DIW Berlin
German Institute
for Economic Research

Discussion Papers
739

Boriss Siliverstovs
Dieter Schumacher

Estimating Gravity Equations: To Log or not to Log?

Berlin, October 2007

Opinions expressed in this paper are those of the author and do not necessarily reflect views of the institute.

IMPRESSUM

DIW Berlin
German Institute for Economic Research
Mohrenstr. 58
10117 Berlin
Tel. +49 (30) 897 89-0
Fax +49 (30) 897 89-200
http://www.diw.de

ISSN print edition 1433-0210
ISSN electronic edition 1619-4535

Available for free downloading from the DIW Berlin website.

Estimating Gravity Equations: To Log or not to Log?[§]

Boriss Siliverstovs *

DIW Berlin

Dieter Schumacher**

Europe University Viadrina / DIW Berlin

October 29, 2007

Abstract

This study compares two alternative approaches to estimate parameters in gravity equations. 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 the non-linear multiplicative specification of the gravity model. We use the trade flows for all products, for all manufacturing products as well as for manufacturing products broken down by three-digit ISIC Rev.2 categories. We base our conclusions on the generalised gravity model of Bergstrand (1989) that allows us to investigate differences in factor-proportions and home-market effects at the industry level. In addition, we compare the effects of other explanatory variables such as exporter and importer total income, distance, preferential trade agreements, common border, historical ties, and common language on the volume of trade. Our study provides comprehensive evidence on likely qualitative and/or quantitative differences in the values of estimated coefficients as a result of application of an alternative estimation method. Our main conclusion is that both estimation results as well as results of the regression misspecification tests provide supporting evidence for the PQML estimation approach over the OLS estimation method.

Keywords: generalised gravity equation, Poisson regression

JEL code: F12.

[§]The paper has benefited from comments by an anonymous referee and by the participants at the following conferences: the 4th Nordic Econometrics Meeting, Tartu, Estonia, the 8th Annual Conference of the European Trade Study Group (ETSG), Vienna, Austria, the 21th Annual Congress of the European Economic Association (EEA), Vienna, Austria, the XIth Spring Meeting of Young Economists (SMYE), Sevilla, Spain, and the 5th Annual Conference of the European Economics and Finance Society (EEFS), Heraklion, Greece.

*DIW Berlin, Mohrenstraße 58, 10117 Berlin, Germany, e-mail: bsiliverstovs@diw.de

**DIW Berlin, Mohrenstraße 58, 10117 Berlin, Germany, e-mail: dschumacher@diw.de

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 a few most popular areas of application. Despite the fact that the gravity equation is formulated in multiplicative form, the majority of empirical 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 the introduction of gravity models, their estimation in the multiplicative form has been prohibitively expensive both in terms of time and computing power, if even possible. This is no longer true given the advances of computing facilities. Nevertheless, conventional practice is still to estimate 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, for the purpose of estimation, the original equation in the multiplicative form is 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 already been 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 by means of rather small-scale Monte Carlo simulations. In particular, they show that the consistency of the OLS estimator crucially depends on a very restrictive and, therefore, in practice rather unrealistic assumption on the error term. This finding is very disturbing as 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. Given these results and their consequences, Santos Silva and Tenreyro (2006) strongly recommend that the gravity type models should be estimated in the multiplicative form and suggest a simple quasi-maximum likelihood estimation technique based on Poisson regression. The Poisson Quasi Maximum Likelihood (PQML) estimator yields consistent estimates of the parameters of the multiplicative form of the gravity model and, therefore, it offers a viable alternative that is likely to seriously challenge the established practice of estimating gravity equations in the log-linearised form.

As an empirical illustration, Santos Silva and Tenreyro (2006) provide the comparative analysis of the coefficient estimates of the standard gravity model[1] obtained by both the PQML and OLS methods. For this purpose, they use the aggregated trade flows collected for 136 countries. They show that there are substantial differences in the coefficient estimates obtained using the PQML method when compared to those obtained by the OLS method, suggesting a substantial bias in the OLS estimates. This finding should raise serious concerns on whether conventional practice of estimating parameters of gravity equations is trustworthy.

This paper provides a more comprehensive empirical evidence on the performance of the PQML procedure in comparison to the traditional OLS estimation method using not only the aggregated trade flows – as done

[1] They also briefly report the estimation results of the Anderson-van Wincoop gravity equation as well as those obtained using a smaller subsample of countries. Since the differences in the results obtained using the PQML and OLS methods appear to be robust to the types of the gravity model as well as to the subsamples, we have chosen to concentrate on the results reported for the standard gravity equation only.

in Santos Silva and Tenreyro (2006) – but also the trade flows broken down by 25 three-digit ISIC Rev.2 industries as well as for manufacturing as a whole. We base our comparative analysis on the generalised gravity model of trade at the industry level suggested in Bergstrand (1989) which remains the only study in the literature that provides the theoretical foundation for the gravity equation applied to the disaggregated trade flows. In particular, Bergstrand (1989) shows that the generalised gravity equation can be used in order to tentatively classify industries into labour- or capital-intensive and those that tend to produce luxuries or necessities in consumption. Furthermore, Schumacher and Siliverstovs (2006) show that in the model of Bergstrand (1989), in addition to the traditional comparative advantage effects arising from differences in relative factor endowment and per capita income, there is also a home-market effect arising from difference in total income.

Thus, by estimating parameters of the generalised gravity model at the industry level, we are able to investigate several important issues that cannot be addressed at the aggregate level and, therefore, are absent from the analysis of Santos Silva and Tenreyro (2006). First, since the relationship between the relative factor endowments and bilateral trade flows is of fundamental importance in the trade literature we investigate how conclusions on the relative factor intensity of the manufacturing industries vary depending on the estimation method applied. In the same vein, we also investigate whether there are any substantial qualitative and/or quantitative differences in classification of the industries into those that tend to produce luxury versus necessity goods. Finally, estimation of the parameters of the generalised gravity model by both the OLS and PQML procedures allows us to investigate to what extent magnitude and appearance of the home-market effect for different industries depend on the estimation methodology.

Furthermore, since the generalised gravity model of Bergstrand (1989) also contains the "traditional" gravity model variables, i.e., total exporter and importer income, and distance, as well as preferential trade agreement, adjacency, historical ties, and common language dummies, we are able to verify whether the conclusions reached in Santos Silva and Tenreyro (2006) on substantial differences in the OLS and PQML parameter estimates for these variables also hold in our data set. First, in order to make our study comparable with Santos Silva and Tenreyro (2006), we report differences in the observed coefficient estimates for aggregated trade flows as well as for manufacturing trade flows as a whole among 22 OECD countries. Second, we investigate whether the results obtained for the aggregated trade flows hold when we estimate the generalised gravity model using trade flows broken down by separate industries.

