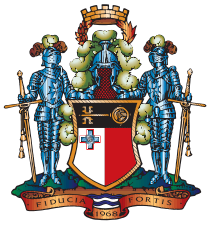

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THE GRAVITY MODEL FOR MALTESE GOODS EXPORTS AND IMPORTS

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BOX 3: THE GRAVITY MODEL FOR MALTESE GOODS EXPORTS AND IMPORTS[1]

Introduction

Gravity models are equations that attempt to explain trade flows between countries. Generally, they are based on theories of international trade which suggest that pairs of countries which are close, either geographically or in terms of cultural similarities, will tend to trade more often with each other than with more distant countries. Gravity models consider factors like geographical distance, languages or common historical links as determinants of trade flows. The distance variable can be looked at as a proxy for transportation costs, which of course are a key variable to trade. Furthermore, gravity models try to account for the possibility that larger countries with a larger combined "economic mass" will have a larger GDP and will tend to trade in larger volumes than countries with smaller economic mass. Hence, a relatively limited number of variables would describe a good proportion of trade patterns between countries. In turn, this explains why gravity models have gained prominence over alternative models of international trade.

Malta's economy emerged from a system based around the servicing of British military forces, over time developing in a very dynamic economy in the Mediterranean region, with high value-added goods exports, tourism as well as financial services exports. This development reflected a number of policy measures, which allowed a continued process of economic renewal to take hold and led to the attraction of new industries. This process allowed Malta to be resilient to shocks in the global economy, allowing for periods of strong economic growth and improved living standards.

In fact, over the period 1965 to 2017, Malta's economic growth reflected its foreign trade performance. Total trade as a percentage of nominal GDP stood at 157.0% in 1965, rising to 254.0% in 1995, and reaching a high of 325.9% in 2012. Key turning points in Malta's economic development came with the signing of an association agreement with the European Economic Community (EEC) in 1970, the setting up of an international financial services centre in the mid-1990s, and the accession to the European Union in 2004.

Nonetheless, this growth in Malta's foreign trade has not drawn much attention from researchers. Indeed, the available studies on Malta's trade patterns focus on the composition of Maltese trade with the expected impact of the 2008/9 crisis, (Azzopardi, 2009),[2] and a simple gravity model analysis on merchandise trade flows between Malta and the EU (Spiteri, 2008).[3] The gravity model equations in Ellul (2019) are the first attempt to explain the historical development of export growth over time in Malta using these methodologies, and focusing on trade agreement effects.[4]

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[1] Prepared by Reuben Ellul. The author is a Principal Economist within the Economic Analysis Department at the Central Bank of Malta. The views expressed are those of the author and do not necessarily reflect those of the Central Bank of Malta. Any errors are the author's own.

[2] Azzopardi, R.M. (2009), 'Malta's Open Economy: Weathering the Recessional Storm?,' *South European Society and Politics*, vol. 14, no. 1, pp. 103-120.

[3] Spiteri, J. (2008), 'Malta - EU Merchandise Trade Flows: A Gravity Model Approach,' University of Malta: Msida.

[4] Ellul, R. (2019), "The gravity model for Maltese goods exports and imports," *CBM Working Paper* WP/01/2019, Central Bank of Malta.

The gravity model estimates for Malta

Trade data used in Ellul (2019) are sourced from the International Monetary Fund Direction of Trade Statistics. They cover the period from 1960 to 2016. There are more than 200 countries and territories included, with coverage depending on data availability. Information relating to geographical distances, common cultural background, including languages and colonial history, are obtained from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) databases, following Mayer and Zignago (2011).[5] In terms of methodology, the basis for gravity models is Sir Isaac Newton's law of universal gravitation. One of the earliest applications in economics belongs to Tinbergen (1962).[6] This model attempts to link trade flows between countries and with their respective GDP, geographical distance, and other factors affecting trade – such as common languages and cultural backgrounds (Anderson and van Wincoop, 2003).[7] In the simplest form, following Santos Silva and Tenreyro (2006),[8] the econometric model for stochastic gravity states that

$$T_{ijt} = K_0 \frac{M_{it}^{\beta 1} M_{jt}^{\beta 2}}{D_{ij}^{\beta 3}} \varepsilon_{ijt}$$

