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ECON 270: International Trade

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Honey, I Can't Find Comparative Advantage[1]

INTRODUCTION

The theory of comparative advantage is a staple of every introductory economics class, but examining how it manifests in actual trade patterns is no simple task. Smith and Ricardo formulated comparative advantage with a two-good model, and the comparative-advantage-inspired Hecksher-Olin and Stolper-Samuelson theories share similar assumptions. These theories can be expanded to more than two goods, but the real world is more complex: the Harmonized Tariff Schedule covers over 17,000 specified goods, for example. The variety of goods combines with other realities, like those found in Krugman's new trade theory, that muddy the waters for an examination into comparative advantage using Smith and Ricardo's framework. This paper will examine bilateral trade patterns between 1,242 country pairs and see if there is increased trade between countries that have different GDP distributions among economic sectors. I find that there is little evidence of comparative-advantage-based trade using this proxy for comparative advantage.

Attempts to confirm comparative-advantage-driven trade are not unprecedented. Costinot and Donaldson (2012) use agricultural data that describe the productivity of certain parcels of land in producing 17 crops and find empirical evidence of Ricardo's ideas. Bernhofen and Brown (2005) used a comparative advantage lens to quantify Japan's benefits from trade after

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[1] This title was inspired by the title of a paper Professor Anderson showed me during his office hours.

Commodore Perry's arrival in the 19th century. A variety of econometric measures of comparative advantage have appeared as well. In 1961, Bela Balassa introduced "revealed comparative advantage" ("RCA") which divides a country's exports of a given good by the country's total exports, which then divides the world exports of that good by total world trade. This provides a measure of comparative advantage as it compares whether a country exceeded what its "fair share" of exports would have been if all countries exported an amount proportional to their whole exports.

This paper will examine comparative advantage using the gravity model of international trade. Anderson et al. (2022) used the gravity model as a control in their study of the impact of homicide rates on international trade. Similarly, Rose (2000) used it as a control in his examination of common currencies and their impact on trade. Rose created his dataset using United Nations trade data and United States International Trade Commission data on gravity model related statistics. This paper will use the same data for trade and gravity metrics. I use World Bank data on broadly defined economic sectors to measure economy similarity.

If comparative-advantage-based trade appears in real life, then countries with dissimilar economies will trade more than those with similar economies after accounting for gravity-model effects. In the following section I will further describe the data I use for this analysis. In section 3 I detail this paper's empirical strategy. In section 4 I discuss the results, and in section 5 I conclude.

DATA

Finding data for this analysis was relatively easy. The US International Trade Commission publishes statistics useful for examining gravity-model trade, though it does not publish the trade volumes themselves. The UN Comtrade Database aggregates annual bilateral import and export flows for country pairs. Unfortunately, downloading this data is no easy task—downloads are limited to a single country's bilateral trade for at most five years. Due to this limitation, this paper only analyzes bilateral trade between 2000 and 2014 where at least one of the parties is either the United States, China, Japan, Germany, the United Kingdom, India, South Africa, and/or Brazil. The first six countries in the previous list are the six largest economies. I included South Africa and Brazil for income and geographic diversity. Unfortunately, the selection process was somewhat arbitrary, but it would have been a pain to manually download the data for all countries in the 15-year window. Despite the limitations, we are left with 16,154 observations, where each observation is bilateral trade in a year between 2000 and 2014 (inclusive) to which the US, China, Japan, Germany, the UK, India, Brazil, and/or South Africa was a party.

As stated in the introduction, thousands of products are traded internationally. Analyzing all of them would be impossible. Some aggregation is necessary, obviously, but there aren't many datasets that do this consistently for multiple countries over time. I found the World Bank's data on broad economic sectors an accessible way of measuring a country's comparative advantage. The data contain four sectors—"Industry," "Agriculture," "Services," and "Manufacturing"—measured as a fraction of a country's GDP. This level of aggregation leaves much to be desired, but this is the most extensive dataset I could find. Besides, disaggregating sectors further would increase complexity and perhaps cause some countries to be excluded.

I believe this data can be used to analyze a country's comparative advantage. According to the comparative advantage theories (Ricardo, Stolper-Samuelson, Hecksher-Olin, etc.), a country should specialize by producing the product in which it has a lower opportunity cost than its trading partners. We can't examine those opportunity costs directly, but we can examine the increased production of the good that's traded—or that sector's contribution to the country's total economic output, as in our case. I understand this approach has limitations, especially when the economic sector data is so aggregated, but for a basic analysis on so many countries it might be appropriate.