Last but not least, we follow Santos Silva and Tenreyro (2006) and employ the misspecification tests suggested therein 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 assumptions underlying the model. 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 remainder of the paper is organised as follows. Section 2 presents the generalised gravity model of Bergstrand (1989). Section 3 describes the data used in the empirical analysis. Section 4 discusses the gravity model estimation issues. Section 5 describes the obtained results. The final section concludes.

2 The generalised gravity quation

In international trade, gross aggregate trade flows between a pair of countries are typically explained either by the following specification of the gravity model[2]

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

or by the following specification

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

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 the corresponding country, and the distance variable, D_{ij}, as in equation (1) or, additionally, by exporter and importer population variables, L_i and L_j, which may enter a gravity model either on their own[3] 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 factors or their combination that exercise either promoting or deferring role for bilateral trade flows such as preferential trade agreements, historical ties, common language, etc., is added to equations (1) and (2). Lastly, η_{ij} is the error term.

Until recently, despite the overwhelming empirical success of the gravity model in explaining bilateral patterns 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 studies of Anderson (1979), Bergstrand (1985), and Helpman and Krugman (1985, ch. 8). Observe that although these studies have been able, in the end, to derive the multiplicative functional form of the gravity equation (1), exporter and importer per capita incomes (or, equally, populations), that enter equation (2), were ignored therein. Bergstrand (1989) introduces a significant advance in the 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 the 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 of an exporting country and expenditure capabilities of an importing country, respectively.

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

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

where we have introduced a new notation for the capital-labour endowment ratio of an exporting country,

[2] See, for example, Tinbergen (1962), Poyhonen (1963), Geraci and Prewo (1977), Feenstra et al. (2001).
[3] See, for example, Linnemann (1966), Aitken (1973), Sattinger (1978), Sapir (1981).

c_i. 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^a_{ij} represents the trade flow of exports from country i to country j, the variable X^a_{ji} stands for the reverse flow of goods exported from country j to country i, i.e. imports of country i from country j. Then, equation (3) can also be re-written for the variable X^a_{ji} 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 export-to-import ratio which reads as

$$\frac{X^a_{ij}}{X^a_{ji}} = \left(\frac{Y_i}{Y_j}\right)^{\beta^a_1-\beta^a_3} \left(\frac{c_i}{c_j}\right)^{\beta^a_2} \left(\frac{Y_i/L_i}{Y_j/L_j}\right)^{-\beta^a_4} \tag{4}$$

As discussed in Schumacher and Siliverstovs (2006), such transformation allows one to differentiate between the two different sources that shape the sectoral pattern of export-to-import ratios, i.e. the traditional comparative advantage effects, arising from the relative capital-labour endowment ratios and the relative income per capita ratios on the one hand, and the home-market effect, arising from the relative economic size on the other. Observe that the other variables such as a distance, $D_{ij} = D_{ji}$, or the dummy variables 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 export-to-import ratio.

Thus, the coefficients β^a_2 and β^a_4 measure the magnitude of the traditional comparative advantage effects on the sectoral pattern of 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-labour endowment ratio and per capita income. As stressed in Bergstrand (1989), β^a_2 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 ($\beta^a_2 > 0$) then this would indicate that the relevant goods tend to be capital intensive in production and when it is negative ($\beta^a_2 < 0$) then the relevant goods tend to be labour intensive in production[4]. Moreover, the interpretation of the importer per capita income as a taste preference variable allows one to classify goods into either "luxury" or "necessity" categories in consumption, depending on whether the coefficient is positive ($\beta^a_4 > 0$) or negative ($\beta^a_4 < 0$). Note that the export-to-import ratio in equation (4) is larger the larger β^a_2 and the smaller β^a_4, i.e., the more the respective good is capital intensive in production and the more it is a necessity in consumption. Conversely, it is smaller the smaller β^a_2 and the larger β^a_4, i.e., the more the respective good is labour intensive in production and the more it is luxury in consumption.

Similarly, as discussed in Schumacher and Siliverstovs (2006), if the two countries i and j have the same

[4]The capital or labour intensity of an industry can be inferred only in the special case of two industries and two factors of production. In the multi-industry case, however, "a weak inference of the relative factor intensity can be made using exporter per capita income coefficient estimates from a gravity equation" (Bergstrand, 1989, p. 146) referring to Deardorff (1982), who provided a "weak" generalization of the Heckscher-Ohlin theorem by proving that countries tend to export those goods which use intensively their abundant factor.

capital-labour endowment ratio and the same per capita income, the export-to-import ratio only depends on the relative size of these two economies. The export-to-import ratio in equation (4) increases with higher β_1^a and lower β_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 the exporting country relative to the total income of the importing country. The positive difference $(\beta_1^a - \beta_3^a > 0)$ indicates a home-market effect which may arise for more differentiated goods because the producers in the exporting country can exploit higher economies of scale.

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 difference of the exporter and importer total 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[5] (in US $ million) for all products combined, manufacturing products as a whole, and broken down by 25 three-digit ISIC Rev.2 industries for trade among 22 OECD countries.[6] 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 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.

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.[7] 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, $CUSTA_{ij}$, and Asia-Pacific Economic Cooperation, $APEC_{ij}$, ties by language, Lan_{ij}, and historical 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 same preference zone, or have the same language or historical ties.[8] Otherwise the value of the dummy variables is zero.

[5] 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.

[6] Member countries in 1993, excluding Iceland and taking Belgium/Luxembourg together.

[7] 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: $cosD_{ij} = \sin\varphi_i * \sin\varphi_j + \cos\varphi_i * \cos\varphi_j * \cos(\lambda_j - \lambda_i)$ 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 φ = latitude, λ = longitude.

[8] 0.5 for second languages and 0.5 for historical ties until 1914.

4 Model Estimation Issues

In this section, we discuss the two alternative estimation procedures of the gravity model of trade: the traditional OLS approach and the Poisson Quasi Maximum Likelihood approach of Santos Silva and Tenreyro (2006). 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 η_{ij}, and, therefore $\ln(\eta_{ij})$, are statistically independent of the regressors. In particular, the variance of the error term $\ln(\eta_{ij})$ should be constant and, henceforth, should not depend on the values of the regressors.

