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Title of the Thesis: Structural Change and Energy Use in Indian Economy: An Input-Output Analysis with Special Reference to India's International Trade

Thesis Abstract

The energy requirements of an economy depend on the rate of growth as well as the sector-wise energy intensities. This has environmental implications which are well recognized. The changes could be relatively strong for the developing countries in comparison to the developed nations, especially if the former exhibit faster growth. The emphasis on inter-sectoral relationships in the theory of structural change underscores the transformation of all sectors of the economy, while also highlighting changes in the behavior of different agents including the consumer and international trade. The present research attempts to make an appraisal of the structural changes in the Indian economy and the induced energy use with reference to India's international trade. The specific objectives of the study are to analyse the inter-temporal changes in total energy use and the changes in the inter-sectoral linkages within the economy. The study also decomposes the sources of inter-temporal change in energy use pattern. The effect on energy use pattern by India's changing international trade is another aspect of the present study. It attempts to assess the impact of increase in India's international trade from an energy perspective.

The analysis shows that relative significance of the composite energy output has strengthened in the overall economy which effectively deepened the sector-wise linkages of the energy sector. Increasing inter-sectoral relationships confirm that energy sector is more integrated with the economy through its stimulus for the input producing sectors and responsiveness to the output using sectors. Inter-temporal comparison of total energy

intensity shows improvement over time with few exceptions. Results of the decomposition analysis show continuous increase in additional energy use attributed to final demand shifts. Over the long term, technological changes contributed to lower additional energy requirements. The direct energy savings became effective sooner than the technological changes in indirect energy use. The expansionary effect of economy and restructuring of the demand pattern contribute to increasing energy use which was countered by the changes in consumption basket representing the joint effect of consumer preferences and policy shifts. The estimate of balance of energy embodied in India's trade shows a negative energy balance at the aggregate level. An overall energy deficit is suggested with the consumption-based estimates exceeding the production-based estimates of embodied energy. The contribution of petroleum product sector in lowering the overall energy deficit of the economy is well recognized due to the notable energy surplus embodied in exports from the sector. The aggregate non-energy category shows a consistently significant contribution in the overall energy deficit of the economy highlighting import of energy in embodied (indirect) form. This underscores the need to improve conditions for domestic manufacturing in the medium and high technology segments. The contribution of secondary energy, more specifically the petroleum products, is noteworthy in shaping India's energy balance. This is in sharp contrast to the worsening energy deficit of the non-energy sectors mainly in the non-ferrous basic metals and machinery & equipment which import large amount of embodied coal energy.

Future policies which stimulate output should be carefully formulated to minimize the externalities arising mainly from import leakages. The high proportion of indirect energy intensity in total energy intensity, compared with direct energy intensity, mandates a focus on energy consumption in the production chain rather than in the production process. The saving potential of consumption pattern indicates that consumer preferences, based on price and availability, may be exploited to achieve energy conservation. India's deficit of embodied energy on account of non-energy imports offers an opportunity for carbon markets. The developed countries can invest in emission reduction activities in India to generate emission reduction credits. India will benefit from the access to technology, reduce energy intensity, and improve energy efficiency which will help to narrow the energy deficit.