

To log or not to log,

OR

How to estimate a gravity model?<sup>§</sup>

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**Abstract**

This study compares two alternative approaches to estimation of the gravity model using the trade flow data at the aggregate as well as at the disaggregate levels according to the ISIC. Specifically, we compare the traditional OLS approach applied to the log-linear form of the gravity model with the Poisson Quasi Maximum Likelihood (PQML) estimation procedure applied to non-linear multiplicative specification of the gravity model. Our main conclusion is that both the estimation results as well as the results of the regression misspecification tests provide a supporting evidence for the PQML estimation approach over the OLS estimation method.

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# 1 Introduction

Since the seminal works of Tinbergen (1962) and Linnemann (1966), the gravity models have been extensively applied in explaining various economic phenomena such as regional patterns of trade, of foreign direct investment, and migration, to mention just few most popular areas of application. Despite the fact that the gravity equation is formulated in multiplicative form, majority of the studies have estimated the parameters of interest using the log-linearised form as it has been originally suggested in Tinbergen (1962) and Linnemann (1966). Clearly, at the time of introduction of gravity models their estimation in the multiplicative form has been prohibitively expensive both in terms of time and computing power if ever possible. This is no longer true given the advances of computing facilities. Notwithstanding that the conventional practice is still to estimate the parameters of gravity equations in log-linearised form, as we have already mentioned above. Moreover, this is also true in a wide range of various economic applications where the original equation in the multiplicative form for the purpose of estimation first being transformed either using the logarithms or some other nonlinear function, as noted in Santos Silva and Tenreyro (2006).

The question of consistent estimation of model parameters in such situations have been already addressed in the literature, (e.g. see Goldberger, 1968; Manning and Mullahy, 2001). Santos Silva and Tenreyro (2006) contribute to the discussion on which estimation approach yields more credible results by assessing the potential bias of the elasticities in the log-linearised regression models both via both rather small-scale Monte Carlo simulations and a single empirical example. Based on this somewhat limited evidence, they strongly recommend that the gravity type models in particular as well as other constant-elasticity models in general should be estimated in the multiplicative form and suggest a simple quasi-maximum likelihood estimation technique based on Poisson regression for this purpose. According to Santos Silva and Tenreyro (2006), the Poisson Quasi Maximum Likelihood (PQML) estimator is not prone to the drawbacks of the OLS estimation procedure in such cases – problematic handling of zero observations and, more importantly, its crucial reliance on a very restrictive, and, therefore, rather unrealistic assumption on the error term that ensures its consistency – and therefore it offers a viable alternative that is likely to seriously challenge the established practice. Nonetheless, at present the OLS estimation of gravity model parameters still remains a dominant procedure in applied trade studies, from which policy evaluations and policy prescriptions are often being made.

The main contribution of this paper is that we provide a more comprehensive empirical evidence on the comparative advantage of the Poisson Quasi Maximum Likelihood (PQML) procedure over the traditional OLS estimation method. In doing so, we apply both the OLS and the PQML estimators to the Bergstrand's (1989) generalised gravity model of trade at the industry level. For this purpose, we use the trade flows amongst the 22 OECD countries in all products combined, agriculture, mining and quarrying, manufacturing products as a whole and broken down by 25 three-digit ISIC Rev.2 industries. Hence, our empirical evidence will be based on the 29 gravity models estimated using the aggregated trade flows (as in Santos Silva and Tenreyro, 2006) and the more disaggregated trade flows for the various industries. To the best of our knowledge, the PQML estimator has not been applied so far to the gravity model specified using industry

level data.

For the given data at hand, in our comparative analysis of the estimation results of these two alternative procedures we proceed as follows. First, we compare the estimated elasticities for the aggregated data for all goods combined. This enables us to compare whether the conclusions reached in Santos Silva and Tenreyro (2006) on the differences in the estimated elasticities done using a different dataset that also contains aggregated trade flows hold in our data as well. Second, we will look at the differences in the obtained coefficient values using the data broken down in such narrower categories as agriculture, mining and quarrying, and manufacturing products as a whole. At this stage, we will see to which extent the conclusions on the differences between these two estimation approaches that are obtained for the aggregated data hold when the gravity model is estimated using more disaggregated data. Finally, we will investigate to which extent further disaggregation of the manufacturing goods according to the three-digit ISIC categories change the earlier obtained conclusions when the gravity model is estimated using the manufacturing data as a whole.

In particular, we intend to restrict ourselves to the following three main research questions. First, we would like to investigate whether the empirical finding of Santos Silva and Tenreyro (2006) that the total income elasticity tend to be smaller than a unity under the PQML but not under the OLS estimation procedure, reported for the aggregated trade flows, also holds for more disaggregated data. The finding that the total income elasticities are lower than unity is consistent with the observation that the trade-to-GNP ratio decreases with total GNP, i.e., the smaller is the country the more open it is to international trade, and hence would support the PQML estimation procedure rather than the OLS method.

Second, we intend to utilise the following feature of the generalised gravity model of Bergstrand (1989) which in addition to the usual “gravity” explanatory variables, i.e., the total income of the exporting and importing countries and the distance between them, also includes the capital endowment of the exporting country and the per-capita income of the importing country. Bergstrand (1989) shows that the capital-endowment elasticity can be used to identify capital-intensive versus labour-intensive goods whereas the per-capita income elasticity can be used to distinguish between necessities and luxuries in consumption. He does not give, however, an interpretation of the coefficients that refer to total income of the two countries. Schumacher and Siliverstovs (2006) show that in a gravity model with monopolistic competition in the spirit of Bergstrand (1989), there is also a home market effect, which appears when an elasticity of exports with respect to domestic income exceeds an importing country’s income elasticity, besides the comparative advantage effect arising from differences in factor endowment and per capita income. Thus, by considering the generalised gravity equation, we can not only see the differences in the estimated coefficient values as reported by either the OLS or the PQML procedures but also we can observe to which extent these two estimation procedures yield different results with respect to detecting the home market effect in various industries under consideration as well as with respect to identifying these industries as capital-intensive or labour-intensive, and as necessities or luxuries in consumption.

Third, we investigate whether the empirical finding reported in Santos Silva and Tenreyro (2006) that the trade deterring role of geographical distance is significantly larger under OLS also holds in our data at

the different (dis-)aggregation levels.

Fourth, the distinctive feature of Santos Silva and Tenreyro (2006) is that they do not only suggest an alternative gravity model estimation procedure but also provide the misspecification tests that can be applied either to the log-linear form or to the non-linear multiplicative form of the gravity model in order to verify model underlying assumptions. As Santos Silva and Tenreyro (2006) argue such a misspecification check is important as the consistency of the OLS estimator in the considered circumstances crucially depends on the very restrictive assumption on the properties of the error term that might not be so easily fulfilled in practice.

The paper proceeds as follows. Section 2 presents the generalised gravity model of Bergstrand (1989). Section 3 describes the data used in the empirical analysis. The next section discusses the gravity model estimation issues. Section 5 describes the obtained results. The final section concludes.

## 2 The generalised gravity equation

In international trade, bilateral gross aggregate trade flows between the countries are typically explained either by the following specification of the gravity model<sup>1</sup>

$$X_{ij} = e^{\alpha_0} (Y_i)^{\alpha_1} (Y_j)^{\alpha_2} (D_{ij})^{\alpha_3} \eta_{ij} \quad (1)$$

or by the following specification

$$X_{ij} = e^{\beta_0} (Y_i)^{\beta_1} (Y_i/L_i)^{\beta_2} (Y_j)^{\beta_3} (Y_j/L_j)^{\beta_4} D_{ij}^{\beta_5} \eta_{ij} \quad (2)$$

where  $X_{ij}$  is the U.S. dollar value of the trade flow from country  $i$  to country  $j$  that is explained by the “core” variables such as exporter and importer nominal income,  $Y_i$  and  $Y_j$ , usually expressed in terms of GNP of a corresponding country, and the distance variable,  $D_{ij}$ , as in equation (1) or, additionally, as well as by exporter and importer population variables,  $L_i$  and  $L_j$ , which may enter a gravity model either on their own<sup>2</sup> or via the per capita income values as in equation (2). Observe that usually a vector of dummy variables (not shown), which represent any other factor or their combination that exercise either promoting or deferring role for the bilateral trade between countries such as preferential trade agreements, historical ties, common language, etc., is added to equations (1) and (2). Lastly,  $\eta_{ij}$  is the error term.

Until recently, despite the overwhelming empirical success of the gravity model in explaining bilateral pattern of trade, the theoretical foundations underpinning this type of models have been rather underdeveloped. The first successful attempt to provide the formal theoretical justification to the gravity model as specified in equation (1) can be attributed to the following studies of Anderson (1979), Bergstrand (1985), and Helpman and Krugman (1985, ch. 8). Observe that albeit these studies have been able in the end to derive the multiplicative functional form of the gravity equation, exporter and importer per capita incomes

<sup>1</sup>See, for example, Tinbergen (1962), Poyhonen (1963), Geraci and Prewo (1977), Feenstra et al. (2001).