Observe that, in general, the error term ε_{ij} will be heteroskedastic unless 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

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

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

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

with

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

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. Observe that, namely, 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 estimate the parameters 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[9]

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

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.

[9]A vector of dummy variables, described in Section 3, is also included among the explanatory variables.

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. As 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 micro-econometric models as suggested in Peters (2000). Moreover, 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).

5 Estimation results

In this section, we summarise the estimation results that stem from the application of the OLS and the PQML procedures to the log-linear form and the multiplicative specification of the gravity model, respectively[10]. As seen from Figures 1 – 10, where the estimated coefficients are displayed, there are often quantitative and/or qualitative differences that can be observed[11]. In the figures, the industries are arranged according to the magnitude of the OLS estimates. The corresponding 95% confidence intervals are displayed as well.

Since the amount of information is rather large, we have split this section in two subsections. In section 5.1 we report the comparative analysis of the results that were not covered in Santos Silva and Tenreyro (2006), i.e., we will investigate to what extent the different estimation methods yield various conclusions regarding the factor intensity of a given industry, their tendency to produce luxuries or necessities, as well as the presence of the home-market effect. In section 5.2 we will address the issues that were already covered in Santos Silva and Tenreyro (2006) and investigate to what extent their conclusions regarding estimation differences of the total income elasticities, the distance elasticity as well as the effects of preferential trade agreements, common border, historical ties, and common language hold in our dataset at the different levels of disaggregation, i.e., for the bilateral trade flows of all goods combined, of all manufacturing goods, as well as of the industrial products broken down by the 25 three-digit ISIC Rev.2 categories.

[10] 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 schooling of the exporting country. The bilateral trade data refer to import statistics, the results obtained for export statistics are very similar.

[11] The detailed estimation results are reported in Tables 3 and 4.

5.1 Factor-proportions and home-market effects

Since the relationship between the relative factor intensity and the bilateral trade flows is of uttermost importance in the trade literature, we start with sorting out to what extent a different estimation method influences the classification of the manufacturing industries into those that tend to be either labour- or capital-intensive in production. As shown in Bergstrand (1989), the estimated sign of the capital-labour endowment ratio elasticity $\widehat{\beta}_2^a$ can tentatively reveal the factor intensity of a given industry.

Figure 1 shows the estimated capital-labour endowment ratio elasticity $\widehat{\beta}_2^a$ with the corresponding 95% confidence interval obtained by application of the OLS and the PQML methods and the left panel of Table 1 summarises our findings using the 5% significance level. Thus, such industries as textiles (31), wearing apparel (322), leather and leather products (323), footwear (324), rubber products (355), pottery, china and earthware (361), glass and glass products (362), and structural clay products (369) are classified as those that tend to be labour-intensive by both methods. All these results seem plausible. PQML also suggests that furniture (332) and fabricated metal products (381) industries tend to be labour-intensive while the corresponding coefficient estimates are not significantly different from zero under OLS.

The following industries were labeled by both methods as those that tend to be capital-intensive: food, beverages and tobacco (31), wood and wood products (331), paper and paper products (341), industrial chemicals (351), other chemical products (352), basic non-ferrous metals (372), and measuring, photo and optical equipment (385). In addition, the OLS estimated coefficients were positive and statistically significant at the 5% level for printing and publishing (342), plastic products (356), machinery (382), electrical machinery (383), transport equipment (384), and other manufacturing (390), indicating that these products also tend to be capital-intensive. The corresponding PQML estimated coefficients for these six industries were found to be insignificantly different from zero and therefore contain no information on whether these products tend to be either capital- or labour-intensive.

On the basis of this comparison, we can conclude that despite the observed numerical differences in the values of the estimated $\widehat{\beta}_2^a$ coefficients both procedures largely lead to a rather similar classification of the various manufacturing industries in terms of their factor intensity. The only difference is that under OLS the list of the industries that tend to be capital-intensive is almost as twice as large as that under PQML (13 vs 7 industries). Observe that there is not a single case when the same industry was classified simultaneously as labour- and capital-intensive according to the results of both estimation procedures at the 5% significance level.

Figure 2 displays the elasticity of the importer per capita income $\widehat{\beta}_4^a$ estimated by both methods. As shown in Bergstrand (1989), one can use this information in order to tentatively classify the industries into those that produce luxury or necessity goods. The middle panel of Table 1 summarises our findings using the 5% level of significance. First, we observe that the corresponding coefficient values $\widehat{\beta}_4^a$ 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, the coefficient estimates obtained by both methods are positive and statistically significant at the 5% level for such industries as wearing apparel (322), footwear(324), furniture (332), printing and publishing (342), and other manufacturing (390) suggesting that these products are luxuries. In addition, OLS results imply that luxuries in consumption are produced by such industries as wood and wood products (331), rubber products (355), plastic products (356), and pottery, china and earthware (361). In sum, OLS results suggest more industries that tend to produce luxuries than the results obtained by the PQML procedure.

Concerning industries that tend to produce necessities, we observe the opposite, i.e., the PQML procedure tends to classify more products as necessities in comparison to the OLS estimation results. Thus, judging at the 5% significance level the following industries like iron and steel basic industry (371), machinery (382), and transport equipment (384) are classified as those that tend to produce necessities by the PQML method. At the same time, at this level of significance there is a single industry (industrial chemicals (351)) whose products appear to be necessities according to the OLS estimation results. Overall, the results seem to be plausible. Note that there is not a single industry that appears to be classified differently according to the OLS and PQML procedures.

Figure 3 displays the difference between the estimated exporter's and importer's total income elasticities $\widehat{\beta}_1^a - \widehat{\beta}_3^a$. As shown in Schumacher and Siliverstovs (2006), this difference, whenever it is positive, defines the home-market effect for a respective industry. The right panel of Table 1 indicates the industries where the home-market effect has been identified using the 5% significance level. As seen according to the OLS results, the home-market effect has been identified in the following 16 out of 25 industries: transport equipment (384), rubber products (355), footwear (324), pottery, china and earthware (361), printing and publishing (342), glass and glass products (362), electrical machinery (383), machinery (382), other chemical products (352), plastic products (356), wearing apparel (322), other manufacturing (390), fabricated metal products (381), structural clay products (369), measuring, photo and optical equipment (385), and furniture (332). At the same time, PQML results suggest that the home-market effect appears in a smaller number of industries including rubber products (355), footwear (324), printing and publishing (342), electrical machinery (383), machinery (382), other chemical products (352), plastic products (356), fabricated metal products (381), measuring, photo and optical equipment (385), as well as leather and leather products (323) using the 5% significance level. Observe that the list of industries where the home-market effect has been identified by means of the OLS regression includes all the industries but one (leather and leather products (323)) where the home-market effect has been identified by means of the PQML procedure. Thus, under OLS one identifies more industries where the home-market effect is present (16 versus 9 industries). Also observe that not only the number of industries with the home-market effect but also the magnitude of the home-market effect seems to be smaller under PQML than under OLS.

