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Energy and Labour Use in Andhra Pradesh Industry

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Abstract

The objective of this paper is to explore the possibilities of substitution between energy and labour in the registered manufacturing of Andhra Pradesh as a whole, as well as disaggregated manufacturing activities at the two-digit level during 1980-81 to 1997-98. The proportions of inputs used in production, such as labour and energy, are determined by the choice of technology on the one hand and substitution among inputs on the other. In this paper we do not estimate production functions to get the parameters of substitution or the nature of underlying technology. Instead, we directly look at factor intensities, input ratios and relative prices to gain insights into the possibilities of substitution.

Energy and Labour Use in Andhra Pradesh Industry[1]

Deepita Chakravarty[2]

Introduction

This paper explores substitution between fuel and labour in the registered manufacturing sector of Andhra Pradesh[3]. Statistics from the industrially advanced countries show significant reductions in energy use per unit of output, often referred to as energy conservation (Sweeney, 1984), in response to climbing energy prices. Energy conservation does not only mean the reduction of 'waste' in use of energy or 'fat' in the system. It also means, more importantly, substitution of one input for another: capital for energy, labour for energy, and so on, combinations of inputs responding to relative prices.

On the contrary, some Asian countries[4] have shown notable increases in energy consumption per unit of output while experiencing rapid increases in GDP. India is not an exception in this regard. Although the energy intensity of heavy industries has started declining in this country, it is still around 20 per cent higher than that in the developed countries. The Indian manufacturing sector is well-known for its obsolete facilities and processes responsible for high energy consumption. Even in the modern facilities, energy management is often quite poor. Moreover, energy intensity in some machinery and fabrication industries has increased because these industries have changed from labour intensive to energy intensive ways of production (Ishiguro et al., 1995).

1. An earlier version of this paper was presented in a seminar at the Centre for Economic and Social Studies, Hydearabad in August, 2002.

2. I would like to thank N Krishnaji for his comments. I also thank the participants of the above-mentioned seminar for their suggestions.

3. For the rest of this paper we refer Andhra Pradesh as AP.

4. These include China, India, Indonesia, Koria and Thailand.

There have been earlier studies on the energy sector relating to India as well as to Andhra Pradesh[5]. However, in this study we ask somewhat different questions, not addressed before. How far is the present industrial structure in AP energy dependent given the way it is rapidly changing? Is it possible to substitute labour for energy? Such questions arise from the fact that labour is abundant and energy expensive.

The proportions of inputs used in production, such as labour and energy, are determined by the choice of technology on the one hand and substitution among inputs on the other. In this paper we do not estimate production functions to get the parameters of substitution or the nature of underlying technology. Instead, we directly look at factor intensities, input ratios and relative prices to gain insights into the possibilities of substitution.

Section II
Data

We concentrate on the registered manufacturing sector of Andhra Pradesh as a whole, as well as disaggregated manufacturing activities at the two-digit level. The Annual Survey of Industries (ASI) published by the Central Statistical Organization (CSO) provides fairly detailed information about the industrial categories under registered manufacturing. Presently, this data set is available till 1997-98 for the state of AP. In this paper the time period considered is 1980-81 to 1997-98. However this data source does not give us the energy consumption figures directly. It gives the total quantity of fuel, the source of energy, consumed by the industrial categories. ASI defines fuel as the combination of total amount of electricity, oil and lubricants and coal consumed in the production process.

These fuel consumption expenditure figures are given in nominal terms. In order to get the figures in real terms one needs an appropriate price deflator. A wholesale price index number is readily available for this composite category at the all-India level. Within the fuel group, prices of coal and mineral oils are centrally determined and applicable for the states as well. Only

5. Sambamurti (1984), Reddy (2001), Gopalakrishnan (1990).

electricity prices are determined by the state governments and likely to vary from state to state. Moreover, among different energy categories, electricity plays a very important role in the industrial sector[6] . However, in AP some of the industrial establishments, mainly the electricity intensive ones have their own (captive) power generation units (Rao et al., 1998). This implies that these firms buy coal and other fuels to generate electricity rather than buying electricity directly. Considering all these factors we have decided to use the all India wholesale price index number for this composite category.