To measure a country's comparative advantage relative to another country I created a variable called "sector differences" for each observation. For pair *ij* at time *t*, "sector differences" is calculated with the following formula:

Equation (1): Sector Differences

$$\text{Sector Differences}_{ijt} = \left|\text{Industry }\%_{it} - \text{Industry }\%_{jt}\right| + \left|\text{Agriculture }\%_{it} - \text{Agriculture }\%_{jt}\right| + \left|\text{Manufacturing }\%_{it} - \text{Manufacturing }\%_{jt}\right| + \left|\text{Services }\%_{it} - \text{Services }\%_{jt}\right|$$

Countries with very similar sector breakdowns will have a very low sector differences variable. For example, Brazil and Croatia had a sector differences value of 1.25 percentage points in 2006, the lowest in the sample. Japan and Liberia had a sector differences value of 173 percentage points in 2002, the largest in the sample. Germany and Ecuador had a sector differences value of 38.9 in 2011, the median. The maximum possible country differences value is 200 percentage points (the countries have no economic sector overlap), and the lowest is zero (the countries have the exact same economic sector breakdown). I believe this is an appropriate measure of relative comparative advantage because we are only interested in the relative difference between two countries and its size, not the specific sectors where a country gets that advantage, and it's easy to put in a regression.

I combined the Comtrade and USITC data and defined total trade as imports plus exports, consistent with economic literature (Rose, 2000). I then added the World Bank economic sector data. After dropping observations that lacked sector data, trade data, GDP data, or other important gravity-model statistics and those that were duplicates, we are left with 16,154 observations. This covers 1,242 country pairs over 15 years, 839 of which have observations for all 15 years. Of the eight countries for which bilateral trade data was downloaded (the US, China, Japan, Germany, the UK, India, Brazil, and South Africa), all except China had about 2,100 observations. China started reporting trade data in 2004, so it has just over 1,600 observations. Thus, a country not in the list above can appear at most 116 times (15 × 7 + 11). Of the 152 countries not in the list of eight, 111 have observations for all eight countries in all available years. Below are statistics for key variables.

Table 1: Summary Statistics

Variable	Mean (std. dev.)	Median	Minimum	Maximum
Year			2000	2014
Sector Differences	42.8 (24.9)	38.9	1.24	174
Total Trade ($)	6.22 billion (28.2 billion)	282 million	325	667 billion
GDP per Capita ($)	17,834 (20,147)	6,467	139	118,824
GDP ($)	2.61 trillion (4.66 trillion)	263 billion	63.1 million	17.5 trillion
Distance (km)	8,335 (4,024)	8272	343	18,966

Empirical Strategy

To estimate whether and how strongly comparative advantage patterns influence trade, I will regress bilateral trade for various country pairs on differences in their economies, along with the other components of the gravity model. Following Rose's framework, the natural log of total trade is regressed on the natural log of distance, the natural log of the product of the countries'

GDPs, the key variable of interest sector differences, and then any other controls. We first estimate the simple version, detailed below in equation (2), which will include only the gravity model components as controls.

Equation (2): Basic Regression

$$\ln\left(\text{Bilateral Trade}_{ijt}\right) = \alpha + \beta_1\left(\text{Sector Differences}_{ijt}\right) + \beta_2\left(\ln\left(\text{Distance}_{ij}\right)\right) + \beta_3\left(\ln\left(\text{GDP}_{it}\times\text{GDP}_{jt}\right)\right) + \mu_{ijt}$$

I then add another variable Rose used in his regressions: the natural log of the product of GDP per capita for the two countries. This is an appropriate control because we want to ensure the coefficient on sector differences explains only what is due to differences in the economies' comparative advantage, not what might happen due to wealth. Wealthy countries are often more open to free trade while simultaneously being more concentrated in services and less concentrated in agriculture. Equation (3) controls for the product of the countries' per capita GDP.