It is also interesting to note that the home-market effect can be detected only when we look at the disaggregated trade flows. The results of both estimation procedures indicate that for all goods combined as well as for all manufacturing goods the difference between the exporter's and the importer's total income elasticities is insignificantly different from zero. This implies that a rather large level of aggregation disguises the home-market effect.

A separate question that is worth investigating is the comparison of the (absolute) magnitude of the estimated home-market effect with the relative factor intensity effects since according to equation (4) either one determines the sectoral pattern of export-to-import ratios. We find that the average absolute value of $\widehat{\beta}_1^a - \widehat{\beta}_3^a$, used to identify the home-market effect, is estimated to be 0.284(0.208) for the OLS(PQML) method, whereas the average absolute value of the capital-labour endowment elasticity $\widehat{\beta}_2^a$ is 1.556(1.288) for the OLS(PQML) method, respectively. This implies that the influence of the relative economic size of the countries on the pattern of comparative advantage is not as strong as that of the relative factor endowment.

5.2 Effects on trade volume

5.2.1 Aggregated trade flows

To begin with, in Table 2 we report both the OLS and the PQML estimated coefficient values along with the standard errors as well as the regression misspecification tests for all goods combined and for manufacturing goods as a whole. The estimation results for the aggregated trade data enable us to compare our conclusions 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 (22 vs 136) and hence the number of the observations (462 vs 18360) is very different in our dataset and theirs. This also implies that the share of zero observations drastically differs in our dataset (0% for both aggregate categories) and theirs (52%).

From Table 2 one can see that both OLS and PQML results for all manufacturing goods are very close to those for all goods combined. This is not surprising as nearly all trade in our sample of OECD countries consists of manufacturing goods while the share of agricultural and mining products is very small. Hence, in the following we will only compare OLS and PQML estimation results for all goods combined. We confine ourselves to the discussion of the following issues that were already covered in Santos Silva and Tenreyro (2006): the magnitude of the exporter and importer total income elasticity, the distance elasticity, the role of preferential trade agreements as well as the effects of a common border, historical ties, and a common language.

As seen in Table 2, for all goods combined, both estimation procedures yield 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 to the Poisson regression results reported in Santos Silva and Tenreyro (2006), but deviates from the OLS regression results reported therein which tend to be 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 the country the more open it is to international trade.

Santos Silva and Tenreyro (2006) observe that the trade deterring role of geographical distance is significantly larger under OLS. Their estimated distance elasticities for the OLS and PQML methods are -1.17(0.03) and -0.78(0.06), respectively, with the corresponding standard errors reported in parentheses. Our results also indicate that the role of distance as trade deterrent tends to be larger under OLS even though the difference is not that prominent: -0.707(0.032) under OLS versus -0.608(0.063) under PQML.

Our estimation results support another finding of Santos Silva and Tenreyro (2006) that the role of the preferential trade agreements is significantly smaller under PQML. This can be illustrated for the countries that are members of the European Union, which is the most important and far-reaching regional preferential trade agreement among the OECD countries. The estimated coefficient for the EU dummy is 0.379 under OLS which should be compared with 0.245 under PQML. This implies that the EU membership of both countries increases bilateral trade by 46 percent according to the OLS results, whereas the Poisson estimate indicates a rise by only 28 percent.

Our results suggest that in the sample of the OECD countries, sharing a border substantially enhances trade according to both estimation methods. Thus, trade between two adjacent countries is 37 percent and 58 percent larger than trade between two countries without a common border according to the OLS and the PQML results, respectively. It is interesting to note that our OLS results practically coincide with those reported in Santos Silva and Tenreyro (2006), but our PQML results state the opposite of the results of Santos Silva and Tenreyro (2006), who find that according to the PQML estimation results sharing a border does not influence trade flows.

Santos Silva and Tenreyro (2006) also briefly discuss estimation differences in the effects of colonial(historical) ties. Their results show that there is no effect of colonial ties on the trade flows under PQML, whereas the OLS estimation results suggest that trade between countries with a colonial relatiohship is about 45 percent larger than trade between countries that do not share such historical links. Our results obtained from the aggregated trade flows for all goods combined indicate that there is a positive and statistically significant effect of historical ties according to both estimation procedures. However, the estimation results obtained for all manufacturing products indicate that the dummy variable for historical ties is only significant under OLS.

We also find that both OLS and PQML regressions indicate a positive and statistically significant effect of trade enhancement between a pair of countries that share common language, which conforms with the respective results of Santos Silva and Tenreyro (2006).

5.2.2 Disaggregated trade flows

Next, we will compare the estimation results obtained for the disaggregated trade flows. Here, again, we will address the issues discussed above at the aggregate level.

Figures 4 and 5 show the estimated exporter's and importer's total income elasticities $\widehat{\beta}_1^a$ and $\widehat{\beta}_3^a$, respectively. A substantial heterogeneity in the estimated coefficient values is present at this level of disaggregation. It is noteworthy, that according to the PQML estimation results the values of the total income elasticities of the exporting country are often much lower than those obtained by the OLS method which often exceed the value of unity. Similarly, although to a lesser degree, the PQML elasticities of the importing country's total income tend to be lower than the corresponding elasticities obtained by the OLS 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. Our results for disaggregated trade flows conform with the observation made by Santos Silva and Tenreyro (2006) that the total income elasticities tend to be smaller under PQML. This is distinct from what we observed from the aggregated trade flows in our dataset, where the values of the total income elasticities were found to be rather similar under both OLS and PQML, as noted above.

Figure 6 displays the estimated distance elasticity values $\widehat{\beta}_5^a$ obtained by both estimation procedures. As seen in all cases reported, the absolute magnitude of the distance elasticity is smaller – oftentimes significantly – under PQML than under OLS. 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. The other interesting result is that the individual distance elasticity values obtained by the OLS for the manufacturing industries in most cases are larger than the distance elasticity value reported for 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 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 -0.622.