At the state level it is not possible to get the wholesale price index numbers for the output corresponding to different industrial categories under the two-digit classification. However, the price of the manufactured items are unlikely to vary widely from state to state, so we deflate the output figures by the wholesale price index numbers derived at the all India level. To get the total manufacturing output in real terms[7] we have added the outputs for different categories in constant prices[8]. A composite index of the wholesale price indices of electrical and non-electrical machinery has been used for deflating the values of fixed capital. To capture the employment variable, we consider the figures given for the number of workers and not employees. This is because employees include working persons not directly related to the production process, for example canteen staff, managerial staff etc.

While it is possible to get the total number of workers engaged in the production process as well as the price per unit of labour (wage rates), it is not easy to get the figures for the total quantity of fuel consumed. However, we have the price index numbers for fuel and to get compatibility we have converted the figures for fuel consumption expenditure into an index with

6. The two-thirds of the total fuel used in the Indian industry is coal. However, in the recent years the importance of natural gas and electricity has increased significantly.

7. In order to get the output figures in real terms, some studies have used double deflation method mainly to correct the effect of the faster growth rates in the industrial raw materials and fuel price indices than the price index of manufactured articles (Balakrishnan *et al*, 1994).

8. The same procedure has been followed by Ahluwalia (1991) at the all India Level.

1981-82 as base. Thus, we have calculated the indices for the quantity of fuel consumed in each of the industrial categories. In order to avoid the problem of incompatibility we have converted all the variables relevant to our analysis into indices with the same base year.

Section III
Trends in factor intensities

In this section we try to analyze the trends in factor intensities during 1980-81 to 1997-98 in the registered manufacturing in AP as a whole and in terms of different disaggregated levels as well. Factor intensity in the production process is defined as the amount of a specific factor required to produce one unit of output.

To begin with we concentrate on the growth rates of gross output and the major inputs for registered manufacturing as a whole. Table 3.1 suggests significant rates of growth for output as well as all the crucial inputs including labour. It is interesting to note here that the rates of growth of output, capital and fuel consumption expenditure are not only quite close to each other but also much higher than that of labour. This suggests possibilities of substitution of labour by either capital or energy or both. In order to understand the net effect of these changes in the production process, let us now turn to the trends in the factor intensities.

Table 3.1:Trends in Gross Output and Major Inputs: Registered Manufacturing of AP (1980-81 to 1997-98) (Value figures are in 1981-82 prices)

Year	Output (in Rs. 100 Crores)	Fuel (in Rs. Crores)	Workers (in Lakhs)	Fixed capital (inRs.100 Crores)
1980-81	32.0	167.7	5.1	10.0
1981-82	32.1	179.2	5.6	10.5
1982-83	41.2	208.8	5.8	11.5
1983-84	47.1	257.5	5.8	14.3
1984-85	49.8	324.7	5.0	14.0
1985-86	53.9	317.8	5.0	14.3
1986-87	55.5	350.8	5.2	13.9
1987-88	61.7	329.0	5.6	12.2
1988-89	69.2	403.4	5.5	14.1
1989-90	76.5	478.5	5.6	12.4
1990-91	91.6	529.7	6.4	32.0
1991-92	106.6	657.1	6.6	37.1
1992-93	129.2	722.6	7.1	46.8
1993-94	135.3	803.6	6.5	49.9
1994-95	161.1	719.9	7.3	44.3
1995-96	164.4	786.4	7.3	40.2
1996-97	165.5	897.2	7.8	45.3
1997-98	185.0	839.3	7.9	43.5
Growth rates (% per annum) 1980-81 to 1997-98	10.9* (32.765)	10.2* (19.782)	2.5* (7.015)	10.7* (8.412)

Note: The regression results are based on 18 observations and the equation used is: $\ln Y = a + bX$, where ln stands for natural logarithm.
t-values are given in the brackets.
'*' indicates significance at 5% level.

The trends depicted in Table 3.2 clearly show the following facts. Contrary to the international experience of energy conservation, energy intensity in the registered manufacturing in AP shows no change (the coefficient of time being insignificant) over the period 1980-81 to 1997-98. This has happened together with an unchanged capital intensity and decreased labour intensity per unit of output. The rate of decline in the labour intensity is as high as 8.4 per cent per annum during the concerned period.