<sup>2</sup>See, for example, Linnemann (1966), Aitken (1973), Sattinger (1978), Sapir (1981).

(or, equally, populations), that enter equation (2), were ignored therein. Bergstrand (1989) introduces a significant advance in derivation of the theoretical foundations of the gravity model in the form of equation (2) by providing an analytical framework that is consistent with modern theories of trade. In doing so, he offered an explicit interpretation of exporter per capita income as a proxy for the country's capital-labour endowment ratio in the spirit of Heckscher-Ohlin, on one hand, and of importer per capita income as the taste preferences in the spirit of Linder (1961), on the other. Exporter and importer output is interpreted as national output in terms of units of capital and expenditure capabilities of an importing country, respectively.

Hence, the generalised gravity model of Bergstrand (1989) can be written as follows

$$X_{ij}^a = e^{\beta_0} (Y_i)^{\beta_1^a} * (c_i)^{\beta_2^a} * (Y_j)^{\beta_3^a} * (Y_j/L_j)^{\beta_4^a} * D_{ij}^{\beta_5^a} * \eta_{ij}, \quad (3)$$

where we have introduced a new notation for the capital-labour endowment ratio of an exporting country,  $c_i$ , which in the subsequent analysis is approximated by either of the following variables like the mean years of schooling of the population,  $hk_i$ , the enrollment ratio in secondary education,  $w_i$ , or the GNP per capita,  $Y_i/L_i$ , as in equation (2). The superscript  $a$  indicates that the gravity model is estimated using both the aggregated trade flows as well as the disaggregated trade flows at the industry level.

Since  $X_{ij}^a$  represents the trade flow of exports from a country  $i$  to a country  $j$ , the variable  $X_{ji}^a$  stands for the reverse flow of goods exported from a country  $j$  to a country  $i$ , i.e. imports of a country  $i$  from a country  $j$ . Then, equation (3) can also be re-written for the variable  $X_{ji}^a$  by interchanging the subscripts  $i$  and  $j$ . Using this fact, an additional insight into the meaning of the parameters of the gravity model can be gained if one considers the country's exports-to-imports ratio which reads as

$$\frac{X_{ij}^a}{X_{ji}^a} = \left(\frac{Y_i}{Y_j}\right)^{\beta_1^a - \beta_3^a} \left(\frac{c_i}{c_j}\right)^{\beta_2^a} \left(\frac{Y_i/L_i}{Y_j/L_j}\right)^{\beta_4^a} \quad (4)$$

As discussed in Schumacher and Siliverstovs (2006), such transformation allows one to differentiate between the two different sources that shape the pattern of sectoral export-to-import ratios, i.e. the traditional comparative advantage effects, represented by the relative capital endowment ratios and the relative income per capita ratios on one hand, and the home market effects, represented by the relative economic size of the economies on the other. Observe that the variables such as a distance,  $D_{ij} = D_{ji}$ , or any other variables such as dummy variables, for example, representing trade preferences, that possess the same property, do not enter equation (4). As can be seen in equation (3), they are relevant for the volume of bilateral trade and affect the commodity structure of trade because the elasticities may vary among industries. But due to the fact that they have the same effect on exports and imports in a given industry they do not, however, have an impact on the relative sectoral trade volumes.

Thus, the coefficients  $\beta_2^a$  and  $\beta_4^a$  measure the magnitude of the traditional comparative advantage effects on the pattern of sectoral export-to-import ratios in bilateral trade arising from different relative factor endowment and from different demand conditions related to per capita income. If the two countries have the same economic size, the pattern is more pronounced, the larger the divergence between the two countries in

terms of capital endowment or per capita income, respectively. The export-to-import ratio in equation (4) is larger the larger  $\beta_2^a$  and the smaller  $\beta_4^a$ , i.e. the more the respective good is capital intensive in production and the more it is necessity in consumption. Conversely, it is smaller the smaller  $\beta_2^a$  and the larger  $\beta_4^a$ , i.e., the more the respective good is labour intensive in production and the more it is luxury in consumption. As stressed in Bergstrand (1989), this allows one to make an inference on the relative factor intensity of an industry, i.e. when the corresponding coefficient of a gravity model is positive ( $\beta_2^a > 0$ ) than this would indicate that the relevant goods are capital intensive in production and when it is negative ( $\beta_2^a < 0$ ) then the relevant goods are labour intensive in production. Moreover, the interpretation of the importer per capita income as a taste preference variable allows to classify the goods into either “luxury” or “necessity” categories in consumption, depending whether the coefficient is positive ( $\beta_4^a > 0$ ) or negative ( $\beta_4^a < 0$ ).

Similarly, as discussed in Schumacher and Siliverstovs (2006), if the two countries  $i$  and  $j$  have the same capital-labour endowment ratio and the same per capita income, the export-to-import ratio only depends on relative size of these two economies. The export-to-import ratio in equation (4) increases with higher  $\beta_1^a$  and lower  $\beta_3^a$  indicating a positive effect arising from the large size of a country as compared to smaller countries. Therefore, the difference ( $\beta_1^a - \beta_3^a$ ) gives the elasticity of good a’s bilateral export-to-import ratio with respect to the total income of an exporting country relative to the total income of an importing country. The positive difference ( $\beta_1^a - \beta_3^a > 0$ ) indicates a home-market effect which may arise because the domestic producers can exploit higher economies of scale while producing in their home country.

Thus, the industries can be ranked (i) by their capital intensity in production using the coefficients of the capital-labour endowment ratio, (ii) by their characteristics in import demand using the coefficients of the per capita GNP of the importing country, and (iii) by the relative size of the exporter versus importer income elasticity, i.e. by the magnitude of the home market effect.

### 3 Data

In the empirical analysis, for the dependent variable we employ the average annual trade flows of the years 1988 to 1990<sup>3</sup> (in US \$ million) for all products combined, agriculture, mining and quarrying, manufacturing products as a whole and broken down by 25 three-digit ISIC Rev.2 industries for 22 OECD countries.<sup>4</sup> For this purpose the OECD foreign trade figures are appropriately re-coded from the original SITC categories.

As for the explanatory variables the data on GNP (in US \$ million) and GNP per capita (in US \$) are taken from World Bank publications and refer to 1989. Observe that in the subsequent empirical analysis, we have employed the following three different proxies of the capital-labour endowment ratio such as (i) the mean years of schooling of the population, (ii) the enrollment ratio in secondary education and (iii) the GNP per capita, rather than going the beaten path and hence considering only the latter proxy as shown in equation (2). This is perfectly legitimate since the theoretical model of Bergstrand (1989) does not impose

<sup>3</sup>The data are assumed to represent trade between market economies. 1988-90 are the last years before trade flows of these economies have been affected by integration of the former centrally planned economies in the central and eastern Europe into the world economy.

<sup>4</sup>Member countries in 1993, excluding Iceland and taking Belgium/Luxembourg together.

any a priori restrictions on the choice of the corresponding proxy variable for the capital-labour endowment ratio.

The distance  $D_{ij}$  (in miles) between the countries  $i$  and  $j$  is calculated as the shortest line between their economic centres  $EC_i$  and  $EC_j$  by latitudinal and longitudinal position.<sup>5</sup> The dummy variables cover: adjacency,  $Adj_{ij}$ , membership in a preference area: European Union,  $EU_{ij}$ , European Free Trade Agreement,  $EFTA_{ij}$ , Free Trade Agreement between the USA and Canada,  $CUSTA$ , and Asia-Pacific Economic Cooperation,  $APEC_{ij}$ , ties by language,  $Lan_{ij}$ , and colonial ties,  $Col_{ij}$ . The value of the dummy variable is 1, if the two countries  $i$  and  $j$  have a common land border, belong to the respective preference zone, or have the same language or historical ties.<sup>6</sup> Otherwise the value of the dummy variables is zero.

## 4 Model Estimation Issues

In this section, we discuss the two alternative estimation procedures of the gravity model of trade: the traditional OLS approach based on the log-linear form of equation (2) and the Poisson Quasi Maximum Likelihood approach of Santos Silva and Tenreyro (2006) based on the original multiplicative specification of the gravity equation.

Typically, the coefficient estimates of the parameters of equation (3) are obtained by taking the logarithmic transformation and then using the OLS procedure with the corresponding standard errors being computed using the heteroskedasticity-robust covariance matrix. However, as pointed out in Santos Silva and Tenreyro (2006), the crucial assumption that needs to be fulfilled for a consistent estimation of the parameters of equation (3) using its log-linear counterpart is that the error term  $\eta_{ij}$ , and, therefore  $\ln(\eta_{ij})$ , are statistically independent of the regressors  $X_{ij}$ . In particular, the variance of the error term  $\ln(\eta_{ij})$  should be constant and, henceforth, it should not depend on the values of the regressors  $X_{ij}$ .

