Energy for Sustainable Development 26 (2015) 56–61

Contents lists available at ScienceDirect

Energy for Sustainable Development

Impact of economic structure on mitigation targets for developing countries

Tejal Kanitkar [a,b,*], Rangan Banerjee [c,1], T. Jayaraman [d,2]

[a] Department of Energy Science and Engineering, Indian Institute of Technology-Bombay, Mumbai 400076, India
[b] Centre for Climate Change and Sustainability Studies, School of Habitat Studies, Tata Institute of Social Sciences, Mumbai 400088, India
[c] Department of Energy Science and Engineering, Indian Institute of Technology-Bombay, Mumbai 400076, India
[d] School of Habitat Studies, Tata Institute of Social Sciences, Mumbai 400088, India

ARTICLE INFO

Article history:
Received 17 May 2014
Accepted 15 March 2015
Available online 1 April 2015

Keywords:
Climate change mitigation
Energy intensity
Emissions intensity
Decomposition analysis

ABSTRACT

Mitigation actions proposed by most developing countries include reductions from a business as usual baseline or reductions in emission intensities. Here we evaluate the implications of such mitigation targets in developing countries, using India as a case study. The analysis shows that for developing countries, the construction of a baseline is subject to substantial uncertainty due to a range of potential structural mixes in the future. Mitigation commitments based on such a baseline are then likely to result either in high costs of mitigation or constraints on the development choices available in the future. Results for India indicate that by 2030 an additional mitigation effort of 19% to 38% would be necessary if the contribution of industry to the GDP was higher than anticipated. Instead of a single baseline with an implicit assumption of structural composition, we propose that for developing countries, a set of alternative baselines should be considered.

Introduction

The greenhouse gas emissions in any country depend on a few key variables — the composition of fuels in primary energy production, the structural composition of the economy, i.e. the relative contribution of primary, secondary and tertiary sectors to the economy, the energy intensity of different sectors, and the emissions intensity of energy. An analysis of past trends reveals the contribution of each of these components to the total change in emissions and can indicate their potential role in the future. This analysis is more important for developing economies, since with unsaturated demands in all sectors, the structure of the economy can vary substantially. Fig. 1 shows the evolution of the relative contributions of three sectors – agriculture, industry and services – to the total value added in the economy for three countries — one developed (UK) and two developing (India and China) for the period 1971–2008.

For India the trend between 1971 and 2008 indicates that the reduction in the contribution of agriculture in the overall economy has been almost entirely compensated by an increase in the share of the services sector in this period. For China on the contrary this trend is markedly different, indicating a similar decline in the contribution of the agricultural sector compensated substantially by industrial sector growth. For developing economies such as India and China in the future, the decline in the share of the agricultural sector may be compensated by changes in the relative share of the industrial and service sectors, the extreme cases corresponding to increase mostly in the industrial sector or mostly in the services sector — shown by points I_I and I_S for India and points C_I and C_S for China in Fig. 1 for an endpoint taken to be 2030 in this paper. The resultant emissions in 2030 from these two countries will depend significantly on the trajectory and endpoint of this shift in the structural composition. A similar argument can be made for several other developing countries as well as shown in Fig. 2.

The range of available structural compositions for the future – denoted by the angle θ in Fig. 2 – implies that a simple extrapolation of historical trajectories for economic growth may be an inaccurate measure of the potential changes in the future. We have examined this hypothesis by back-casting sectoral growth data for a range of countries. We have taken the trends for industrial growth between 1971 and 1990 to project the possible trends for the period 1991 to 2010. The projected values are then compared with the actual industrial

* Corresponding author at: Department of Energy Science and Engineering, Indian Institute of Technology-Bombay, Mumbai 400076, India. Tel.: +91 2225525861, +91 2225768910; fax: +91 2225525375.
E-mail addresses: tejal.kanitkar@tiss.edu, tejalkanitkar@iitb.ac.in (T. Kanitkar), ranganbanerjee@iitb.ac.in (R. Banerjee), tjayaraman@tiss.edu (T. Jayaraman).
[1] Tel.: +91 2225767883.
[2] Tel.: +91 2225525372.

