	13801	369.12	37.39	0.0
28.12	2190.55	16320	404.71	40.33	1472.0
31.92	2876.00	17540	350.76	50.01	1450.3
38.16	3354.27	19547	360.71	54.19	2086.3
28.58	2829.42	19050	328.75	57.95	1616.8
23.87	2346.43	22495	365.70	61.51	1630.0
43 39	4299.95	22745	396.40	61.57	3737.3
1.35	129.47	20174	402.57	50.11	521.1
54.50	5455.45	18580	529.36	35.10	2579.9
32.41	4709.18	—	—	—	—
—	—	—	—	—	—

Perhaps the most interesting and intriguing result of our analysis is the absence of any clear-cut relationship between the estimated time-profile of sugar output evasion and the varying extent of controls over sugar prices and marketing.

Notes

1. See the *Report of the Committee on Controls and Subsidies*, (Government of India, Ministry of Finance, 1979) for a detailed list of controls and regulations which have been applicable to the sugar industry.
2. While a causal relationship between controls and black income generation is widely believed to exist, good empirical studies of the issue are notable by their absence. Such studies are generally not possible if the estimates of evasion and black income generation are limited to one or two years, as in the case of the recent research on excise evasion in copper (NIPFP, 1982), Plastics (NIPFP, 1983b) and cotton fabrics (NIPFP, 1984a).
3. Bagchi (1975) points out that the technical advances were mainly a product of government support in these countries.
4. See *Investigation of Accounts, Volume II* for instances of use of these mechanisms, detected by the Income-tax Department (CBDT, 1981).
5. See National Federation of Cooperative Sugar Factories (1982), pp. 155-181.
6. *Ibid.*
7. See National Sugar Institute (1960) and the National Federation of Cooperative Sugar Factories (1982), pp. 186-265.
8. The above discussion of efficiency in the sugar industry in India has been confined to the period 1960-80. An account of the changes in efficiency during the 1930s, when the first major expansion of the industry occurred, may be found in Bagchi (1975).
9. A more complete treatment is given in Appendix 3.
10. '*', '**' and '***' indicated that the coefficient is significantly different from zero at the 10 per cent, 5 per cent and 1 per cent levels of significance respectively.
11. Capacity here is calculated by multiplying the number of factories operating by the number of days (consolidated to 22 hours of working) of running and the average crushing capacity in tons per day.
12. We should emphasise that given our methodology the estimated time-profile (or pattern) of evasion is more robust than the point estimates for individual years.

13. The Government of India passed the Sugar-cane Act in 1934 to provide for a minimum price of cane, to be fixed by the provincial governments. Further, for the enforcement of the Sugar-cane Rules, cane inspectors were appointed. However, Bagchi (1975) reports that evidence before the Indian Tariff Board pointed to continuing monopsonistic exploitation of cultivators by sugar factories. Often the minimum price was treated as the maximum price.
14. Recovery of 10 per cent of *gur* from sugar-cane does not mean 10 per cent of sugar content. The latter may not amount to more than 5-6 per cent, the rest being composed of various forms of organic matter.
15. A three-year period was chosen as this roughly covers one cycle of sugar-cane cultivation.
16. The phenomenon of underpayment may be much more widespread because of effective control exercised over the cane farmers by traders and sugar mill managers. Kickbacks may be paid to directors (and their agents) who can oblige farmers, in return, through early harvesting, registration and payments.
17. Both the excise duty rates (which are *ad valorem*) and the tariff values are changed from time to time. What is necessary is a weighted average of the duty to be paid over the year. The average rate based on clearances is one such weighted average.