Santos Silva and Tenreyro (2006) point out that the role of preferential trade agreements seems to be smaller under PQML than under OLS. When we consider the effects of the EU membership on the bilateral trade flows, our estimation results tend to support their conclusion not only on the aggregate level, as discussed above, but also at the sectoral level in most industries, see Figure 7. As seen with a few exceptions, the OLS coefficient is larger than the corresponding coefficient estimated by the PQML procedure. According to both estimation procedures the strongest effect of the EU membership is found in the following industries: food, beverages and tobacco (31), footwear (324), textiles (321), wearing apparel (322), and leather products (323), i.e., in labour-intensive consumer goods which are still relatively highly protected by EU trade policy. It is interesting to note that the EU dummy coefficient estimated by the PQML method is negative and statistically significant for wood and wood products as well as for paper and paper products. This indicates that the intra-EU trade in these two industries is significantly below the OECD-wide average.

It is natural to expect that countries that share a common border will tend to trade more intensively than countries that do not share a border. According to the results of Santos Silva and Tenreyro (2006) only the OLS results support this view whereas the PQML results indicate that sharing a border does not influence trade flows. In our dataset we find the opposite evidence. Figure 8 illustrates the point. On the one hand, according to the OLS estimation results, the border dummy is positive and significant only for two industries (food, beverages and tobacco (31) and textiles (321)) whereas for the remaining 23 manufacturing products it is found insignificant. Also observe that the point estimate of the role of the common border takes both positive as well as negative values under OLS. On the other hand, according to the PQML results, all estimated coefficients of the adjacency dummy are positive and 18 out of 25 are statistically significant at the 5% significance level. The magnitude of the PQML coefficients also tend to be larger than that of the corresponding OLS coefficient whenever they are positive.

We also have compared the estimated coefficients for the historical ties dummy. As seen from Figure 9, the coefficient values typically are larger under OLS than under PQML. Also the number of positive and statistically significant coefficients at the 5% level is larger according to the OLS estimation results (11 versus 5). Thus, our results support evidence reported in Santos Silva and Tenreyro (2006) that OLS regressions tend to boost the significance of the effect of colonial past on bilateral trade.

With respect to the effect of common language on bilateral trade we find that the OLS procedure indicates stronger influence than that implied by the PQML estimation results, see Figure 10. However, the list of industries where the language dummy is statistically and economically significant is practically the same under both estimation procedures, which supports the conclusions of Santos Silva and Tenreyro (2006) on the positive role of common language on the volume of trade.

Last but not least, we would like to discuss the results of the misspecification tests[12]. First, 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 rejects the null hypothesis, implying that the OLS estimator is biased. The outcomes of the RESET test also indicate possible misspecification of the conditional mean in the log-linearised gravity equation. Second, 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 conduct a comparative analysis of the estimated parameters in the generalised gravity model of Bergstrand (1989) using the traditional OLS estimator applied to the log-linearised from of the model as well as the Poisson Quasi Maximum Likelihood estimation technique suggested in Santos Silva and Tenreyro (2006). Our data set allows us to address differences and similarities of the results for aggregated trade flows and for manufacturing goods as well as for manufacturing trade disaggregated at the three-digit level.

We present two sets of results. The first set shows to what extent an alternative estimation method leads to differences in the tentative classification of industries according to their relative factor intensity, their tendency to produce luxuries vs necessities in consumption as well as by the presence of a home-market effect. Observe that by estimating parameters of the generalised gravity model at the industry level, we are able to investigate these important issues that cannot be addressed at the aggregate level and, therefore, are

[12]The detailed table with the estimation results is omitted for the sake of saving space but we make it available upon request.

absent from the analysis of Santos Silva and Tenreyro (2006).

The second set contains results that can be compared to those reported in Santos Silva and Tenreyro (2006). Similarly to their study, we compare the estimated coefficients of the exporter and importer total incomes, distance, preferential trade agreements, common border, historical ties, and common language. First, in doing so, we are able to verify whether the conclusions of Santos Silva and Tenreyro (2006) on substantial differences in the OLS and PQML parameter estimates for aggregated trade flows also hold in our data set at the aggregate level. This is an interesting question to be investigated as our data set contains less countries and, hence, less observations, the set of countries is more homogenous including only OECD countries, and the number of zero recorded trade flows at the aggregate level is zero. Second, we also investigate the robustness of observed differences in estimated coefficients when we estimate the gravity equation using disaggregated manufacturing trade flows.

Our main results can be summarised as follows. The tentative classification of manufacturing industries into those that tend to be either labour- or capital-intensive, those that tend to produce either luxuries or necessities in consumption, and those where the home-market effect is detected does not lead to contradictory conclusions according to both estimation procedures. However, we have observed the following regularities. First, the list of industries tentatively classified as capital-intensive under OLS is almost as twice as large as that under PQML. Second, the list of industries that tend to produce luxuries is larger under OLS as well. On the contrary, PQML suggests more industries that tend to produce necessities in consumption. Third, OLS identifies more industries than PQML where the home-market effect is present. Also the magnitude of the home-market effect seems to be smaller under PQML than under OLS. Furthermore, the estimation results suggest that the influence of the relative economic size of the countries on the pattern of comparative advantage is not as strong as that of the relative factor endowment.

Our estimation results for all products and for all manufacturing goods practically coincide as most trade between OECD countries is in manufacturing. We find that the estimated exporter and importer total income elasticities are very similar under both estimation procedures and about of a similar magnitude reported in Santos Silva and Tenreyro (2006) for the Poisson regression. In this respect, our results differ from those in Santos Silva and Tenreyro (2006) where the corresponding OLS elasticities are found to be close to unity and thus appear to be much larger than the corresponding PQML elasticities. Our results support the finding of Santos Silva and Tenreyro (2006) that the trade deterring role of distance seems to be smaller under PQML than under OLS. So is the trade-promoting role of preferential trade agreements (e.g., EU dummy). We find that under both estimation procedures sharing a border or having historical ties significantly enhance trade. Santos Silva and Tenreyro (2006) detect the trade-promoting role of a common border and of historical ties only under OLS but not under PQML. Finally, our results confirm those of Santos Silva and Tenreyro (2006) about an economically and statistically significant effect of a common language that appears to be robust across alternative estimation procedures.

At the disaggregate level, our results mostly confirm the findings of Santos Silva and Tenreyro (2006). This holds for exporter and importer total income elasticities, distance elasticity, preferential trade agreements, historical ties, and for common language. Regarding the role of a common border, however, we find just the opposite to what is stated in Santos Silva and Tenreyro (2006). Namely, our results suggest that under PQML sharing a border has a stronger effect on the volume of trade than under OLS.

All in all, several stylised facts seem to emerge on the differences and similarities between the estimation outcomes of the gravity equation by those two methods. These facts appear to be robust across different samples and levels of aggregation. However, we must acknowledge that at present more research is needed in order to access their general validity.

