

## Machine Learning in Gravity Models: An Application to International Recycling Trade Flow

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**Abstract :** Predicting trade patterns is critical to decision-making in public and private domains, especially in the current context of trade disputes among major economies. In the past, U.S. recycling has relied heavily on strong demand for recyclable materials overseas. However, starting in 2017, a series of new recycling policies (bans and higher inspection standards) was enacted by multiple countries that were the primary importers of recyclables from the U.S. prior to that point. As the global trade flow of recycling shifts, some new importers, mostly developing countries in South and Southeast Asia, have been overwhelmed by the sheer quantities of scrap materials they have received. As the leading exporter of recyclable materials, the U.S. now has a pressing need to build its recycling industry domestically. With respect to the global trade in scrap materials used for recycling, the interest in this paper is (1) predicting how the export of recyclable materials from the U.S. might vary over time, and (2) predicting how international trade flows for recyclables might change in the future. Focusing on three major recyclable materials with a history of trade, this study uses data-driven and machine learning (ML) algorithms---supervised (shrinkage and tree methods) and unsupervised (neural network method)---to decipher the international trade pattern of recycling. Forecasting the potential trade values of recyclables in the future could help importing countries, to which those materials will shift next, to prepare related trade policies. Such policies can assist policymakers in minimizing negative environmental externalities and in finding the optimal amount of recyclables needed by each country. Such forecasts can also help exporting countries, like the U.S. understand the importance of healthy domestic recycling industry. The preliminary result suggests that gravity models---in addition to particular selection macroeconomic predictor variables--are appropriate predictors of the total export value of recyclables. With the inclusion of variables measuring aspects of the political conditions (trade tariffs and bans), predictions show that recyclable materials are shifting from more policy-restricted countries to less policy-restricted countries in international recycling trade. Those countries also tend to have high manufacturing activities as a percentage of their GDP.

**Keywords :** environmental economics, machine learning, recycling, international trade

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