Observe that in general the error term  $\varepsilon_{ij}$  will be heteroskedastic unless the very specific conditions on the error term are met. In order to see this, write the conditional expectation of  $X_{ij}$  in the stochastic equation (3) as follows

$$E(X_{ij}|Z_{ij}) = e^{\beta_0} (Y_i)^{\beta_1^a} * (c_i)^{\beta_2^a} * (Y_j)^{\beta_3^a} * (Y_j/L_j)^{\beta_4^a} * D_{ij}^{\beta_5^a} \quad (5)$$

where we have assumed that  $E(\eta_{ij}|Z_{ij}) = 1$  and the vector  $Z_{ij} = (1, Y_i, c_i, Y_j, Y_j/L_j, D_{ij})'$  represents the explanatory variables. This implies the following

$$X_{ij} = E(X_{ij}|Z_{ij}) * \eta_{ij} = E(X_{ij}|Z_{ij}) + \varepsilon_{ij},$$

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<sup>5</sup>The national capitals were taken as the economic centre (EC) except for Canada (Montreal), the United States (Kansas City as a geographical compromise between the centres of the East and West Coasts), Australia (Sydney), and West Germany (Frankfurt/Main). The formulae are:  $\cos D_{ij} = \sin \varphi_i * \sin \varphi_j + \cos \varphi_i * \cos \varphi_j * \cos(\lambda_j - \lambda_i)$  and  $D_{ij} = \arccos(\cos D_{ij}) * 3962.07$  miles for  $EC_i = (\varphi_i; \lambda_i)$  and  $EC_j = (\varphi_j; \lambda_j)$  with  $\varphi$  = latitude,  $\lambda$  = longitude.

<sup>6</sup>0.5 for second languages and 0.5 for historical ties until 1914.

with

$$\eta_{ij} = 1 + \frac{\varepsilon_{ij}}{E(X_{ij}|Z_{ij})} \quad \text{and} \quad E(\eta_{ij}|X_{ij}) = 1.$$

Hence the error term that is associated with each observation is  $\varepsilon_{ij} = X_{ij} - E(X_{ij}|Z_{ij})$  and it is very likely to be heteroskedastic. Hence, the presence of heteroskedasticity of the error term will render the OLS estimation procedure applied to the log-linear form of equation (3) inconsistent, as discussed in Santos Silva and Tenreyro (2006).

An alternative way to get the parameter estimates of equation (3) is to apply the Poisson Quasi Maximum Likelihood (PQML) estimator using the fact that the conditional expectation of  $X_{ij}$  in the stochastic equation (3) can be written as the following exponential function<sup>7</sup>

$$E(X_{ij}|Z_{ij}) = \exp[\beta_0^a + \beta_1^a \ln(Y_i) + \beta_2^a \ln(c_i) + \beta_3^a \ln(Y_j) + \beta_4^a \ln(Y_j/L_j) + \beta_5^a \ln D_{ij}] \quad (6)$$

Thus, the PQML procedure offers a viable alternative to the traditional OLS estimation procedure for consistent estimation of the parameters of the gravity model in the original multiplicative form. An additional advantage of the PQML estimator is that because there is no more need in undertaking the logarithmic transformation of the dependent variable the problematic handling of observed zero trade flows is no more an issue in this procedure.

Since the homoscedasticity assumption of the error term turns out to be crucial for consistent estimation of the slope parameters of model in equation (3) using its log-linear transformation, Santos Silva and Tenreyro (2006) suggest to employ the auxiliary test regressions for the purpose of checking whether this assumption is fulfilled for a given model and a dataset at hand. Due to the fact that the Poisson estimator remains consistent even when the variance function is misspecified, both auxiliary test regressions are based on the PQML estimation results. The first one is a Park-type regression, see Park (1966). The second one is based on the Gauss-Newton regression (GNR), see Davidson and MacKinnon (1993). The former test is used to check whether the constant-elasticity model (3) can be consistently estimated in the log-linear form, and the latter test is used to check whether the assumption implied by the Poisson model, i.e., the conditional variance is proportional to the conditional mean, holds. The correct specification of the conditional mean in the Poisson regression can also be checked with the RESET test of Ramsey (1969) adopted to the microeconomic models as suggested in Peters (2000). Moreover, an additional information on the specification of the log-linear model can be obtained by employing the Lagrange-Multiplier (LM) heteroskedasticity test (see Wooldridge, 2002, p. 127) and the heteroskedasticity robust version of the RESET test of Ramsey (1969).

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<sup>7</sup>Note that the corresponding regression models have been estimated when the vector of dummy variables, described in Section 3, has been also included among the explanatory variables.

## 5 Estimation results

In this section, we report the estimation results that stem from application of the OLS and the PQML procedures to the log-linear form and the multiplicative specification of the gravity model, respectively. In Tables 1 and 2 we report both the OLS and the PQML estimated coefficient values along with the standard errors as well as the regression misspecification tests are reported for all goods combined as well as for agriculture, mining and quarrying, manufacturing industry as a whole, respectively. Tables 3 and 4 report the OLS and the PQML estimation results for manufacturing industries disaggregated according to the three-digit ISIC categories, respectively.<sup>8</sup>

### 5.1 Estimation results: ISIC 0

The estimation results of the gravity model based on the aggregate trade data that are reported in Table 1 enable us to compare our conclusions reached on the differences and the similarities between these two approaches with those reached in Santos Silva and Tenreyro (2006). While drawing comparisons, one has, however, to keep in mind that the country coverage and hence the number of the observations is very different in our dataset and theirs: 462 versus 18360. This also implies that the share of zero observations differs drastically in our dataset and theirs: 0% versus 52%. As seen in Table 1, both estimation procedures have yielded very similar coefficient estimates of the total income elasticities of the exporting and importing countries, which are about 0.75. These coefficients magnitude is very close for the Poisson regression results reported in Santos Silva and Tenreyro (2006), but deviates from the OLS regression results reported therein which tend to be somewhat larger and close to unity. The finding that the income elasticities are lower than unity is consistent with the observation that the trade-to-GNP ratio decreases with total GNP, i.e., the smaller is the country the more open it is to international trade. Furthermore, as shown in Schumacher and Siliverstovs (2006) and discussed in Section 2, we can utilise the total income elasticities in order to identify the home market effect. Well, in the aggregated data we find none, and that finding holds for both estimation procedures in our dataset. Another interesting finding is that our estimation results support the empirical finding reported in Santos Silva and Tenreyro (2006) that the trade deterring role of geographical distance is significantly larger under OLS, i.e. the distance elasticity under the PQML tends to be smaller than under the OLS estimation procedure. Apart from the facts that in the Poisson regression the capital endowment elasticity is significantly smaller than in the OLS regression, and the adjacency dummy takes a larger value according to the PQML method, the rest of the estimation results is more or less similar.

### 5.2 Estimation results: ISIC 1-3

Next, consider the estimation results reported for the determinants of the further disaggregated trade flows into agriculture, mining and quarrying, manufacturing industry as a whole, see Table 2. Such disaggregation introduces a significant portion of heterogeneity in the estimated elasticities of the gravity models. Observe

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<sup>8</sup>As the various proxies for the capital-labour endowment ratio have yielded very similar results, we have chosen to report only those for the mean years of education,  $hk_i$ , of the exporting country.

that the corresponding measures of goodness-of-fit,  $R^2$  and Pseudo- $R^2$ , take much smaller values for agriculture and mining and quarrying when compared with those values reported for all the products as a whole in Table 1. On the contrary, the both values of  $R^2$  and Pseudo- $R^2$ , reported for the manufacturing goods, remain at nearly the same level of about 0.90. We also note that despite the fact that the distance elasticities differ across the industries, the earlier conclusion on the larger trade deterring role of geographical distance according to the OLS results, observed for the aggregate products, holds also at this level of disaggregation, as in every single case the corresponding estimate of the distance elasticity is much smaller in the Poisson regression. Another interesting result is that we also do not find the home market effect at this level of disaggregation either. Below we will investigate whether this conclusion still holds when we consider the determinants of the trade flows in manufacturing products disaggregated according to the three-digit ISIC scheme.

### 5.3 Estimation results: ISIC 31-390

As mentioned above, Tables 3 and 4 report the OLS and the PQML estimation results for manufacturing industries disaggregated according to the three-digit ISIC categories, respectively. While these tables contain rather vast amount of information, we would like to focus specifically at the following questions. First, whether we find any specific distinguishing pattern in the values of the total income elasticities that we obtain using either of the estimation methods. Second, we would like to investigate whether the home market effect that did not appear at the more aggregated levels as discussed above can be detected at this disaggregation level. Third, since we work within the framework of the generalised gravity model of Bergstrand (1989), we intend to determine whether the classification of the various manufacturing industries into capital- or labour-intensive as well as into “luxuries” or “necessities” in consumption is robust to the alternative estimation procedures. Fourth, we investigate whether the conclusion reached above on the larger trade deterring role of geographical distance according to the OLS results, reported in Santos Silva and Tenreyro (2006), as well as in Subsections 5.1 and 5.2, holds also at this level of disaggregation.