Last but not least, both estimation procedures were subjected to diagnostic testing. The outcome of these procedures unequivocally indicates that the assumption that ensures OLS consistency is very likely to be violated and, at the same time, finds no serious departures from assumptions underlying Poisson regressions. Thus, our paper provides broader empirical evidence for the view, already expressed in Santos Silva and Tenreyro (2006), that the conventional practice of estimating gravity equations in the log-linearised form should be questioned and replaced by more appropriate nonlinear approaches.

References

Aitken, N. D. (1973). The effect of EEC and EFTA on European trade: A temporal cross-section analysis. *American Economic Review 63*, 881–892.

Anderson, J. E. (1979). A theoretical foundation for the gravity equation. *American Economic Review 69*, 106–116.

Bergstrand, J. H. (1985). The gravity equation in international trade: Some microeconomic foundations and empirical evidence. *The Review of Economics and Statistics 67*, 474–481.

Bergstrand, J. H. (1989). The generalized gravity equation, monopolistic competition, and the factor proportions theory in international trade. *The Review of Economics and Statistics 71*(1), 143–153.

Davidson, R. and J. G. MacKinnon (1993). *Estimation and Inference in Econometrics*. Oxford: Oxford University Press.

Deardorff, A. V. (1982). The general validity of the Heckscher-Ohlin theorem. *American Economic Review 72*(4), 683–694.

Feenstra, R. C., J. A. Markusen, and A. K. Rose (2001). Using the gravity equation to differentiate among alternative theories of trade. *Canadian Journal of Economics 34*(2), 430–442.

Geraci, V. J. and W. Prewo (1977). Bilateral trade flows and transport costs. *The Review of Economics and Statistics 59*, 67–74.

Goldberger, A. (1968). The interpretation and estimation of Cobb-Douglas functions. *Econometrica 36*(3/4), 464–472.

Helpman, E. and P. Krugman (1985). *Market Structure and Foreign Trade*. Cambridge, MA: MIT Press.

Linder, S. B. (1961). *An Essay on Trade and Transformation.* New York: John Wiley and Sons.

Linnemann, H. (1966). *An Econometric Study of International Trade Flows.* Amsterdam: North-Holland Publishing Co.

Manning, W. G. and J. Mullahy (2001). Estimating log models: To transform or not to transform? *Journal of Health Economics 20*, 461–494.

Park, R. (1966). Estimation with heteroskedastic error terms. *Econometrica 34*(4), 888.

Peters, S. (2000). On the use of the RESET test in microeconometric models. *Applied Economics Letters 7*, 361–365.

Poyhonen, P. (1963). A tentative model for the volume of trade between countries. *Rewiew of World Economics 90*(1), 93–100.

Ramsey, J. B. (1969). Test for specification errors in classical linear least squares regression analysis. *Journal of the Royal Statistical Society B 31*, 350–371.

Santos Silva, J. M. C. and S. Tenreyro (2006). The log of gravity. *The Review of Economics and Statistics 88*(4), 641–658.

Sapir, A. (1981). Trade benefits under the EEC generalized system of preferences. *European Economic Review 15*, 339–355.

Sattinger, M. (1978). Trade flows and differences between countries. *Atlantic Economic Journal 6*, 22–29.

Schumacher, D. and B. Siliverstovs (2006). Home-market and factor-endowment effects in a gravity approach. *Review of World Economics (Weltwirtschaftliches Archiv) 127*(2), 330–353.

Tinbergen, J. (1962). *Shaping the World Economy.* New York: Twentieth Century Fund.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross-Section and Panel Data.* Cambridge, MA: MIT Press.

Table 1: Classification of industries

ISIC Rev.2	Manufacturing industry	Capital- vs labour-intensive		Luxury vs necessity		Home-market effect	
		OLS	PQML	OLS	PQML	OLS	PQML
31	Food, beverages, tobacco	capital	capital	•	•	•	•
321	Textiles	labour	labour	•	•	•	•
322	Wearing apparel	labour	labour	luxury	luxury	yes	•
323	Leather, leather products	labour	labour	•	•	•	yes
324	Footwear	labour	labour	luxury	luxury	yes	yes
331	Wood, wood products	capital	capital	luxury	•	•	•
332	Furniture	•	labour	luxury	luxury	yes	•
341	Paper, paper products	capital	capital	•	•	•	•
342	Printing, publishing	capital	•	luxury	luxury	yes	yes
351	Industrial chemicals	capital	capital	necessity	•	•	•
352	Other chemical products	capital	capital	•	•	yes	yes
353-4	Petroleum refineries and products	labour	•	•	•	•	•
355	Rubber products	labour	labour	luxury	•	yes	yes
356	Plastic products	capital	•	luxury	•	yes	yes
361	Pottery, china, earthware	labour	labour	luxury	•	yes	•
362	Glass, glass products	labour	labour	•	•	yes	•
369	Structural clay products	labour	labour	•	•	yes	•
371	Iron and steel basic industries	•	•	•	necessity	•	•
372	Basic non-ferrous metals	capital	capital	•	•	•	•
381	Fabricated metal products	•	labour	•	•	yes	yes
382	Machinery	capital	•	•	necessity	yes	yes
383	Electrical machinery	capital	•	•	•	yes	yes
384	Transport equipment	capital	•	•	necessity	yes	•
385	Measuring, photo, and optical equipment	capital	capital	•	•	yes	yes
390	Other manufacturing	capital	•	luxury	luxury	yes	•

"•" – indicates that the null hypothesis that $\widehat{\beta}_2^a = 0$, $\widehat{\beta}_4^a = 0$, and $(\widehat{\beta}_1^a - \widehat{\beta}_3^a) = 0$ for the left, middle, and right panels, respectively, cannot be rejected at the 5% significance level.

