EMPIRICAL ANALYSIS OF CO_2 EMISSIONS AND GDP RELATIONSHIPS IN OECD COUNTRIES

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Overview

Decoupling CO_2 emissions from income growth is an important world issue today. Generally, decoupling can be represented by the income elasticity of CO_2 emissions. If the elasticity is positive and greater than or equal to +1.0, then CO_2 emissions is directly coupled with income growth; there is no decoupling. If the elasticity is positive and less than +1.0, there is relative decoupling. The percentage growth of CO_2 emissions is smaller than that of income growth. There is absolute decoupling when the elasticity is zero or negative. As income grows, CO_2 emissions will either stay at the same level or even decline. In this aspect, understanding how the OECD countries have performed historically would be useful. This paper applies simple and multiple regression analysis to derive empirical estimates of "apparent" and "net" income elasticity of CO_2 emissions and then use them to classify the 30 OECD countries into decoupling status groups of absolute decoupling (AD), relative decoupling (RD) and close coupling (CC). The AD status can also be further divided into negative income elasticity (NE) and zero elasticity (Zero E) categories. Therefore, running from the most to the least desirable, the decoupling status continuum is either (AD — RD — CC) or (NE — Zero E — RD — CC) for 3-way or 4-way classification, respectively.

Methods

Linear regression of natural logarithm-transformed variables is the method used to estimate the elasticity. Apparent income elasticity is derived from simple regression between per capita CO_2 emissions and per capita GDP. Net income elasticity estimates are derived by introducing additional explanatory variables such as the fuel share ratio, defined as (share of nuclear energy + share of renewable energy)/ (share of coal + share of oil), and real prices of energy into multiple regression. Three different energy price series were tested: light fuel oil for industrial use, electricity for industrial use and consumer price index (CPI) for energy. Data for 30 OECD countries from 1970 through 2004 from IEA and SourceOECD are used.

Results

- For 14 of the 30 countries, the decoupling status is not affected by the choice of models.

  - ✓ Seven countries (Germany, Hungary, Luxembourg, Poland, Slovak Republic, Sweden and Switzerland) would stay in the AD group, regardless of the model in question. Among them, Germany maintains the NE status under Model 1a (simple regression using 1970-2004 data) and Switzerland maintains the Zero E status. The other 5 countries downgrade from NE status to Zero E status when the additional explanatory variables are included in the regression.

  - ✓ Six countries (Austria, Finland, Ireland, Italy, Japan and Norway) stay in the RD group.

  - ✓ Portugal stays with the CC status.

- For 8 countries (Belgium, Canada, Czech Republic, Demark, France, Iceland, United Kingdom, and United States), the decoupling status deteriorates from AD in Model 1a to RD in Model 2 (introducing the fuel share ratio variable as the second explanatory variable) or the three versions of Model 3 (including fuel share ratio and real energy prices variables as the second and third explanatory variables).

- Korea and Spain also show deterioration, moving from RD to CC status.

- For the other 6 countries (Australia, Greece, New Zealand, Netherlands, Mexico and Turkey), the decoupling status improves as fuel share ratio and real energy price variables are introduced. Netherlands and Australia improve from RD to Zero E while the other four countries improve from CC to RD. Mexico shows major improvement as industrial fuel oil prices are introduced.

- Among the three energy price series tested in this study, the relative CPI-Energy is the best price data series for inclusion in multiple regression analysis because it yields coefficient of the price variable that is with the expected sign and is statistically significant for the largest number of countries, 15 versus 5 or 6 for the other two price series.

Conclusions

Given the data and methods used in this analysis, it appears that for 14 of the 30 OECD countries, using the apparent elasticity derived from simple regression to classify a country's decoupling status will do it correctly for the 3-way classification. Introduction of the fuel share ratio and real energy price variables will not affect the classification, although the absolute values of the elasticity estimates may be different. Specifically, Germany, Hungary, Luxembourg, Poland, Slovak Republic, Sweden and Switzerland would stay in the AD group; Austria, Finland, Ireland, Italy, Japan and Norway stay in the RD group; Portugal stays with the CC status.

For the other 16 countries, utilizing the apparent elasticity estimate derived from simple regression as the guide proves to be off the mark. For Belgium, Canada, Czech Republic, Denmark, France, Iceland, Korea, Spain, United Kingdom and United States, it would be over-optimistic. For Australia, Greece Mexico, Netherlands, New Zealand and Turkey, it would tend to be overly pessimistic. Hence, for these latter 16 countries, it would be necessary to introduce the fuel share ratio and real energy prices variables into the regression. In a sense, this finding is consistent with the earlier consensus in the literature that empirically derived EKC would largely depend on the characteristics of the countries, the models and the variables incorporated into the models.

References

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