Table 3.2: Input - Output Ratios (in 1981-82 prices) Per cent

Year	Fuel intensity	Labour intensity	Capital intensity
1980-81	5.2	157.9	31.4
1981-82	5.6	176.1	32.7
1982-83	5.1	141.6	27.9
1983-84	5.5	123.6	30.4
1984-85	6.5	99.7	28.1
1985-86	5.9	93.4	26.5
1986-87	6.3	94.1	25.1
1987-88	5.3	89.9	19.7
1988-89	5.8	80.1	20.3
1989-90	6.3	73.1	16.3
1990-91	5.8	69.4	35.0
1991-92	6.2	62.3	34.8
1992-93	5.6	54.7	36.2
1993-94	5.9	47.8	36.8
1994-95	4.5	45.0	27.5
1995-96	4.8	44.4	24.5
1996-97	5.4	47.1	27.4
1997-98	4.5	42.8	23.5
Growthrates (% per annum) 1980-81 to 1997-98	-0.7 (-1.475)	-8.4* (-21.351)	-0.3 (-0.264)

Note: The regression results are based on 18 observations and the equation used is: $\ln Y = a + bX$, where ln stands for natural logarithm.

t-values are given in the brackets.

'*' indicates significance at 5% level.

Factor intensity can decline for several reasons. The time period concerned is not a short one so that possibilities of technological change cannot be ruled out altogether. Technological change can lead to different factor proportions. However, the rate of growth of capital intensity has turned out to be insignificant in this period (Table 3.2). This finding is not suggestive of a significant technological modernization as it is supposed to alter the factor proportions especially capital per unit of output. The situation is more like a horizontal expansion, where new investment leads to more output leaving the existing factor proportions unchanged. However, the above argument regarding capital intensity may fall apart if we consider the problem in valuing fixed capital. ASI provides the book value of net fixed capital stock. It is difficult to find a universally accepted method of measuring capital both in theory as well as in practice (Ahluwalia, 1991). Researchers have used mainly the 'perpetual inventory accumulation method' with different qualifications (for example, Ahluwalia, 1991; Goldar, 1992; Chaudhuri, 2002). The focus of this study is not on technological modernization but on the possibilities of substitution between labour and fuel. Thus we have not tried any refined measure to estimate the present value of fixed capital. Our approach to fixed capital is rather preliminary.

Secondly, a significant change in the output composition can also lead to a decline in one factor intensity with increase in others. However, Table 1.2 suggests no change in the other two factor intensities. Moreover, the percentage composition of output by various industry groups does not suggest a notable change as well[9]. Reduction in the inefficient use of a factor can be considered as the third reason. Part of the sharp decline in the labour intensity may have occurred as a result of increase in the efficiency in labour use particularly in the old industries well known for their 'feather bedding' or 'over manning' practices. Finally, Indian industry is also known to be an inefficient user of energy, as mentioned earlier. Consequently, fuel intensity may remain unchanged despite substitution.

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9. We have divided the various industries into three major groups: low, medium and high according as the fuel intensity is less than 3.5 Per cent, between 3.5 to 8 per cent and over 8 per cent respectively. The percentage composition of output by these three groups has remained more or less unchanged over the concerned period (the corresponding coefficients of time being insignificant).

Figure 3.1

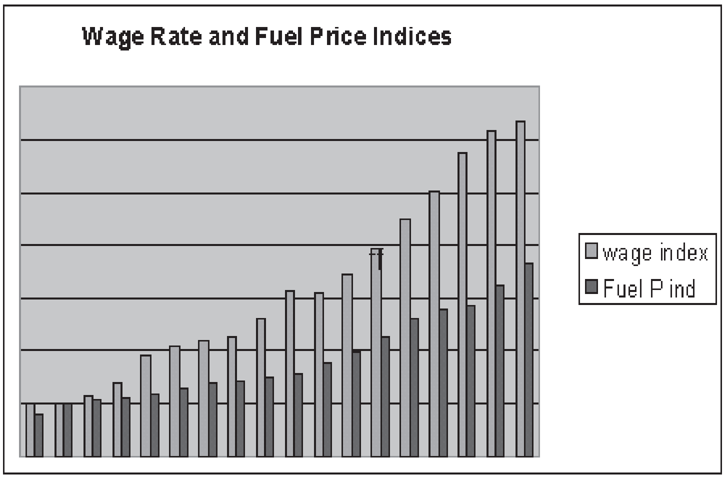

Table 3.3: Indices of Wage Rate and Fuel Price (1981-82 as base)