where T_{ijt} is the bilateral trade flow between countries i and j in period t, M_{it} and M_{jt} are the GDP of country i and country j in period t, respectively; D_{ij} is the bilateral distance between country i and j, K_0 is an unknown constant while $\beta 1$, $\beta 2$ and $\beta 3$ are unknown parameters. The basic equation is extended with other characteristics that affect bilateral trade, such as sharing a common border, historic colonial ties, entry into regional trade agreements, and tariffs. The equation is traditionally converted into linear form through logarithms, and estimated by ordinary least square (OLS) methods, such that

$$ln\, T_{i\,j\,t} = \alpha_0 + \beta_1 ln\, M_{i\,t} + \beta_2 ln\, M_{j\,t} - \beta_3 ln\, D_{i\,j} + \epsilon_{i\,j\,t}$$

where $\alpha_0 = ln\, K_0$ and $\epsilon_{i\,j\,t} = ln\, \varepsilon_{i\,j\,t}$. This approach, while popular, was not originally based on micro-founded economic theories. Theoretical foundations for gravity models were eventually developed in the 1970s and 1980s. These equations included multilateral resistance terms to account for trade barriers, and elasticities of substitution between goods.

Ellul (2019) uses OLS, Poisson pseudo-maximum likelihood (PPML) methods, zero-inflated Poisson methodologies, and a Heckman estimator to estimate gravity equations applied to different datasets and periods.[9] As a caveat, one has to remember that these methodologies have different assumptions which may lead to differing results. A number of attributes common in the gravity literature are included as regressors in the equation. These include

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5 Mayer, T. and Zignago, S. (2011), 'Notes on CEPII's distances measures: the GeoDist Database,' CEPII Working Paper, 2011-25. The CEPII provides a large set of variables covering a wide array of geographical characteristics for almost all countries in the world.

6 Tinbergen, J. (1962), 'Shaping the World Economy: Suggestions for an International Economic Policy,' Books (Jan Tinbergen). Twentieth Century Fund, New York. Retrieved from http://hdl.handle.net/1765/16826.

7 Anderson, J. E. and van Wincoop, E. (2003), 'Gravity with Gravitas: A Solution to the Border Puzzle,' American Economic Review, 93 (1): 170-192. DOI: 10.1257/000282803321455214

8 Santos Silva, J. and Tenreyro, S. (2006), 'The Log of Gravity,' *The Review of Economics and Statistics*, 88, issue 4, pp. 641-658.

9 For more details on the methodologies discussed in this paper, kindly refer to Ellul, R. (2019), "The gravity model for Maltese goods exports and imports," *CBM Working Papers* WP/01/2019, Central Bank of Malta.

partners' GDP level, and Malta's GDP, distance between Malta and its respective bilateral partner, population, partners' geographical size, a variable that accounts for a common official language, a variable that represents a common colonial background, as well as dummies to account for Malta's membership in the EU and its association agreement with the EEC.

The main results from the study are that Maltese trade in goods is negatively affected by distance, and positively affected by a set of other variables which account for historical and cultural links.

The estimated values for the distance coefficients are broadly stable across methodologies and robustness checks employed (see Table 1). Nominal figures for the period 1960-2016 show how for every 10.0% difference in distance, exports and imports fall by 11.1% and 7.5% respectively, on average across the methodologies used. In real terms, a 10.0% difference in distance decreases real exports by 6.9%, on average, across the methodologies, and imports by 5.5%. Subsidiary gravity equations based on trade excluding fuel, aircraft and ships returned very close results to the previous estimates with respect to distance coefficients. However, differences emerged for the variables accounting for institutional and cultural backgrounds. Once these specific trade sectors are excluded, the likelihood of importing goods from countries with similar backgrounds becomes broadly insignificant.