Before addressing the first issue, recall that the total income elasticities of exporting and importing countries were of approximately the same magnitude for the aggregated data and for the manufacturing industries as a whole. As seen in Tables 3 and 4, this is no longer the case. A substantial heterogeneity in the estimated coefficient value is present at this level of disaggregation. It is noteworthy, that according to the OLS estimation results the values of the total income elasticities of exporting country are much larger than those obtained by the PQML method, and, moreover, they often exceed value of unity. A similar results hold that the OLS elasticities of the total income of importing country tend to be in general larger, albeit to the lesser degree, than the corresponding elasticities obtained by the PQML method. Hence from this point of view, the PQML estimation results are more consistent with the empirical observation that smaller countries tend to be more open to international trade.

As the presence of the home market effect concerns, we do detect it in various industries. Table 5 presents the industries where the home market effect has been found using different significance levels. While at the 1% level the PQML procedure tend to select somewhat smaller number of the industries with the home

market effect than the OLS procedure, at the 10% level there is rather large overlap. Thus, despite the fact that the estimated elasticities of the total income of exporting and importing countries tend to be somewhat smaller under the PQML than under the OLS estimation procedure, the list of the industries where the home market effect, defined as the positive difference between the exporter and the importer total income elasticities, is detected appear rather robust to the alternative estimation procedures under consideration. This conclusion is supported by the rather high value of the Spearman’s rank correlation coefficient (0.664) that compares relative ranking of the 25 manufacturing industries according to the magnitude of the home market effect.

Third, Tables 6 and 7 summarise our conclusion with respect to the classification of the various manufacturing industries into capital- versus labour-intensive and into “luxury” versus “necessity” in consumption, depending on significance level chosen, respectively. Also here, the list of industries that are classified as either capital- or labour-intensive is almost the same according to the results of these two estimation approaches. For example, at the 10% significance level the following industries are labelled as labour-intensives by both methods simultaneously: textiles, wearing apparel, leather and leather products, footwear, rubber products, pottery, china, and earthenware, glass and glass products, structural clay products, which appear a rather reasonable. The large similarity in the relative ranking of industries according to the magnitude of the capital endowment elasticity,  $\hat{\beta}_2^a$ , is also supported by the Spearman’s rank correlation coefficient value of 0.756.

Regarding the classification of the manufacturing industries into “luxury” versus “necessity” in consumption, we observe that the corresponding coefficient values  $\hat{\beta}_4^a$  appear to be rather weakly determined as the associated standard errors are quite large. As a result, there is a rather large number of industries where these coefficient estimates appear to be insignificant. Nevertheless, at the 5% level both methods indicate that wearing apparel, footwear, furniture, and printing and publishing industries can be classified as “luxury” in consumption. Also here the Spearman’s rank correlation coefficient takes rather high value of 0.689, indicating high correlation between the relative rankings of the industries according to the magnitude of  $\hat{\beta}_4^a$  coefficient.

Fourth, Figure 1 displays the estimated distance elasticity,  $\hat{\beta}_5^a$ , values obtained by both estimation procedures. As seen, in all cases reported the absolute magnitude of the distance elasticity is smaller – (oftentimes) significantly – according to the PQML procedure when compared with the results of the OLS procedure. Hence, our estimation results unambiguously support the empirical finding reported in Santos Silva and Tenreyro (2006) that the trade deterring role of geographical distance is significantly larger under OLS. Moreover, as we have seen this conclusion holds at all levels of (dis-)aggregation considered in this paper in every single gravity model estimated. The other interesting result is that the individual distance elasticity values obtained by the OLS for the manufacturing industries in most cases larger than the distance elasticity value reported for the manufacturing products as a whole. Indeed, the average distance elasticity over the 25 ISIC three-digit manufacturing industries in question is  $-1.145$ , whereas the distance elasticity value for manufacturing products as a whole (ISIC 3) is  $-0.772$ . This seems counterintuitive and requires further empirical investigation. On the contrary, the average distance elasticity over the 25 ISIC manufacturing

industries in question, as reported by the PQML procedure, is  $-0.655$ , which is very similar to the distance elasticity value for manufacturing products as a whole (ISIC 3)  $-0.622$ , as expected.

Last but not least, we would like to discuss the results of the misspecification tests that are also reported in Tables 1 – 4. The first important result is that according to the Park (1966) test the null hypothesis that the log-linear model is appropriate is in all cases but one rejected for all industries at the usual significance levels. In addition, when applied to the log-linear model, the LM-test for heteroskedasticity unequivocally and of the RESET test to some lesser extent support this conclusion. The second result is that the misspecification tests applied to the Poisson model generally find no serious departures from the model assumptions. Thus, according to the RESET test results applied to the Poisson model we cannot reject the null hypothesis of correct specification of the conditional mean for this model at the usual significance levels for most industries. Moreover, in most cases we cannot reject the null hypothesis at the 1% significance level that the assumption implied by the Poisson model, i.e., that the variance is proportional to the conditional mean, holds for the industries in question. Nonetheless, even when the statistical tests indicate that this assumption is likely to be violated, the PQML estimator suggested in Santos Silva and Tenreyro (2006) still remains consistent but its efficiency can be improved upon by some other Quasi Maximum Likelihood estimator that imposes different assumptions on the variance function.

## 6 Conclusion

In this paper, we applied the Poisson Quasi Maximum Likelihood estimation technique suggested in Santos Silva and Tenreyro (2006) to the generalised gravity model of trade derived at the industry level in Bergstrand (1989). To this end, we use the trade flows amongst the 22 OECD countries in all products combined, agriculture, mining and quarrying, manufacturing products as a whole and as broken down into the 25 three-digit ISIC Rev.2 industries. Given rather limited empirical evidence on the comparative performance the PQML estimator in the context of the gravity models of trade, our exercise sheds additional light on the issue of potential advantage of this estimation technique over the traditional OLS estimation approach.

Our main finding can be summarised as follows. First, the total income elasticity tend to be smaller under the PQML rather than under the OLS estimation procedure, reported for the aggregated trade flows, also holds for more disaggregated data. The finding that the total income elasticities are lower than unity is consistent with the observation that the trade-to-GNP ratio decreases with total GNP, i.e., the smaller is the country the more open it is to international trade, and supports the PQML estimation procedure rather than the OLS method.

Second, both the estimation methods lead to the conclusion that the home market effects can only be detected for the manufacturing goods disaggregated at the three-digit ISIC level but not at the aggregated level. At the same time, despite the fact that the PQML coefficient values oftentimes differ significantly from those obtained by the OLS method, the relative ranking of the manufacturing industries (i) by the relative size of the exporter versus importer income elasticity, i.e. by the magnitude of the home market effect, (ii) by their capital intensity in production using the coefficients of the capital-labour endowment ratio, and

(iii) by their characteristics in import demand using the coefficients of the per capita GNP of the importing country is rather robust to the alternative estimation techniques considered in this paper.

Furthermore, our estimation results unambiguously support the empirical finding reported in Santos Silva and Tenreyro (2006) that the trade deterring role of geographical distance is significantly larger under OLS. This discrepancy between the estimation results of these two procedures holds for all products, for agriculture, mining and quarrying, and for manufacturing industry as a whole, but it is at most evident for the manufacturing industries that are disaggregated at the three-digit ISIC level.

Lastly, the regression misspecification tests indicate that the regression error term homoskedasticity assumption that ensures consistency of the OLS procedure is strongly violated in the dataset at hand, and simultaneously favour the PQML estimation procedure.

Thus, as our overall conclusion from investigating the comparative performance of the OLS versus the PQML estimation procedures using not only the aggregated (as in Santos Silva and Tenreyro, 2006) but also the disaggregated trade flow data we would like to point out that both the estimation results as well as the model misspecification tests seem to provide a supporting evidence for the Poisson regression over the traditional OLS approach in estimating the parameters of the gravity models of trade.