Year	Wage Rate Index	Fuel Price Index
1980-81	100.2	80.0
1981-82	100.0	100.0
1982-83	113.8	106.5
1983-84	140.1	112.5
1984-85	190.2	117.3
1985-86	208.9	129.8
1986-87	219.6	138.6
1987-88	226.3	143.3
1988-89	262.5	151.2
1989-90	311.5	156.6
1990-91	310.2	175.8
1991-92	345.6	199.0
1992-93	395.1	227.1
1993-94	448.9	262.4
1994-95	500.4	280.4
1995-96	575.7	285.4
1996-97	616.1	324.2
1997-98	634.7	365.7

In sum, the figures reported in Table 3.2 do not lead us to any precise conclusion. The behaviour of relative prices of fuel and labour may give us some clue. Figure 3.1 shows that during 1980-81 to 1997-98 the cost of labour has increased more sharply than that of fuel. While the increase in fuel price is around 3.5 times, the increase in wage rate is around 6.5 times in 1997-98 compared to 1981-82 (Table 3.3). Thus a possibility of substitution between fuel and labour as a response to the changes in the relative prices exists.

Manufacturing as a whole represents a number of activities. While labour is an essential part of all production activities energy is also used virtually in all these categories especially in the ambience of the factory sector. But depending on the nature of production, factor proportions vary widely. Thus it is quite likely that the input intensities will be different in different types of activities in general and according to the technology involved within a single activity in particular. We therefore prefer to look at the problem at a disaggregated level.

We consider fuel, labour and capital intensities for different industrial categories under manufacturing at the two-digit level. Table 3.4 suggests that fuel intensity has increased only in the industrial categories of non-metallic mineral products and electrical and non-electrical machineries. While the non-metallic minerals are generally energy intensive products by nature, use of fuel has increased in the machinery group especially since the early 1990s with the increase in the proportion of electrical machinery in the group.

The industrial categories of food products, transport equipment, other manufacturing, leather and rubber products show no change in the fuel intensity in production (the corresponding coefficients of time being insignificant). The results for the rest of the categories suggest declining trends in the fuel intensity. Contrary to the diverse behaviour of the fuel intensity across industries, labour intensity has declined in almost all the categories under manufacturing except for rubber products where the time trend is insignificant.

Part of this decline in the labour intensity is probably the result of more efficient use of labour as mentioned earlier. The categories showing simultaneous decline in energy and labour intensity corroborate the experience of the industrially advanced countries as depicted in Jorgenson (1984). However, this trend does not apparently permit the possibility of