http://dx.doi.org/10.1016/j.esd.2015.03.003
0973-0826/

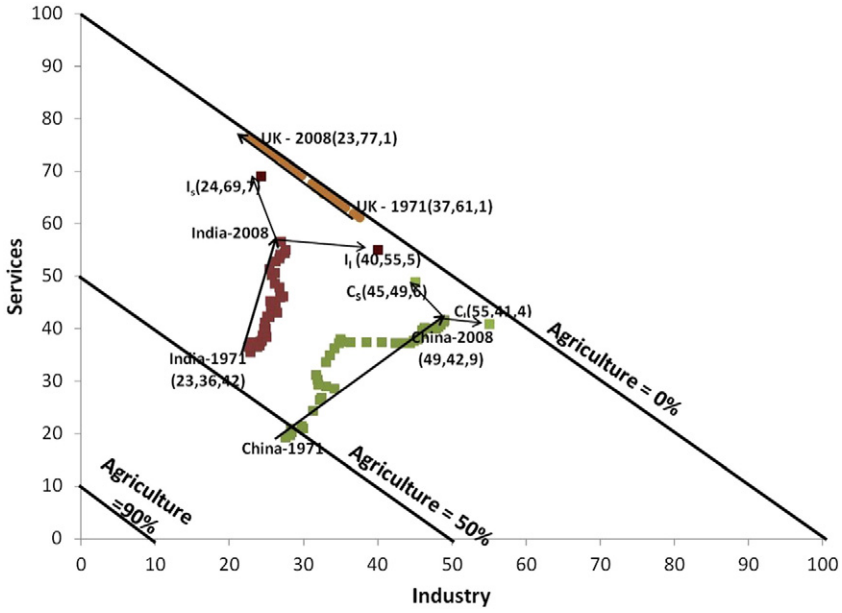

Fig. 1. Relative contribution of the agricultural, industrial and services sectors to total value added in three countries — UK, China and India between 1971 and 2008. The share of the agricultural sector to total GDP is measured on the 45° line while the shares of the industrial and services sectors are measured on the x and y axes respectively.
Data Source: World Bank, World Development Indicators.

growth in each country for this time period. Fig. 3 shows the actual and projected trajectories of growth for the industrial sectors in four developing countries for the period between 1971 and 2010

Given the same improvements in energy efficiency and the same changes in the composition of primary energy sources that the countries actually experienced, the projected numbers would have resulted in 23% lower emissions in China and 13% higher emissions in Brazil as compared to the actual emissions in 2010. Fig. 3 highlights the fact that an extrapolation of the past is not a robust method to project for the future or decide a baseline for emissions. Developing economies can choose among different possible options for development depending upon their unique national priorities.

Analysis of past trends in emissions for India

For a developing economy, the increase in emissions due to changes in structural composition may be offset partially by efficiency improvements and technological innovation in the energy sector. Other than the structural composition of the economy, these parameters can also affect the total emissions significantly. Using the decomposition method, the

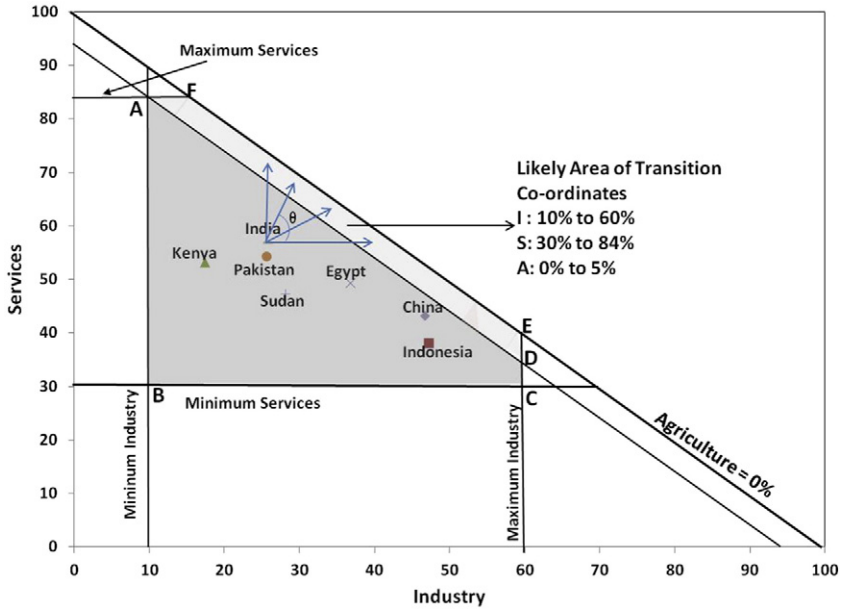

Fig. 2. Relative contributions to total value from the agricultural, industrial and services sectors in seven developing economies — India, Kenya, Pakistan, Egypt, Sudan, China and Indonesia in 2010. Shaded area A–B–C–D roughly denotes the area where most developing countries are currently situated in terms of their relative sectoral contributions. Shaded area D–E–F–A roughly denotes the area of likely transition for developing countries by 2030. The angle θ shown for India denotes the range of possible transitions.
Data Source: World Bank, World Development Indicators.