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Table 1: OLS and PQML estimation results: all goods combined

ISIC	OLS	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
0	coeff.	0.753	0.571	0.753	0.014	-0.707	0.314	0.379	-0.135	-0.003	0.794	0.328	0.882	-0.001	0.910	[0.000]	[0.654]	462
	s.e	0.020	0.107	0.023	0.048	0.032	0.089	0.072	0.095	0.164	0.144	0.122	0.238	0.027				
	p-value	0.000	0.000	0.000	0.778	0.000	0.000	0.000	0.157	0.986	0.000	0.008	0.000	0.977				
	<b>PQML</b>	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	Pseudo- $R^2$	Park (1966)	RESET	GNR
0	coeff.	0.745	0.070	0.747	-0.104	-0.608	0.460	0.245	0.044	-0.216	0.912	0.293	0.513	-0.001	0.937	[0.001]	[0.202]	[0.022]
	s.e	0.032	0.143	0.037	0.062	0.063	0.124	0.104	0.126	0.210	0.185	0.116	0.228	0.030				
	p-value	0.000	0.626	0.000	0.095	0.000	0.000	0.019	0.728	0.305	0.000	0.012	0.025	0.968				

Table 2: OLS and PQML estimation results: agriculture, mining and quarrying, and manufacturing products as a whole

ISIC	OLS	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.	
1	coeff.	0.613	-0.787	0.768	0.022	-0.544	0.817	1.237	-0.885	-0.116	1.434	0.528	1.025	-0.154	0.539	[0.000]	[0.987]	462	
	s.e	0.073	0.266	0.065	0.142	0.099	0.250	0.177	0.260	0.471	0.516	0.416	0.669	0.090					
	p-value	0.000	0.003	0.000	0.878	0.000	0.001	0.000	0.001	0.001	0.806	0.006	0.126	0.085					
2	coeff.	0.766	0.154	1.038	0.047	-1.324	-0.173	-0.232	-0.781	0.329	1.059	1.148	1.785	-0.273	0.529	[0.000]	[0.009]	462	
	s.e	0.094	0.385	0.084	0.196	0.124	0.294	0.231	0.524	0.788	0.744	0.418	0.839	0.120					
	p-value	0.000	0.689	0.000	0.811	0.000	0.557	0.316	0.137	0.676	0.156	0.006	0.034	0.023					
3	coeff.	0.788	0.554	0.750	0.015	-0.772	0.217	0.409	-0.065	-0.018	0.796	0.405	0.796	0.038	0.892	[0.000]	[0.425]	462	
	s.e	0.023	0.124	0.026	0.054	0.038	0.098	0.078	0.105	0.165	0.148	0.130	0.304	0.029					
	p-value	0.000	0.000	0.000	0.788	0.000	0.027	0.000	0.540	0.540	0.914	0.000	0.002	0.009					
<b>PQML</b>																			
1	coeff.	0.520	0.236	0.556	0.261	-0.349	0.782	1.044	-1.139	-0.503	1.924	-0.396	1.064	-0.036	0.697	[0.000]	[0.450]	[0.034]	
	s.e	0.091	0.437	0.082	0.228	0.120	0.260	0.226	0.333	0.461	0.488	0.354	0.556	0.079					
	p-value	0.000	0.590	0.000	0.253	0.004	0.003	0.000	0.000	0.001	0.276	0.000	0.265	0.056	0.645				
2	coeff.	0.101	4.996	0.646	0.419	-0.833	-0.483	-0.289	-0.455	0.579	1.837	-0.365	2.347	-0.545	0.609	[0.000]	[0.000]	[0.648]	
	s.e	0.140	2.227	0.110	0.345	0.146	0.351	0.423	0.520	0.426	0.626	0.612	0.794	0.142					
	p-value	0.470	0.025	0.000	0.225	0.000	0.170	0.494	0.381	0.381	0.175	0.003	0.551	0.003	0.000				
3	coeff.	0.783	-0.098	0.753	-0.133	-0.622	0.472	0.236	0.122	-0.244	0.867	0.325	0.397	0.029	0.929	[0.000]	[0.389]	[0.053]	
	s.e	0.036	0.156	0.042	0.071	0.068	0.126	0.114	0.140	0.259	0.244	0.117	0.269	0.031					
	p-value	0.000	0.533	0.000	0.060	0.000	0.000	0.040	0.384	0.384	0.347	0.000	0.006	0.140	0.339				

Table 3: OLS estimation results: disaggregated manufacturing industries

ISIC	OLS	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APECA_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
31	coeff.	0.339	0.910	0.826	0.089	-0.417	0.586	1.765	-0.275	-0.518	1.032	0.902	0.802	-0.488	0.744	[0.000]	[0.209]	462
	s.e	0.045	0.170	0.043	0.110	0.058	0.151	0.121	0.206	0.417	0.288	0.173	0.375	0.056				
	p-value	0.000	0.000	0.000	0.421	0.000	0.000	0.000	0.182	0.214	0.000	0.000	0.033	0.000				
321	coeff.	0.696	-1.412	0.607	0.164	-0.779	0.420	0.921	-0.242	-0.872	0.921	0.731	0.942	0.089	0.696	[0.000]	[0.102]	462
	s.e	0.043	0.217	0.047	0.116	0.065	0.174	0.140	0.274	0.409	0.300	0.226	0.445	0.058				
	p-value	0.000	0.000	0.000	0.158	0.000	0.016	0.000	0.378	0.034	0.002	0.001	0.035	0.122				
322	coeff.	0.945	-3.260	0.687	1.254	-1.460	-0.447	0.746	0.095	-0.597	0.753	0.712	0.938	0.258	0.786	[0.005]	[0.000]	462
	s.e	0.052	0.269	0.057	0.127	0.074	0.282	0.197	0.330	0.538	0.284	0.257	0.467	0.068				
	p-value	0.000	0.000	0.000	0.000	0.000	0.114	0.000	0.774	0.268	0.008	0.006	0.045	0.000				
323	coeff.	0.907	-0.497	0.913	-0.098	-0.843	0.294	0.680	0.107	-0.893	0.505	0.418	1.021	-0.005	0.670	[0.000]	[0.062]	462
	s.e	0.058	0.250	0.056	0.139	0.079	0.211	0.184	0.276	0.449	0.401	0.237	0.482	0.070				
	p-value	0.000	0.047	0.000	0.481	0.000	0.163	0.000	0.698	0.047	0.208	0.079	0.035	0.940				
324	coeff.	1.185	-2.143	0.662	0.901	-1.165	-0.132	1.551	0.561	-0.249	-0.086	1.278	0.414	0.522	0.646	[0.000]	[0.219]	462
	s.e	0.070	0.498	0.085	0.148	0.097	0.321	0.248	0.448	0.636	0.465	0.325	0.625	0.098				
	p-value	0.000	0.000	0.000	0.000	0.000	0.681	0.000	0.211	0.696	0.853	0.000	0.508	0.000				

continued overleaf

Table 3: OLS estimation results: disaggregated manufacturing industries (continued)

ISIC	OLS	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
331	coeff.	0.648	2.323	0.696	0.350	-1.331	0.296	0.173	0.278	0.534	1.332	0.660	1.528	-0.048	0.587	[0.000]	[0.057]	462
	s.e	0.074	0.401	0.081	0.170	0.113	0.286	0.248	0.326	0.820	0.652	0.426	0.696	0.102				
	p-value	0.000	0.000	0.000	0.040	0.000	0.301	0.485	0.394	0.515	0.042	0.122	0.029	0.638				
332	coeff.	1.022	0.534	0.837	0.984	-1.435	0.415	0.479	0.333	-0.141	0.760	0.549	1.209	0.185	0.753	[0.000]	[0.008]	462
	s.e	0.062	0.306	0.064	0.152	0.092	0.283	0.202	0.290	0.463	0.354	0.299	0.549	0.082				
	p-value	0.000	0.081	0.000	0.000	0.000	0.143	0.018	0.251	0.761	0.033	0.067	0.028	0.023				
341	coeff.	0.774	3.510	0.839	-0.258	-1.471	0.029	-0.057	0.281	0.265	1.451	-0.281	1.793	-0.065	0.647	[0.000]	[0.000]	462
	s.e	0.067	0.392	0.079	0.151	0.118	0.268	0.220	0.373	0.814	0.435	0.297	0.657	0.087				
	p-value	0.000	0.000	0.000	0.088	0.000	0.915	0.795	0.452	0.745	0.001	0.345	0.007	0.454				
342	coeff.	1.178	1.395	0.719	0.670	-1.125	-0.101	0.844	-0.162	-0.434	0.153	1.970	1.127	0.459	0.802	[0.000]	[0.000]	462
	s.e	0.046	0.289	0.057	0.131	0.078	0.201	0.159	0.302	0.308	0.301	0.236	0.656	0.063				
	p-value	0.000	0.000	0.000	0.000	0.000	0.617	0.000	0.592	0.160	0.611	0.000	0.086	0.000				
351	coeff.	0.962	0.979	0.906	-0.320	-1.141	-0.078	0.335	-0.128	-0.686	0.599	0.791	0.321	0.056	0.798	[0.000]	[0.020]	462
	s.e	0.041	0.203	0.047	0.106	0.074	0.152	0.130	0.145	0.239	0.247	0.244	0.536	0.054				
	p-value	0.000	0.000	0.000	0.003	0.000	0.608	0.010	0.378	0.004	0.016	0.001	0.549	0.301				

continued overleaf

Table 3: OLS estimation results: disaggregated manufacturing industries (continued)