Table 3.4: Trends of Factor Intensities in Different Categories of Manufacturing

Industrial categories	Fuel Intensity	Labour Intensity	Capital Intensity
20-21 (Food Products)	-0.018 (-1.795)	-0.108* (-15.889)	-0.055* (-3.241)
22 (Bever. & Tobacco)	-0.035* (-4.323)	-0.065* (-6.106)	-0.024* (-2.168)
23 (Cotton Textiles)	-0.027* (-3.708)	-0.110* (-19.867)	-0.068*(-6.231)
24 (Other Textiles)	-0.082* (-3.831)	-0.162* (-11.304)	0.027 (1.030)
25 (Jute Products)	-0.038* (-6.040)	-0.089* (-13.012)	-0.071* (-7.455)
26 (Tex. Products)	-0.029* (-2.123)	-0.087* (-4.412)	-0.049* (-2.114)
27 (Wood Products)	-0.096* (-2.840)	-0.124* (-4.043)	-0.212* (-6.409)
28 (Paper & Pep. Prod.)	-0.027* (-4.257)	-0.062* (-11.047)	-0.068* (-3.668)
29 (Leather Products)	-0.009 (-0.945)	-0.050* (-6.386)	-0.112* (-6.361)
30 (Rubber Products)	-0.011 (-0.542)	-0.036 (-1.788)	-0.059* (-2.151)
31 (Chemical Prod.)	-0.018* (-2.088)	-0.068* (-8.383)	-0.013 (-0.739)
32(Non-metallic minerals)	0.027* (3.044)	-0.084* (-11.047)	-0.002 (-0.172)
33 (Basic Metal)	-0.028* (-3.982)	-0.072* (-7.285)	0.091* (2.619)
34 (Metal Products)	-0.031* (-3.147)	-0.103* (-13.207)	-0.017 (-0.887)
35-36 (Machinery)	0.015* (2.284)	-0.019* (-3.358)	-0.016* (-2.391)
37(Transport Equipments)	-0.011 (-1.004)	-0.077* (-9.582)	-0.064* (-4.464)
38 (Other Manufact.)	-0.028 (-1.825)	-0.081* (-5.435)	0.062* (2.579)

Note: The regression results are based on 18 observations and the equation estimated is: $\ln Y = a + bX$, where ln stands for natural logarithm.

'*' indicates significance at 5% level.

t-values are given in the brackets.

We have not considered the group '39' as data for this group are not available for the initial years.

explaining the situation entirely in terms of substitution as a result of changes in the relative prices of fuel and labour. In fact, in the Western countries, significant change in the technology was the main factor behind the simultaneous decline of both the intensities.

However, in the present case the behaviour of capital intensity is not indicative of a definitive change in the technology. In most of the cases capital intensity has declined significantly with the exception of the basic metal category. The increase in the capital intensity in the basic metal category is clearly a result of technological modernization with the initiation of Vizag Steel plant in the early 1990s. Incidentally the basic metal category is the most capital-intensive one under manufacturing. Capital intensity can decline mainly for two reasons. First, as a result of significant technological modernization, increase in the rate of growth of output can be much higher than that of capital. Consequently, there can be a decline in capital per unit of output. Secondly, an increase in the capacity utilization can also reduce capital intensity. This simply leads to an expansion of production activities with already installed machinery.

Among the industries showing declining trends for all the three factor intensities, some references about textiles suggest a significant technological modernization of the production process in the neighboring states of Maharashtra and Tamil Nadu (Roy, 1998; Chakravarty, 2002). However, these broad classifications still represent a highly aggregative picture of the actual facts. The reasons behind the decrease in capital intensity in textiles can well be a combination of technological modernization as well as an increase in capacity utilization. A firm level investigation can only settle the matter. But there seems to be no evidence of technological modernization in the jute industry, one more candidate in this group. This is because demand for jute has been declining over quite a long stretch of time. Moreover, as the value of capital considered here is not adjusted for the value of discarded machinery[10], the decline in capital intensity, especially in the jute industry, probably has taken place as a result of selling off of the discarded machinery,

10. As suggested in Goldar, 1992.

may be even as scrap. Incidentally, the rate of growth of fixed capital in this industry over the entire period is negative.

The industrial category of non-metallic minerals may be considered as the only case where a substitution between fuel and labour has taken place as a result of decline in the relative prices. In this category, fuel intensity has increased with a significant declining trend in labour intensity and an insignificant trend in the capital needed to produce one unit of output. However, Table 3.3 shows a number of cases where all the three factor intensities have declined during the concerned period, as mentioned above. We have also mentioned that simultaneous decline in all the factor intensities or, decline in one factor intensity without any increase in the intensity of other factors can result from increases in the efficiency of the use of those factors. However in this process of declining factor intensities, given a technologically determined substitutability between two factors, the possibility of using one factor in the place of the other in a limited manner cannot be altogether eliminated, especially when the increase in prices of one input is considerably lower than in the other.