Table 2: OLS and PQML estimation results for all goods combined and for all manufacturing goods

	OLS	$\ln(Y_i)$	$\ln(c_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	Adj_{ij}	EU_{ij}	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	Lan_{ij}	Col_{ij}	Home market	R^2	LM-test (Het.)	RESET	Obs.
All goods	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				
All manuf. goods	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	0.914	0.000	0.002	0.009	0.196				
	PQML	$\ln(Y_i)$	$\ln(c_i)$	$\ln(Y_j)$	$\ln(Y_j/L_j)$	$\ln(Dist_{ij})$	Adj_{ij}	EU_{ij}	$EFTA_{ij}$	$CUSTA_{ij}$	$APEC_{ij}$	Lan_{ij}	Col_{ij}	Home market	Pseudo-R^2	Park (1966)	RESET	GNR
All goods	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				
All manuf. goods	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	0.347	0.000	0.006	0.140	0.339				

Table 3: OLS estimation results: disaggregated manufacturing industries

ISIC Rev.2	**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.
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 Rev.2	**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 Rev.2	**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.
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 Rev.2	**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	0.000	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				

continued overleaf

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

ISIC Rev.2	**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 Rev.2	**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	Pseudo-R^2	Park (1966)	RESET	GNR
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	0.753	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 Rev.2	**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	Pseudo-R^2	Park (1966)	RESET	GNR
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 Rev.2	**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	Pseudo-R^2	Park (1966)	RESET	GNR
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 Rev.2	**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	Pseudo-R^2	Park (1966)	RESET	GNR
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	0.009	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 Rev.2	**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	Pseudo-R^2	Park (1966)	RESET	GNR
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	0.127	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	0.290	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	0.013	0.138	0.004	0.942	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	0.002	0.097	0.355	0.877	0.562				

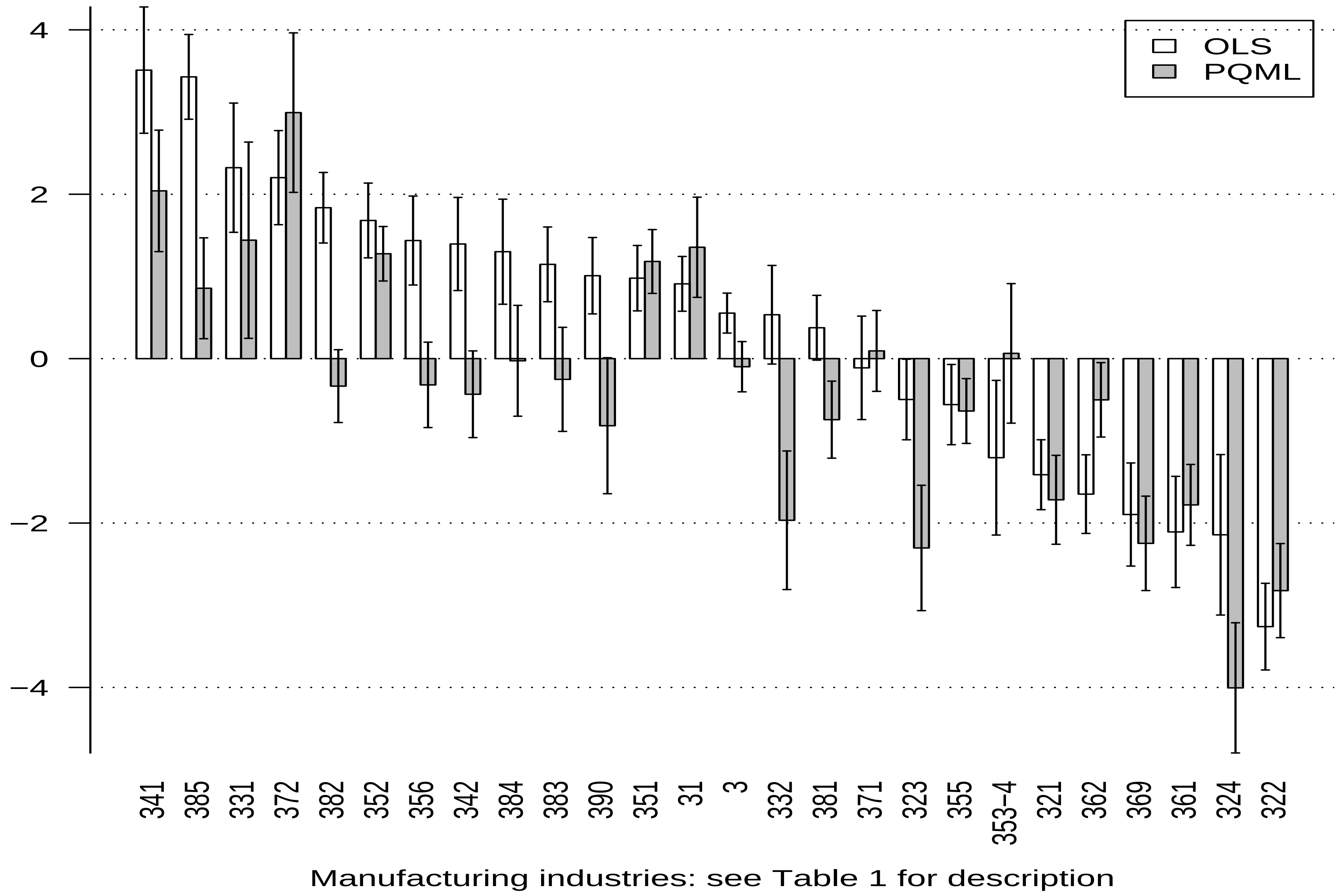

Figure 1: Estimated exporter capital-labour endowment ratio elasticity $\widehat{\beta_2^a}$