ISIC	OLS	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APECA_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
352	coeff.	1.051	1.681	0.739	-0.027	-1.016	-0.185	0.673	-0.121	-0.705	-0.255	1.134	0.430	0.312	0.738	[0.000]	[0.004]	462
	s.e	0.055	0.232	0.061	0.129	0.085	0.180	0.156	0.263	0.373	0.334	0.307	0.631	0.069				
	p-value	0.000	0.000	0.000	0.835	0.000	0.303	0.000	0.644	0.059	0.446	0.000	0.496	0.000				
353-4	coeff.	1.394	-1.205	1.242	-0.177	-1.676	-0.248	0.844	-0.343	-0.395	0.916	1.272	0.925	0.152	0.628	[0.000]	[0.003]	462
	s.e	0.085	0.480	0.098	0.189	0.133	0.368	0.307	0.468	0.887	0.673	0.408	0.847	0.125				
	p-value	0.000	0.012	0.000	0.350	0.000	0.500	0.006	0.464	0.657	0.174	0.002	0.275	0.223				
355	coeff.	1.267	-0.559	0.691	0.214	-1.172	-0.131	0.581	0.488	0.513	0.728	0.339	1.301	0.576	0.779	[0.000]	[0.004]	462
	s.e	0.047	0.249	0.054	0.100	0.077	0.169	0.136	0.189	0.552	0.406	0.279	0.512	0.067				
	p-value	0.000	0.025	0.000	0.033	0.000	0.439	0.000	0.010	0.353	0.074	0.225	0.011	0.000				
356	coeff.	0.890	1.437	0.601	0.448	-1.153	0.135	0.836	-0.038	0.031	0.404	1.091	0.589	0.289	0.793	[0.000]	[0.000]	462
	s.e	0.041	0.276	0.052	0.106	0.070	0.169	0.127	0.192	0.369	0.299	0.241	0.435	0.057				
	p-value	0.000	0.000	0.000	0.000	0.000	0.423	0.000	0.841	0.934	0.178	0.000	0.177	0.000				
361	coeff.	1.350	-2.108	0.879	0.380	-0.939	0.248	0.850	0.714	-1.087	-0.340	1.169	1.493	0.472	0.705	[0.000]	[0.039]	462
	s.e	0.058	0.345	0.065	0.153	0.085	0.239	0.204	0.274	0.571	0.542	0.335	0.686	0.078				
	p-value	0.000	0.000	0.000	0.014	0.000	0.298	0.000	0.010	0.058	0.531	0.001	0.030	0.000				

continued overleaf

Table 3: OLS estimation results: disaggregated manufacturing industries (continued)

ISIC	OLS	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
362	coeff.	1.258	-1.648	0.830	0.251	-1.225	0.104	0.313	0.173	-0.642	0.808	1.083	0.991	0.429	0.700	[0.000]	[0.004]	462
	s.e	0.058	0.244	0.070	0.143	0.101	0.258	0.205	0.271	0.291	0.302	0.366	0.573	0.085				
	p-value	0.000	0.000	0.000	0.081	0.000	0.687	0.128	0.524	0.028	0.008	0.003	0.085	0.000				
369	coeff.	1.106	-1.896	0.891	-0.077	-1.281	0.179	0.413	0.538	0.154	0.440	0.468	0.951	0.214	0.722	[0.000]	[0.005]	462
	s.e	0.059	0.320	0.064	0.123	0.100	0.233	0.145	0.248	0.413	0.349	0.290	0.748	0.073				
	p-value	0.000	0.000	0.000	0.532	0.000	0.442	0.004	0.030	0.709	0.209	0.107	0.204	0.004				
371	coeff.	1.107	-0.112	0.967	-0.300	-1.777	-0.096	-0.229	0.689	-1.336	2.297	-0.548	2.235	0.139	0.703	[0.000]	[0.000]	462
	s.e	0.069	0.321	0.077	0.159	0.109	0.229	0.190	0.245	0.479	0.383	0.300	0.682	0.098				
	p-value	0.000	0.728	0.000	0.060	0.000	0.676	0.229	0.005	0.005	0.005	0.000	0.069	0.001	0.158			
372	coeff.	0.823	2.202	1.023	-0.017	-1.335	0.289	-0.191	0.310	-0.793	2.133	-0.512	2.020	-0.199	0.735	[0.000]	[0.000]	462
	s.e	0.062	0.292	0.065	0.164	0.089	0.224	0.181	0.214	0.479	0.459	0.366	0.797	0.084				
	p-value	0.000	0.000	0.000	0.916	0.000	0.198	0.293	0.147	0.099	0.000	0.162	0.012	0.019				
381	coeff.	0.935	0.376	0.713	0.166	-1.149	0.177	0.331	0.361	-0.236	0.650	0.798	0.836	0.222	0.809	[0.000]	[0.029]	462
	s.e	0.036	0.201	0.045	0.097	0.067	0.151	0.110	0.184	0.249	0.254	0.214	0.437	0.050				
	p-value	0.000	0.061	0.000	0.088	0.000	0.240	0.003	0.050	0.345	0.011	0.000	0.056	0.000				

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Table 3: OLS estimation results: disaggregated manufacturing industries (continued)

ISIC	OLS	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
382	coeff.	1.121	1.836	0.729	-0.082	-0.955	-0.293	0.373	0.261	0.063	-0.135	0.935	0.238	0.392	0.812	[0.000]	[0.013]	462
	s.e	0.042	0.219	0.048	0.092	0.065	0.185	0.133	0.177	0.299	0.309	0.232	0.405	0.056				
	p-value	0.000	0.000	0.000	0.371	0.000	0.114	0.005	0.142	0.833	0.663	0.000	0.557	0.000				
383	coeff.	1.110	1.147	0.692	0.040	-1.041	-0.322	0.409	0.359	0.509	-0.005	0.741	0.515	0.418	0.783	[0.000]	[0.003]	462
	s.e	0.049	0.232	0.051	0.103	0.070	0.187	0.131	0.155	0.414	0.443	0.274	0.445	0.063				
	p-value	0.000	0.000	0.000	0.696	0.000	0.086	0.002	0.021	0.220	0.992	0.007	0.248	0.000				
384	coeff.	1.497	1.301	0.822	0.011	-1.133	-0.022	0.531	0.147	0.533	0.827	0.387	1.388	0.675	0.782	[0.000]	[0.000]	462
	s.e	0.054	0.326	0.066	0.139	0.087	0.245	0.181	0.282	0.734	0.316	0.257	0.490	0.068				
	p-value	0.000	0.000	0.000	0.939	0.000	0.930	0.003	0.601	0.468	0.009	0.132	0.005	0.000				
385	coeff.	1.014	3.428	0.811	-0.009	-0.744	0.037	0.564	0.138	-0.549	-0.187	0.739	0.301	0.203	0.805	[0.000]	[0.012]	462
	s.e	0.045	0.263	0.052	0.091	0.064	0.196	0.151	0.238	0.455	0.348	0.287	0.441	0.063				
	p-value	0.000	0.000	0.000	0.920	0.000	0.849	0.000	0.563	0.228	0.592	0.010	0.496	0.001				
390	coeff.	1.059	1.009	0.829	0.569	-0.866	0.029	0.475	-0.011	-0.907	0.157	0.515	0.367	0.230	0.763	[0.000]	[0.000]	462
	s.e	0.051	0.237	0.054	0.127	0.072	0.220	0.159	0.199	0.385	0.368	0.289	0.491	0.068				
	p-value	0.000	0.000	0.000	0.000	0.000	0.897	0.003	0.957	0.019	0.670	0.075	0.455	0.001				

Table 4: PQML estimation results: disaggregated manufacturing industries

ISIC	PQML	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lat_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
31	coeff.	0.315	1.355	0.675	0.109	-0.378	0.510	1.571	-0.482	-0.845	1.567	0.338	0.987	-0.361	0.831	[0.001]	[0.479]	[0.024]
	s.e	0.060	0.311	0.052	0.162	0.079	0.160	0.190	0.198	0.395	0.392	0.225	0.444	0.057				
	p-value	0.000	0.000	0.000	0.500	0.000	0.002	0.000	0.015	0.033	0.000	0.134	0.027	0.000				
321	coeff.	0.685	-1.717	0.624	-0.025	-0.654	0.446	0.729	-0.059	-0.774	0.474	0.796	-0.048	0.061	0.823	[0.000]	[0.882]	[0.071]
	s.e	0.059	0.276	0.047	0.108	0.080	0.180	0.139	0.226	0.344	0.211	0.157	0.292	0.049				
	p-value	0.000	0.000	0.000	0.815	0.000	0.014	0.000	0.795	0.025	0.025	0.000	0.869	0.213				
322	coeff.	0.681	-2.822	0.573	0.917	-0.692	0.403	0.657	-0.140	-0.863	-0.101	0.998	-0.088	0.108	0.721	[0.000]	[0.557]	[0.016]
	s.e	0.084	0.292	0.082	0.235	0.115	0.212	0.263	0.332	0.406	0.319	0.248	0.648	0.079				
	p-value	0.000	0.000	0.000	0.000	0.000	0.058	0.013	0.673	0.034	0.034	0.000	0.892	0.170				
323	coeff.	0.960	-2.303	0.783	-0.276	-0.407	0.421	0.699	0.422	-0.073	-0.799	0.768	0.008	0.177	0.686	[0.000]	[0.033]	[0.083]
	s.e	0.095	0.389	0.080	0.156	0.120	0.228	0.242	0.327	0.419	0.396	0.307	0.519	0.081				
	p-value	0.000	0.000	0.000	0.077	0.001	0.065	0.004	0.198	0.862	0.044	0.013	0.988	0.029				
324	coeff.	1.115	-4.005	0.710	1.389	-0.432	0.237	1.574	1.013	0.278	-1.741	1.390	-0.132	0.406	0.718	[0.000]	[0.001]	[0.076]
	s.e	0.164	0.404	0.147	0.428	0.163	0.263	0.461	0.481	0.621	0.580	0.473	0.862	0.155				
	p-value	0.000	0.000	0.000	0.001	0.008	0.367	0.001	0.036	0.654	0.003	0.003	0.878	0.009				