Section IV
Possibilities of Substitution between fuel and labour

In order to understand the nature of substitutability between fuel and labour we begin by looking at the behaviour of the ratio of total expenditure on fuel ($p_1 q_1$) to total wage bill ($p_2 q_2$) where the p and q stand for the respective prices and quantities. This preliminary approach to the problem, without bringing in the prices directly in the picture, can give us interesting insights. A Cobb-Doglus (C-D) production function along with the marginal productivity conditions implies $p_1x_1/p_2x_2 = a_1/a_2$, a constant, implying a constant elasticity of substitution with the value unity. So, an observed near constancy of a ratio of input expenditures is consistent with a C-D production function, with a unit elasticity of substitution. Table 4.1 depicts the time trends of the ratio between fuel consumption expenditure and wage bill for the manufacturing as a whole as well as for the industrial classifications at the two-digit level.

At the two digit level, the time trend for this ratio is insignificant for the industry groups of beverage and tobacco, textile products, wood products, leather products, rubber products and other manufacturing among the relatively low fuel intensity group[11]. Among the high fuel-intensity group, industrial categories of paper products, chemicals and basic metal also show an insignificant trend for the concerned ratio. Incidentally, almost all the above-mentioned industries under the low intensity group are highly labour intensive as well. In these cases the fuel consumption expenditure is practically insignificant, when compared with the total expenditure incurred on labour. This particular feature is likely to be partly responsible for the insignificance of the time trends of the ratio (p_1q_1/ p_2q_2) in these labour intensive industries. However, the non-significance of the time trend for the industries in the relatively higher fuel intensity group cannot be explained along these lines. The results for these industries are consistent with a Cobb-Doglus technology.

Let us now turn to the industries for which the time trend of the ratio between total expenditure on fuel and wage bill is significant over the concerned period. Incidentally, the coefficient of time for the concerned ratio is significant at the aggregate as well. Clearly, this result is not consistent with a Cobb-Doglus production function.

In order to deal with the issue directly, let us finally look at the elasticity of substitution between fuel and labour. Elasticity of substitution (ES) is defined as the ratio of the proportionate change in the factor proportions to the proportionate change in the slope of the isoquant. Now as the implicit assumption holds that entrepreneur is rational and thus cost is minimized, the slope of the isoquant is equal to relative factor prices. Therefore when cost is minimized we can redefine the ES as the ratio of the proportionate change in factor proportions to proportionate change in relative factor prices. Elasticity of substitution is, in fact a very simple way of describing how technology would change in response to change in relative prices. To be more precise ES can give us an idea about the effect of increase in fuel

11. Here, by relatively low fuel intensity we mean fuel intensity being 8 per cent and below and relatively high means above 8 percent.

prices on the level of employment given the other factors of production constant. This implies that high ES between fuel and labour will lead to a significant change in the factor use as a result of changes in the relative prices.

Table 4.1: Trends in the Ratio Between Fuel Expenditure and Wage Bill

Industrial categories	coefficient	t-value	R squared
20-21 (Food Products)	0.046*	2.414	0.27
22 (Bever. & Tobacco)	0.008	0.009	0.00
23 (Cotton Textiles)	0.062*	19.116	0.95
24 (Other Textiles)	0.086*	4.226	0.53
25 (Jute Products)	0.008*	3.251	0.39
26 (Tex. Products)	0.001	0.111	0.00
27 (Wood Products)	(-) 0.002	(-) 0.248	0.00
28 (Paper & Pep. Prod.)	(-) 0.004	(-) 0.348	0.00
29 (Leather Products)	0.003	0.911	0.05
30 (Rubber Products)	0.021	0.773	0.04
31 (Chemical Prod.)	0.049	1.607	0.14
32(Non-metallic minerals)	0.420*	12.654	0.91
33 (Basic Metal)	(-) 0.039	(-) 1.175	0.08
34 (Metal Products)	0.016*	2.332	0.25
35-36 (Machinery)	0.001	0.302	0.00
37(Transport Equipments)	0.015*	5.498	0.65
38 (Other Manufact.)	0.007	1.548	0.13
Manufacturing (total)	0.054*	5.546	0.65

Note: The regression results are based on 18 observations and the equation estimated is: $Y = a + bX$.
'*' indicates significance at 5% level.
t-values are given in the brackets.

