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Untangling Gravity

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Summary Untangling Gravity *by* Rutger Teulings

The gravity model is widely used for explaining bilateral exports. It does not only explain the data very well but it also has a strong theoretical foundation. However, both the empirical as well as the theoretical gravity model is tangled. This hampers interpretation and identification of driving variables in the model. In this dissertation I will make a start with untangling gravity divided over three chapters. Each chapter discusses different aspects in the gravity model and proposes solutions to untangle them. This allows me, among others, to evaluate the impact of four different Brexit scenarios.

In Chapter 2 I introduce “untangling normalization”. Fixed effects (FE) in panel data models overlap each other and prohibit the identification of the impact of “constant” regressors. Think of regressors that are constant across countries in a country-time panel with time FE. The traditional approach is to drop some FE and constant regressors by normalizing their impact to zero. I introduce untangling normalization, meaning that I orthogonalize the FE and, if present, the constant regressors. The untangled FE are easier to interpret. Moreover, I can exploit the constant regressors and shrink the resulting FE. If they are zero, the true values of the impacts of the constant regressors are identified, so untangling facilitates identification and I can test for this. I apply the approach to a gravity model for OECD countries' exports to the US. The constant regressors US GDP, world GDP and the US effective exchange rate are not identified due to the time FE. I find that the regressors explain 98% of the time FE, making the latter redundant. Hence, I achieve identification.

In Chapter 3 I derive a real gravity equation and gain several new insights that were hidden in the nominal specification used so far. Most importantly, the real effective exchange rate (REER) of the exporter and, via the importer's terms of trade, also the importer's REER matter, and the identification of the elasticity of substitution is possible. I estimate real gravity for 18 OECD countries. Therefore, I extend the untangling normalization method from an *it* to an *ijt* panel data model and use it to exploit all variables suggested by theory, despite a broad set of FE. I find that both REERs are important and estimate an elasticity of substitution of 1.5. If I assume homogeneous parameters, as is common, the remaining unexplained exporter-time and importer-time deviations are still substantial, relaxing this assumption improves this. I now explain 64 and 70% of the exporter-time and importer-time deviations, respectively, and thus the majority of the exporter and importer multilateral resistances. Untangling normalization helps to get a better view of what is still unexplained by theory.

Finally, in Chapter 4 I develop an index for economic integration accounting for its gradual and bilateral nature: the Gradual And Bilateral Integration (GABI) index. The graduality captures differences in the depth and path of five stages in economic integration and is an improvement over the use of binary dummy variables. Its bilateral nature allows for country-pair differences, which is not possible with the multilateral indexes in existing literature. I apply the GABI index to a gravity model for 18 OECD countries and estimate the impact of the five stages on exports. The estimates for these five stages allow me to investigate four different Brexit scenarios in a general equilibrium analysis, ranging from soft to cliff edge Brexit. I find that in the latter scenario real export of the UK decreases by a significant 32% in the long run. Other EU countries also experience a decrease in real export, while non-EU countries experience an increase due to trade diversion effects. Similarly, I also investigate potential future free trade agreements like Transatlantic Trade and Investment Partnership (TTIP).