Equation (3): Basic Regression + GDP per Capita Control

$$\ln\left(\text{Bilateral Trade}_{ijt}\right) = \alpha + \beta_1\left(\text{Sector Differences}_{ijt}\right) + \beta_2\left(\ln\left(\text{Distance}_{ij}\right)\right) + \beta_3\left(\ln\left(\text{GDP}_{it}\times\text{GDP}_{jt}\right)\right) + \beta_4\left(\ln\left(\frac{\text{GDP}_{it}}{\text{Pop}_{it}}\times\frac{\text{GDP}_{it}}{\text{Pop}_{it}}\right)\right) + \mu_{ijt}$$

In the third specification, I make controls for common language (l), common legal origin (o), and the existence of a trade agreement between the two countries (f). I also include fixed effects for the eight main countries for which I downloaded data (e) and the 152 other countries (m). Pair fixed effects were not possible due to limitations in the school's Stata subscription—recall that there are 1,242 pairs.

Equation (4): Regression with All Fixed Effects

$$\ln(\text{Bilateral Trade}_{ijt}) = \alpha + \beta_1(\text{Sector Differences}_{ijt}) + \beta_2(\ln(\text{Distance}_i)) +$$
$$\beta_3(\ln(\text{GDP}_{it} \times \text{GDP}_{jt})) + \beta_4\left(\ln\left(\frac{\text{GDP}_{it}}{\text{Pop}_{it}} \times \frac{\text{GDP}_{it}}{\text{Pop}_{it}}\right)\right) + \text{I}_{lofem} + \mu_{ijt}$$

In the final model, I run the full regression again, but include an interaction term between sector differences and the inverse of the natural logarithm distance. This is because there could be a compounding effect of the two variables. Due to transport costs, a country might not trade with the country with the highest comparative advantage in a given product and will instead source imports from a closer country.

Equation (5): Sector Differences and Distance Interaction

$$\ln(\text{Bilateral Trade}_{ijt}) = \alpha + \beta_1(\text{Sector Differences}_{ijt}) + \beta_2(\ln(\text{Distance}_{ij})) +$$
$$\beta_3(\ln(\text{GDP}_{it} \times \text{GDP}_{jt})) + \beta_4\left(\ln\left(\frac{\text{GDP}_{it}}{\text{Pop}_{it}} \times \frac{\text{GDP}_{it}}{\text{Pop}_{it}}\right)\right) +$$
$$\beta_5\left(\text{Sector Differences}_{ijt} \times \frac{1}{\ln(\text{Distance}_{ij})}\right) + \text{I}_{lofcem} + \mu_{ijt}$$

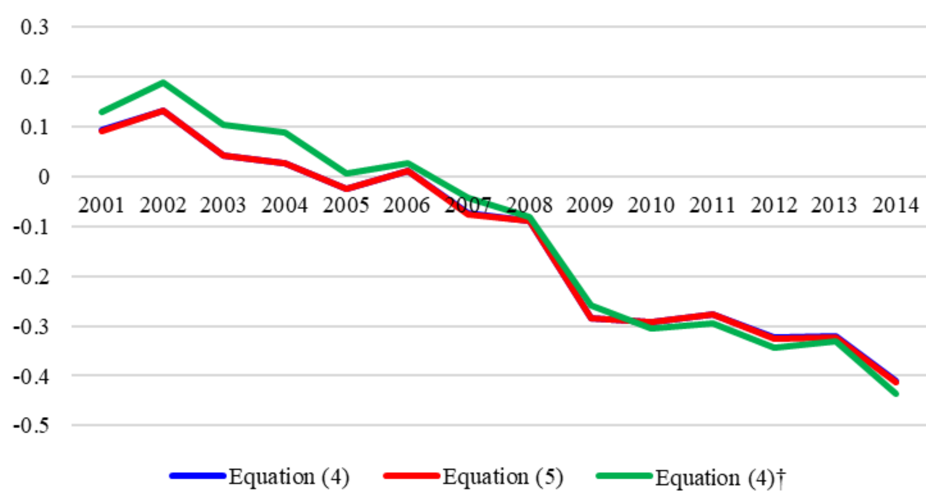
RESULTS

First, this analysis confirms the gravity model of international trade. Trade patterns are largely explained by economic size of trading partners and the distance between them with great statistical significance. Other important control variables like common legal origin, common language, and the existence of a trade agreement have positive coefficients, as expected.

Also notable are the coefficients for the eight major countries. India has the lowest of the eight, -0.39 relative to Brazil's (which was dropped to avoid multicollinearity). Germany has the highest fixed effect of the eight, 0.88 relative to Brazil's. This makes sense given Germany's proximity to other large economies and its relative openness to trade. In both regressions (4) and (5), the ranking among the eight is constant: India, Brazil, United States, United Kingdom, Japan, South Africa, China, and Germany. This consistency is unsurprising considering equations (4) and (5) differ only by the inclusion of the interaction term in (5).