Table 1
ESTIMATES FOR VARIABLE COEFFICIENTS

	Period	OLS		PPML		ZIP		Heckman (Exact Id.)		Heckman (Over Id.)		Heckman (2-step)		Average
Exports														
Distance coefficient (elasticity)														
Nominal	1960-2016	-1.1	***	-0.7	**	-		-1.2	***	-1.2	***	-1.4	***	-1.1
Excl. trade in fuel, ships, aircraft.	2000-2017	-0.9	***	-0.9	***	-		-1.0	***	-0.9	***	-1.0	***	-1.0
Real	1960-2016	-0.9	***	-		-		-0.5	***	-0.9	***	-0.5	***	-0.7
% more likely to trade														
Nominal														
Common language	1960-2016	59.2	*	-		-		-		-		68.6	***	63.9
Common colony	1960-2016	109.6	**	148.6	**	-		130.9	***	124.3	***	164.1	***	135.5
Excl. trade in fuel, ships, aircraft.														
Common language	2000-2017	-		65.3	**	-		-		-		71.6	***	68.5
Common colony	2000-2017	87.5	*	115.9	***	-		102.7	**	59.0	*	123.1	***	97.6
Imports														
Distance coefficient (elasticity)														
Nominal	1960-2016	-0.6	***	-1.1	***	-		-0.7	***	-0.7	***	-0.7	***	-0.7
Excl. trade in fuel, ships, aircraft.	2000-2017	-0.9	***	-1.0	***	-		-0.9	***	-0.9	***	-0.9	***	-0.9
Real	1960-2016	-0.5	**	-0.9	***	-0.8	***	-0.3	*	-0.5	**	-0.3	***	-0.6
% more likely to trade														
Nominal														
Common language	1960-2016	158.5	***	-		-		163.6	***	160.2	***	263.4	***	186.4
Common colony	1960-2016	-		148.6	**	-		-		-		71.9	***	110.2
Excl. trade in fuel, ships, aircraft.														
Common language	2000-2017	209.8	**	-		-		206.0	***	208.6	***	-		208.1
Common colony	2000-2017	-		-		-		-		-		33.7	***	33.7

Sources: Ellul (2019); author's calculations.

*Significant at the 10% level, **Significant at the 5% level, ***Significant at the 1% level.

The importance of trade agreements

While data limitations and breaks in time series have to be considered, the estimates indicate that after correcting for variables such as country distance, country and population size, the EEC-Malta Association Agreement and EU accession had strong and significant impacts on both exports and imports (see Table 2). However, the former had a stronger impact on goods exports than Malta's entry in the EU. In contrast, Malta's entry in the EU had a stronger impact on goods imports. This finding may reflect the fact the Association Agreement opened up European markets for Maltese exports, while import controls were only completely lifted in the run up to EU accession.

Finally, one must note that over the roughly fifty years analysed, Malta passed through a sustained period of very strong change to its economic fabric. This history was marked by trade-driven economic success. In turn, this leads to particular data volatility which has to be highlighted, along with other limitations of this study.

The use of Customs data is affected by particular trade phenomena, such as the re-export of fuel oils by Maltese bunkering operators, and highly integrated firm specific value-chain trade. Such value chains may negate established norms in gravity modelling, such as distance. Moreover, services flows, which have grown significantly in recent years, are excluded from this analysis. The services sector may have experienced a different outcome to the manufacturing industry following EU accession. Finally, the imperfect measuring of price indices is also a caveat for the analysis of real trade flows.

Estimates in the study show how Malta's economic progress benefitted from trade agreements. The very strong rates of goods export growth registered over the past decades are indicative of a complete structural change in the fabric of the Maltese economy since 1960. This change was facilitated by trade agreements. The success story for trade in goods may now be dwarfed by the more recent successes the Maltese economy is registering in services. However, the estimates presented here confirm how economic development in Malta comes arm-in-arm with greater trade integration.

Table 2
ESTIMATES FOR TRADE AGREEMENT COEFFICIENTS

	OLS		PPML		ZIP		Heckman (Exact Id.)		Heckman (Over Id.)		Heckman (2-step)		Average
Exports													
MT EC Agreement													
Nominal	137.1	**	-		-		135.7	**	136.9	**	134.4	***	136.0
Real	1,033.3	***	520.8	***	1,081.1	***	943.8	***	2,222.2	***	918.8	***	1,120.0
MT EU Membership													
Nominal	-		-		-		-		-		-		-
Real	662.7	***	-		-		247.2	***	379.9	***	230.9	***	380.2
Imports													
MT EC Agreement													
Nominal	112.6	**	-		-		108.6	**	111.1	**	108.3	***	110.1
Real	2,218.9	***	247.6	***	775.9	***	1,747.3	***	3,655.3	***	1,342.3	***	1,664.5
MT EU Membership													
Nominal	448.8	***	-		-		437.6	***	445.1	***	437.9	***	442.3
Real	3,624.0	***	284.8	***	-		2,061.3	***	3,478.0	***	1,701.4	***	2,229.9

Sources: Ellul (2019); author's calculations.

*Significant at the 10% level,**Significant at the 5% level,***Significant at the 1% level.