*continued overleaf*

Table 4: Estimation results (continued)

ISIC	PQML	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFT_{ij}$	$CUST_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
331	coeff.	0.256	1.441	0.667	-0.011	-0.847	0.617	-0.789	-0.164	0.093	2.119	-0.363	2.307	-0.412	0.720	[0.002]	[0.421]	[0.300]
	s.e	0.096	0.609	0.089	0.180	0.121	0.291	0.297	0.384	0.477	0.433	0.429	0.803	0.088				
	p-value	0.008	0.018	0.000	0.952	0.000	0.035	0.008	0.669	0.845	0.000	0.398	0.004	0.000				
332	coeff.	0.818	-1.966	0.674	0.797	-0.775	0.853	0.661	0.465	0.167	0.070	0.963	-0.201	0.144	0.799	[0.003]	[0.729]	[0.011]
	s.e	0.102	0.430	0.093	0.248	0.123	0.283	0.250	0.334	0.359	0.281	0.298	0.567	0.089				
	p-value	0.000	0.000	0.000	0.001	0.000	0.003	0.008	0.165	0.641	0.803	0.001	0.723	0.107				
341	coeff.	0.263	2.041	0.743	-0.201	-0.858	0.271	-0.603	-0.121	1.257	0.805	-0.500	1.316	-0.480	0.717	[0.154]	[0.755]	[0.413]
	s.e	0.064	0.377	0.070	0.114	0.109	0.224	0.260	0.277	0.442	0.368	0.329	0.510	0.087				
	p-value	0.000	0.000	0.000	0.079	0.000	0.227	0.021	0.662	0.005	0.029	0.129	0.010	0.000				
342	coeff.	0.932	-0.433	0.580	0.334	-0.664	0.473	0.578	-0.093	-0.366	0.381	1.683	0.690	0.352	0.898	[0.000]	[0.141]	[0.087]
	s.e	0.046	0.269	0.047	0.133	0.085	0.157	0.160	0.294	0.237	0.193	0.139	0.516	0.052				
	p-value	0.000	0.108	0.000	0.012	0.000	0.003	0.000	0.753	0.124	0.049	0.000	0.182	0.000				
351	coeff.	0.673	1.182	0.711	-0.138	-0.629	0.483	0.518	-0.353	-0.220	0.411	0.339	-0.154	-0.038	0.890	[0.000]	[0.002]	[0.003]
	s.e	0.045	0.198	0.042	0.088	0.075	0.160	0.123	0.157	0.189	0.186	0.135	0.333	0.045				
	p-value	0.000	0.000	0.000	0.119	0.000	0.003	0.000	0.025	0.245	0.028	0.013	0.645	0.393				

*continued overleaf*

Table 4: Estimation results (continued)

ISIC	PQML	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
352	coeff.	0.745	1.276	0.652	0.010	-0.602	0.338	0.265	-0.201	-0.801	0.269	0.470	0.320	0.093	0.866	[0.000]	[0.182]	[0.003]
	s.e	0.039	0.169	0.034	0.074	0.061	0.115	0.110	0.173	0.369	0.179	0.106	0.419	0.043				
	p-value	0.000	0.000	0.000	0.896	0.000	0.003	0.016	0.243	0.030	0.134	0.000	0.446	0.031				
353-4	coeff.	0.401	0.064	0.695	0.386	-0.865	0.576	0.183	-0.499	0.179	1.001	0.155	0.863	-0.295	0.683	[0.000]	[0.185]	[0.239]
	s.e	0.098	0.433	0.101	0.330	0.118	0.386	0.271	0.471	0.446	0.450	0.542	0.815	0.117				
	p-value	0.000	0.883	0.000	0.242	0.000	0.136	0.499	0.290	0.688	0.027	0.774	0.290	0.012				
355	coeff.	0.897	-0.637	0.710	0.030	-0.657	0.607	0.405	0.265	-0.074	1.016	0.044	0.405	0.187	0.886	[0.000]	[0.433]	[0.111]
	s.e	0.049	0.201	0.051	0.103	0.076	0.111	0.151	0.190	0.358	0.340	0.188	0.409	0.049				
	p-value	0.000	0.002	0.000	0.771	0.000	0.000	0.007	0.163	0.836	0.003	0.816	0.322	0.000				
356	coeff.	0.764	-0.319	0.627	0.149	-0.766	0.614	0.482	0.213	-0.226	0.514	0.811	0.267	0.137	0.875	[0.000]	[0.017]	[0.022]
	s.e	0.050	0.265	0.059	0.113	0.083	0.188	0.140	0.175	0.310	0.305	0.173	0.369	0.051				
	p-value	0.000	0.230	0.000	0.186	0.000	0.001	0.001	0.225	0.466	0.093	0.000	0.470	0.008				
361	coeff.	0.962	-1.779	0.823	0.108	-0.601	0.354	0.354	0.496	-1.892	0.839	0.743	1.287	0.140	0.750	[0.000]	[0.434]	[0.034]
	s.e	0.077	0.251	0.088	0.175	0.114	0.188	0.245	0.298	0.629	0.486	0.338	0.542	0.080				
	p-value	0.000	0.000	0.000	0.538	0.000	0.060	0.149	0.097	0.003	0.085	0.029	0.018	0.080				

*continued overleaf*

Table 4: Estimation results (continued)

ISIC	PQML	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
362	coeff.	0.737	-0.501	0.715	-0.017	-0.654	0.656	0.510	0.130	0.112	0.340	0.540	0.172	0.022	0.834	[0.000]	[0.120]	[0.001]
	s.e	0.057	0.231	0.059	0.102	0.084	0.158	0.163	0.250	0.332	0.212	0.205	0.334	0.074				
	p-value	0.000	0.031	0.000	0.868	0.000	0.000	0.002	0.601	0.737	0.109	0.607	0.767					
369	coeff.	0.890	-2.247	0.780	-0.017	-0.713	0.751	0.382	0.449	0.118	0.048	0.517	0.485	0.110	0.832	[0.000]	[0.592]	[0.139]
	s.e	0.074	0.293	0.086	0.135	0.096	0.174	0.185	0.276	0.335	0.340	0.206	0.393	0.061				
	p-value	0.000	0.000	0.000	0.898	0.000	0.000	0.039	0.104	0.724	0.888	0.012	0.218	0.070				
371	coeff.	0.566	0.094	0.777	-0.305	-0.782	0.749	0.238	0.214	-0.708	1.031	-0.072	0.125	-0.211	0.801	[0.000]	[0.056]	[0.005]
	s.e	0.067	0.251	0.070	0.117	0.102	0.185	0.193	0.216	0.469	0.465	0.259	0.500	0.070				
	p-value	0.000	0.709	0.000	0.010	0.000	0.000	0.218	0.322	0.132	0.027	0.782	0.802	0.003				
372	coeff.	0.273	2.993	0.729	0.156	-0.585	0.623	0.112	-0.546	-0.121	1.330	-0.049	1.294	-0.456	0.813	[0.000]	[0.076]	[0.966]
	s.e	0.064	0.495	0.055	0.173	0.090	0.171	0.209	0.222	0.283	0.327	0.240	0.486	0.058				
	p-value	0.000	0.000	0.000	0.369	0.000	0.000	0.592	0.014	0.670	0.000	0.837	0.008	0.000				
381	coeff.	0.833	-0.742	0.656	-0.035	-0.798	0.657	0.166	0.430	-0.389	0.736	0.574	0.324	0.177	0.884	[0.000]	[0.133]	[0.027]
	s.e	0.047	0.239	0.054	0.095	0.087	0.174	0.144	0.164	0.335	0.331	0.164	0.295	0.044				
	p-value	0.000	0.002	0.000	0.713	0.000	0.000	0.250	0.009	0.246	0.027	0.001	0.273	0.000				

*continued overleaf*

Table 4: Estimation results (continued)