We have not considered the group '39' as data for this group are not available for the initial years.

Table 4.2: Elasticity of Substitution Between Fuel and Labour[12]

Industrial categories	coefficient	t-value	R squared
20-21 (Food Products)	(-) 1.484*	(-) 5.837	0.68
22 (Bever. & Tobacco)	(-) 0.778*	(-) 4.417	0.55
23 (Cotton Textiles)	(-) 2.706*	(-) 3.726	0.46
24 (Other Textiles)			
25 (Jute Products)	(-) 1.692*	(-) 4.031	0.55
26 (Tex. Products)	(-) 1.075*	(-) 3.412	0.42
27 (Wood Products)	(-) 1.133*	(-) 3.177	0.39
28 (Paper & Pep. Prod.)	(-) 0.879*	(-) 4.944	0.60
29 (Leather Products)	(-) 0.882*	(-) 5.281	0.64
30 (Rubber Products)	(-) 1.533*	(-) 3.898	0.49
31 (Chemical Prod.)	(-) 1.445*	(-) 5.261	0.63
32(Non-metallic minerals)	(-) 3.044*	(-) 9.353	0.85
33 (Basic Metal)	(-) 0.774*	(-) 5.575	0.66
34 (Metal Products)	(-) 0.885*	(-) 4.709	0.58
35-36 (Machinery)	(-) 0.951*	(-) 7.660	0.79
37(Transport Equipments)	(-) 1.270*	(-) 2.531	0.28
38 (Other Manufact.)	(-) 0.455	(-) 1.384	0.11
Manufacturing (total)	(-) 1.980*	(-) 8.680	0.82

Note: Regression results are based on 18 observations. The equation estimated is:
$\ln(q1/q2) = a + b \ln(p1/p2)$, where ln stands for natural logarithm.
'*' indicates significance at 5% level.
We have not considered the group '39' as data for this group are not available for the initial years.

Table 4.2 shows that the ES between fuel and labour during 1980-81 to 1997-98 is significant in all categories of manufacturing except in the case of 'others'. The ES is the highest in the category of non-metallic mineral products followed by textiles and lowest in the category of basic metal followed by beverage and tobacco. Moreover, ES is quite close to unity in the industrial categories of textile products, wood products, paper products,

12. The category of silk textiles (24) has not been included due to the following reason. In the year1980-81 fuel intensity for group 24 was very high, in fact as high as the most fuel intensive category of non-metallic minerals. But immediately after this year fuel intensity has gone down to the level of the lowest intensity category and remained at that level consistently. While there are some evidence of industries moving from low fuel intensity to high or otherwise over this 18 year period, the drastic change experienced in the case of category 24 does leave scope for suspicion about the accuracy of data.

leather products, metal products and in the machinery industry. It is important here to note that most of the industries showing higher ES are also labour intensive industries by nature and therefore it is quite likely that in order to reduce cost of production, the entrepreneurs will shift to a factor of production whose prices have not increased as much as labour whenever it is possible. Thus, the presence of high elasticity of substitution between fuel and labour shows the possibility of opting a fuel intensive production process compared to a labour intensive one when increase in fuel prices are comparatively lower than increase in wage rates. A World Bank study (Ishiguro, 1995) argues that the decline in fuel prices in India like many other Asian developing countries is mainly the result of heavy subsidy on fuel use. In this context, it is worth probing how far the energy price structure is different in AP and so also in India from the developed countries.

If increases in energy costs are comparatively less than in labour costs firms will find it more economic of limiting investments in energy conservation. This is more so because capital scarcity in these countries is a perennial thwarting factor for technological modernization. Instead of investing in energy conservation, firms are inclined to invest in expansion of production capacity, which tends to give better financial returns, especially in the short run.

To conclude, apart from the various adjustments made in order to handle data problems at the state level, this study seriously suffers from the simplifications arising out of the extreme macro nature of the information used. Studies focused on a specific industry or a group of industries are worth trying. Having stated the fact that there is a technical possibility of substitution between fuel and labour, ceteris paribus, what is important now is to study the actual processes involved at the level of firms, to be more precise, at the level of shop floor.

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