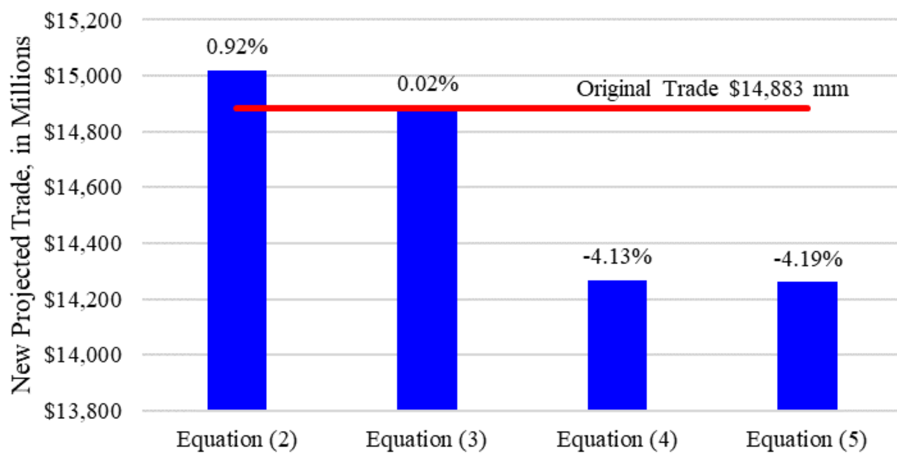
Year fixed effects have been lower for more recent years, and a consistent downward trend begins in 2002. This is interesting because the trade volumes are not adjusted for inflation. What's more, the 15-year span encompasses a variety of economic environments—recessions, expansions, the rise of China, and more. Perhaps trade growth was explained by other control variables, but I felt it was worth graphically representing this decline. I do so in Figure (1). Equations (4) and (5)'s year fixed effects match eachother closely again.

Figure (1): Year Fixed Effects



The results for the comparative advantage proxy—sector differences—are inconclusive. The first two regressions, equations (2) and (3), show small positive relationships with trade. The last two regressions find a larger negative impact. Figure (2) contextualizes these coefficients with the US-Sweden trade relationship in 2014. The coefficient from the first regression is what one might expect if comparative-advantage-based trade holds. With the US-Sweden 2014 example, a 10 percentage point increase in sector differences is associated with a 0.9% increase in trade in equation (2), or $136 million dollars more in trade. Equation (3)'s coefficient is so small that a change in sector differences has almost no impact on trade—the whole effect is eliminated with the inclusion of the natural log of the product of the countries' GDP per capitas. Equations (4) and (5) show unexpected results: Trade *decreases* when the two countries' economies are different, and the effects are large. In the US-Sweden example, a 10 percentage point increase in sector differences is associated with a 4.2% drop in trade for both equations, or $620 million decrease in trade. The coefficients in (4) and (5) have the highest statistical significance.

Figure (2): Impact of Ten Percentage Point Increase in US-Sweden Sector Differences on 2014 Trade



Original US-Sweden Sector Differences Value: 14.3 percentage points

Table 2: Result of Regressions

Equation	(2)	(3)	(4)	(5)	(4)†
Sector Differences	0.000912* (0.000508)	0.0000246** (0.000513)	-0.00422*** (0.000718)	-0.0145** (0.00631)	-0.00212** (0 .00108)
Ln(Distance)	-1.02*** (0.0158)	-1.03*** (0.0160)	-1.11*** (0.0195)	-1.07*** (0.0286)	-1.25*** (0 .0268)
Ln(GDP×GDP)	0.930*** (0.00526)	0.959*** (0.00650)	1.21*** (0.143)	1.22*** (0.143)	1.33*** (0.232)
Ln(GDP/pop × GDP/pop)		-0.0679*** (0.00685)	-0.450*** (0. 145)	-0.456*** (0.145)	-0.558** (0 .234)
Sector Diff / Ln(Distance)				0.0912* (.0550)	
Common Language			0.0777** (0.0313)	0.0809*** (0.0314)	.170*** (0.0412)
Common Legal Origin			0.456*** (0.0442)	0.453*** (.0443)	0.408*** (0 .0587)
Trade Agreement			0.365*** (0.0232)	0.371*** (0.0233)	0.299*** (0.0325)
Constant	-20.4*** (0.317)	-20.5*** (0.318)	-26.1*** (5.78)	-26.7*** (5.78)	-31.1*** (8.45)
Year FE?	No	No	Yes	Yes	Yes
Country FE?	No	No	Yes	Yes	Yes
Observations	16,154	16,154	16,154	16,154	11,583

* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level
† Excludes high-income countries if they are not part of the main eight for which I downloaded data, defined as inflation adjusted per-capita GDP of above $12,000

Why might trade increase if economies become similar? Perhaps trade is simultaneously dominated by intra-industry trade and trade between wealthy countries, both of which cause the results in (4) and (5) despite the controls. As a robustness check, I performed a regression for equation (4) again, dropping all observations where a country was high income (excepting the eight for which I downloaded data). I define high income as an inflation-adjusted GDP per capita greater than $12,000, mirroring the definition of the World Bank. One hundred thirteen countries were not high income. This modified dataset includes 11,583 observations for 912 bilateral trade pairs. I label this analysis (4)† in table (2). This analysis yields a coefficient about half the size of the original equation (4), but still negative. It appears the results in (4) and (5) are not a fluke, and we must find other explanations for these negative coefficients.

This returns us to a criticism I preempted in the Data section of this paper—these economic sectors are too aggregated to analyze comparative advantage. Trade might not be dominated by intra-industry trade, but instead by intra-sector trade. Indeed, Costinot and Donaldson's analysis focused entirely on comparative advantage *within* the agricultural sector, which is aggregated into one monolith here. This is surely applicable to manufacturing, services, and industry. It should not be a surprise, then, that the data don't show comparative advantage. Despite the aggregation, however, I am surprised by the negative coefficients on sector differences.

CONCLUSION

This paper analyzed comparative-advantage-based trade through differences in GDP economic sector breakdowns. I found that increased differences in economic sector breakdowns are associated with decreased trade, contrary to what comparative advantage leads us to believe. The results imply the gravity model of trade explains most trade between countries. Besides this already-confirmed observation, the analysis demonstrates the difficulty of empirically measuring comparative-advantage-based trade. Future analysis into this area should use data that is less aggregated than the economic sector data here to measure comparative advantage.

Appendix A: List of Countries

Afghanistan; Albania; Algeria; Angola; Antigua and Barbuda; Argentina; Armenia; Aruba; Australia; Austria; Azerbaijan; Bahrain; Bangladesh; Barbados; Belarus; Belgium; Belize; Benin; Bermuda; Bhutan; Bolivia; Bosnia and Herzegovina; Botswana; **Brazil***; Burkina Faso; Burundi; Cambodia; Cameroon; Canada; Cayman Islands; Central African Republic; Chad; Chile; **China***; Colombia; Costa Rica; Cote d'Ivoire; Croatia; Cuba; Cyprus; Denmark; Dominica; Dominican Republic; Ecuador; Egypt, Arab Rep.; El Salvador; Equatorial Guinea; Estonia; Fiji; Finland; France; Gabon; Gambia, The; Georgia; **Germany***; Ghana; Greece; Greenland; Grenada; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hungary; Iceland; **India***; Indonesia; Iraq; Ireland; Israel; Italy; Jamaica; **Japan***; Jordan; Kazakhstan; Kenya; Kiribati; Kuwait; Latvia; Lebanon; Lesotho; Liberia; Libya; Lithuania; Luxembourg; Madagascar; Malawi; Malaysia; Maldives; Mali; Malta; Marshall Islands; Mauritania; Mauritius; Mexico; Moldova; Mongolia; Montenegro; Morocco; Mozambique; Myanmar; Namibia; Nepal; Netherlands; New Zealand; Nicaragua; Niger; Nigeria; Norway; Oman; Pakistan; Palau; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Poland; Portugal; Qatar; Romania; Rwanda; Samoa; Sao Tome and Principe; Saudi Arabia; Senegal; Serbia; Seychelles; Sierra Leone; Singapore; Slovenia; **South Africa***; South Sudan; Spain; Sri Lanka; Sudan; Suriname; Sweden; Switzerland; Tajikistan; Tanzania; Thailand; Togo; Tonga; Trinidad and Tobago; Tunisia; Turkmenistan; Turks and Caicos Islands; Uganda; Ukraine; United Arab Emirates; **United Kingdom***; **United States***; Uruguay; Uzbekistan; Vanuatu; Zambia; Zimbabwe

* *Indicates the country was one of the major countries for which data was downloaded—all bilateral trade observations have at least one of these countries as a party*

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