ISIC	PQML	$\ln(Y_i)$	$\ln(hk_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	$Adj_{ij}$	$EU_{ij}$	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	$Lan_{ij}$	$Col_{ij}$	Home market	$R^2$	LM-test (Het.)	RESET	Obs.
382	coeff.	1.036	-0.334	0.762	-0.248	-0.656	0.244	0.025	0.477	-0.532	0.576	0.501	0.203	0.274	0.882	[0.000]	[0.729]	[0.059]
	s.e	0.049	0.226	0.056	0.091	0.086	0.155	0.147	0.172	0.348	0.346	0.127	0.380	0.046				
	p-value	0.000	0.140	0.000	0.007	0.000	0.117	0.868	0.006	0.006	0.127	0.096	0.000	0.593	0.000			
383	coeff.	1.023	-0.252	0.790	-0.233	-0.631	0.432	-0.025	0.573	-0.747	1.014	0.236	0.363	0.233	0.855	[0.000]	[0.222]	[0.062]
	s.e	0.067	0.323	0.078	0.136	0.105	0.149	0.197	0.218	0.429	0.419	0.191	0.443	0.057				
	p-value	0.000	0.436	0.000	0.088	0.000	0.004	0.897	0.009	0.082	0.016	0.218	0.413	0.000				
384	coeff.	0.987	-0.026	0.905	-0.346	-0.571	0.569	0.335	0.484	0.507	0.947	0.028	0.157	0.082	0.873	[0.000]	[0.593]	[0.060]
	s.e	0.073	0.344	0.080	0.146	0.102	0.172	0.220	0.322	0.478	0.439	0.233	0.384	0.074				
	p-value	0.000	0.940	0.000	0.018	0.000	0.001	0.128	0.134	0.134	0.290	0.032	0.905	0.683	0.265			
385	coeff.	1.007	0.856	0.828	-0.173	-0.609	0.347	-0.314	0.271	-1.016	0.403	0.372	-0.026	0.179	0.868	[0.000]	[0.480]	[0.067]
	s.e	0.059	0.313	0.052	0.105	0.093	0.167	0.184	0.213	0.406	0.271	0.127	0.353	0.061				
	p-value	0.000	0.006	0.000	0.099	0.000	0.038	0.088	0.203	0.203	0.013	0.138	0.004	0.004				
390	coeff.	0.861	-0.816	0.798	0.526	-0.557	0.460	-0.383	-0.342	-1.370	0.634	0.168	0.075	0.062	0.760	[0.000]	[0.232]	[0.079]
	s.e	0.095	0.422	0.089	0.240	0.109	0.158	0.203	0.249	0.449	0.381	0.181	0.482	0.108				
	p-value	0.000	0.054	0.000	0.029	0.000	0.004	0.060	0.170	0.170	0.002	0.097	0.355	0.877	0.562			

Table 5: Home market effect in manufacturing industries

ISIC	Manufacturing industry	Home market effect					
		10%		5%		1%	
		OLS	PQML	OLS	PQML	OLS	PQML
3	Manufacturing	.	.	.	.	.	.
31	Food, beverages, tobacco	.	.	.	.	.	.
321	Textiles	.	.	.	.	.	.
322	Wearing apparel	yes	.	yes	.	yes	.
323	Leather, leather products	.	yes	.	yes	.	.
324	Footwear	yes	yes	yes	yes	yes	yes
331	Wood, wood products	.	.	.	.	.	.
332	Furniture	yes	.	yes	.	.	.
341	Paper, paper products	.	.	.	.	.	.
342	Printing, publishing	yes	yes	yes	yes	yes	yes
351	Industrial chemicals	.	.	.	.	.	.
352	Other chemical products	yes	.	yes	yes	yes	.
353-4	Petroleum refineries and products	.	.	.	.	.	.
355	Rubber products	yes	yes	yes	yes	yes	yes
356	Plastic products	yes	yes	yes	yes	yes	yes
361	Pottery, china, earthenware	yes	yes	yes	.	yes	.
362	Glass, glass products	yes	.	yes	.	yes	.
369	Structural clay products	yes	yes	yes	.	yes	.
371	Iron and steel basic industries	.	.	.	.	.	.
372	Basic non-ferrous metals	.	.	.	.	.	.
381	Fabricated metal products	yes	yes	yes	yes	yes	yes
382	Machinery	yes	yes	yes	yes	yes	yes
383	Electrical machinery	yes	yes	yes	yes	yes	yes
384	Transport equipment	yes	.	yes	.	yes	.
385	Measuring, photo, and optical equipment	yes	yes	yes	yes	yes	yes
390	Other manufacturing	yes	.	yes	.	yes	.

“.” – indicates that the null hypothesis that  $\hat{\beta}_1^a - \hat{\beta}_3^a \leq 0$  cannot be rejected at the respective significance level. See Section 2 on how the home market effect is detected.

Table 6: Capital- versus labour intensity in manufacturing industries

ISIC	Manufacturing industry	Capital- versus labour intensity					
		10%		5%		1%	
		OLS	PQML	OLS	PQML	OLS	PQML
3	Manufacturing	capital	.	capital	.	capital	.
31	Food, beverages, tobacco	capital	capital	capital	capital	capital	capital
321	Textiles	labour	labour	labour	labour	labour	labour
322	Wearing apparel	labour	labour	labour	labour	labour	labour
323	Leather, leather products	labour	labour	labour	labour	.	labour
324	Footwear	labour	labour	labour	labour	labour	labour
331	Wood, wood products	capital	capital	capital	capital	capital	.
332	Furniture	capital	labour	.	labour	.	labour
341	Paper, paper products	capital	capital	capital	capital	capital	capital
342	Printing, publishing	capital	.	capital	.	capital	.
351	Industrial chemicals	capital	capital	capital	capital	capital	capital
352	Other chemical products	capital	capital	capital	capital	capital	capital
353-4	Petroleum refineries and products	labour	.	labour	.	.	.
355	Rubber products	labour	labour	labour	labour	.	labour
356	Plastic products	capital	.	capital	.	.	.
361	Pottery, china, earthenware	labour	labour	labour	labour	labour	labour
362	Glass, glass products	labour	labour	labour	labour	labour	.
369	Structural clay products	labour	labour	labour	labour	labour	labour
371	Iron and steel basic industries	.	.	.	.	.	.
372	Basic non-ferrous metals	capital	capital	capital	capital	capital	capital
381	Fabricated metal products	capital	labour	.	labour	.	labour
382	Machinery	capital	.	capital	.	capital	.
383	Electrical machinery	capital	.	capital	.	capital	.
384	Transport equipment	capital	.	capital	.	capital	.
385	Measuring, photo, and optical equipment	capital	capital	capital	capital	capital	capital
390	Other manufacturing	capital	labour	capital	.	capital	.

“.” – indicates that the null hypothesis that  $\widehat{\beta}_2^a = 0$  cannot be rejected at the respective significance level.

Table 7: “Luxury” versus “necessity” in consumption in manufacturing industries

ISIC	Manufacturing industry	Luxury versus necessity in consumption					
		10%		5%		1%	
		OLS	PQML	OLS	PQML	OLS	PQML
3	Manufacturing	.	necessity	.	.	.	.
31	Food, beverages, tobacco	.	.	.	.	.	.
321	Textiles	.	.	.	.	.	.
322	Wearing apparel	luxury	luxury	luxury	luxury	luxury	luxury
323	Leather, leather products	.	necessity	.	.	.	.
324	Footwear	luxury	luxury	luxury	luxury	luxury	luxury
331	Wood, wood products	luxury	.	luxury	.	.	.
332	Furniture	luxury	luxury	luxury	luxury	.	luxury
341	Paper, paper products	necessity	necessity	.	.	.	.
342	Printing, publishing	luxury	luxury	luxury	luxury	luxury	luxury
351	Industrial chemicals	necessity	.	necessity	.	necessity	.
352	Other chemical products	.	.	.	.	.	.
353-4	Petroleum refineries and products	.	.	.	.	.	.
355	Rubber products	luxury	.	luxury	.	.	.
356	Plastic products	luxury	.	luxury	.	luxury	.
361	Pottery, china, earthenware	luxury	.	luxury	.	.	.
362	Glass, glass products	luxury	.	.	.	.	.
369	Structural clay products	.	.	.	.	.	.
371	Iron and steel basic industries	necessity	necessity	.	necessity	.	necessity
372	Basic non-ferrous metals	.	.	.	.	.	.
381	Fabricated metal products	luxury	.	.	.	.	.
382	Machinery	.	necessity	.	necessity	.	necessity
383	Electrical machinery	.	necessity	.	.	.	.
384	Transport equipment	.	necessity	.	.	.	.
385	Measuring, photo, and optical equipment	.	necessity	.	.	.	.
390	Other manufacturing	luxury	.	luxury	.	luxury	.

“.” – indicates that the null hypothesis that  $\hat{\beta}_4^a = 0$  cannot be rejected at the respective significance level.

Figure 1: Estimated distance elasticity,  $\hat{\beta}_5^a$