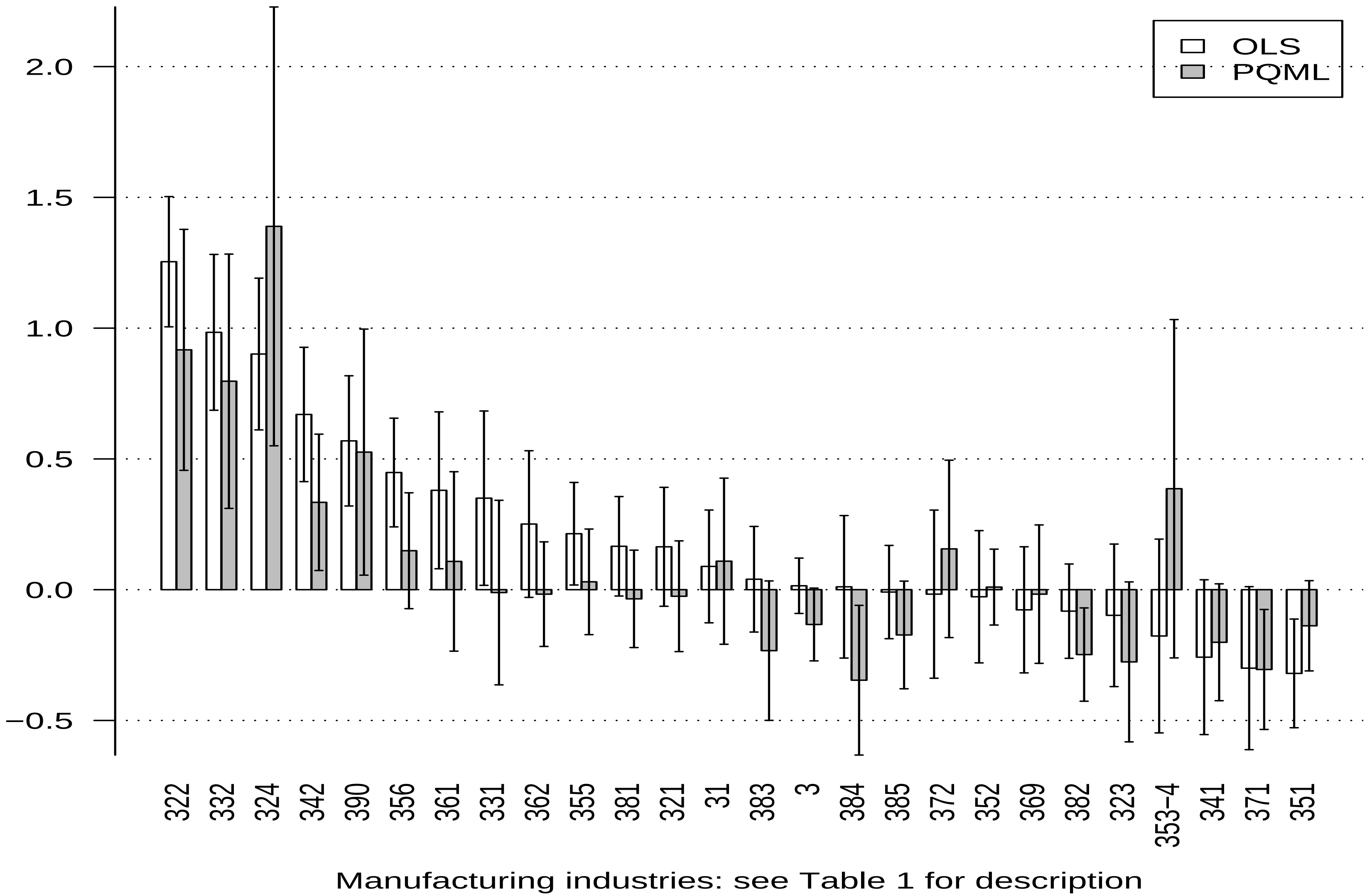

Figure 2: Estimated importer per capita income elasticity $\widehat{\beta_4^a}$

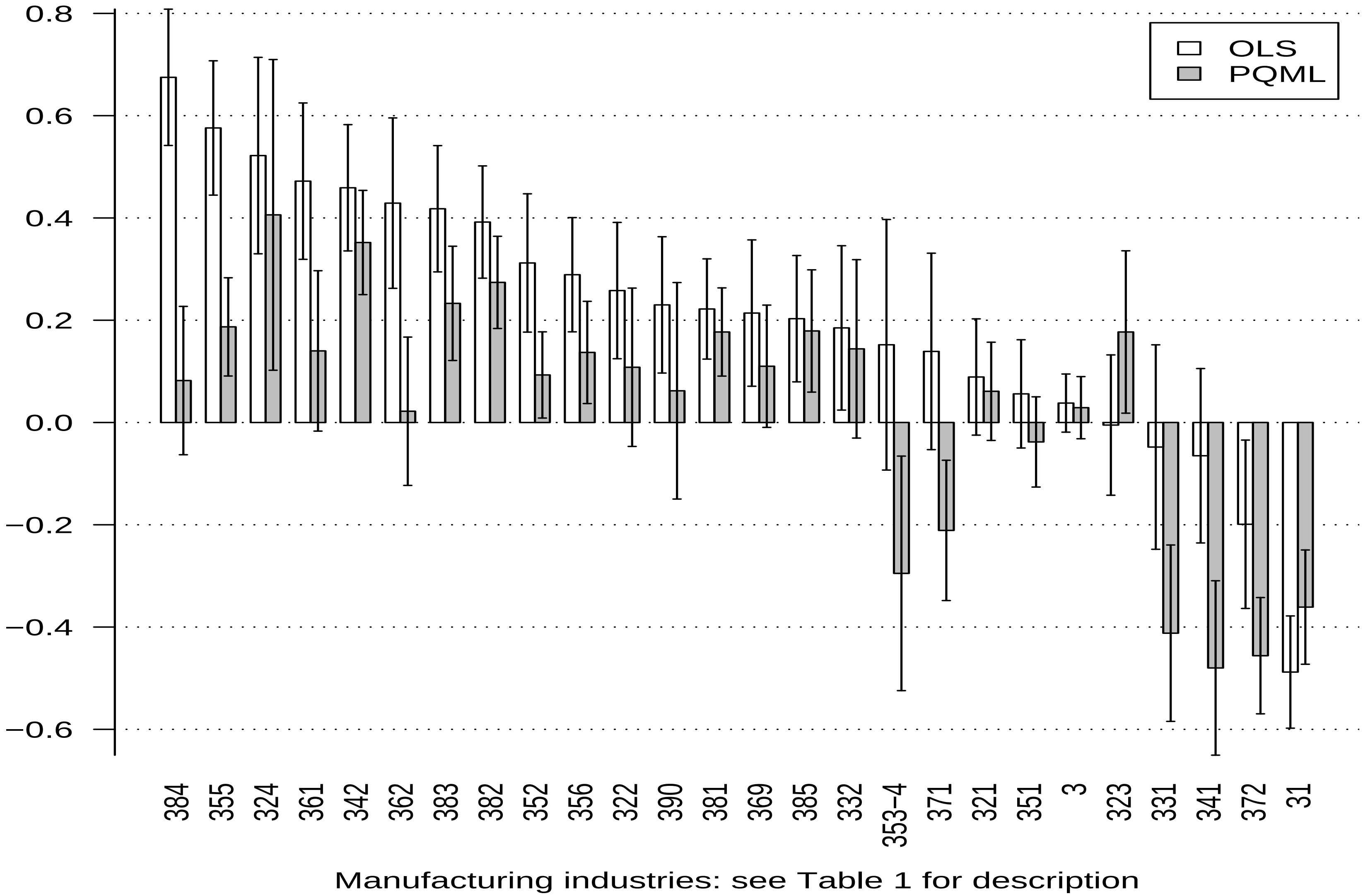

Figure 3: Estimated home-market effect $(\widehat{\beta}_1^a - \widehat{\beta}_3^a)$

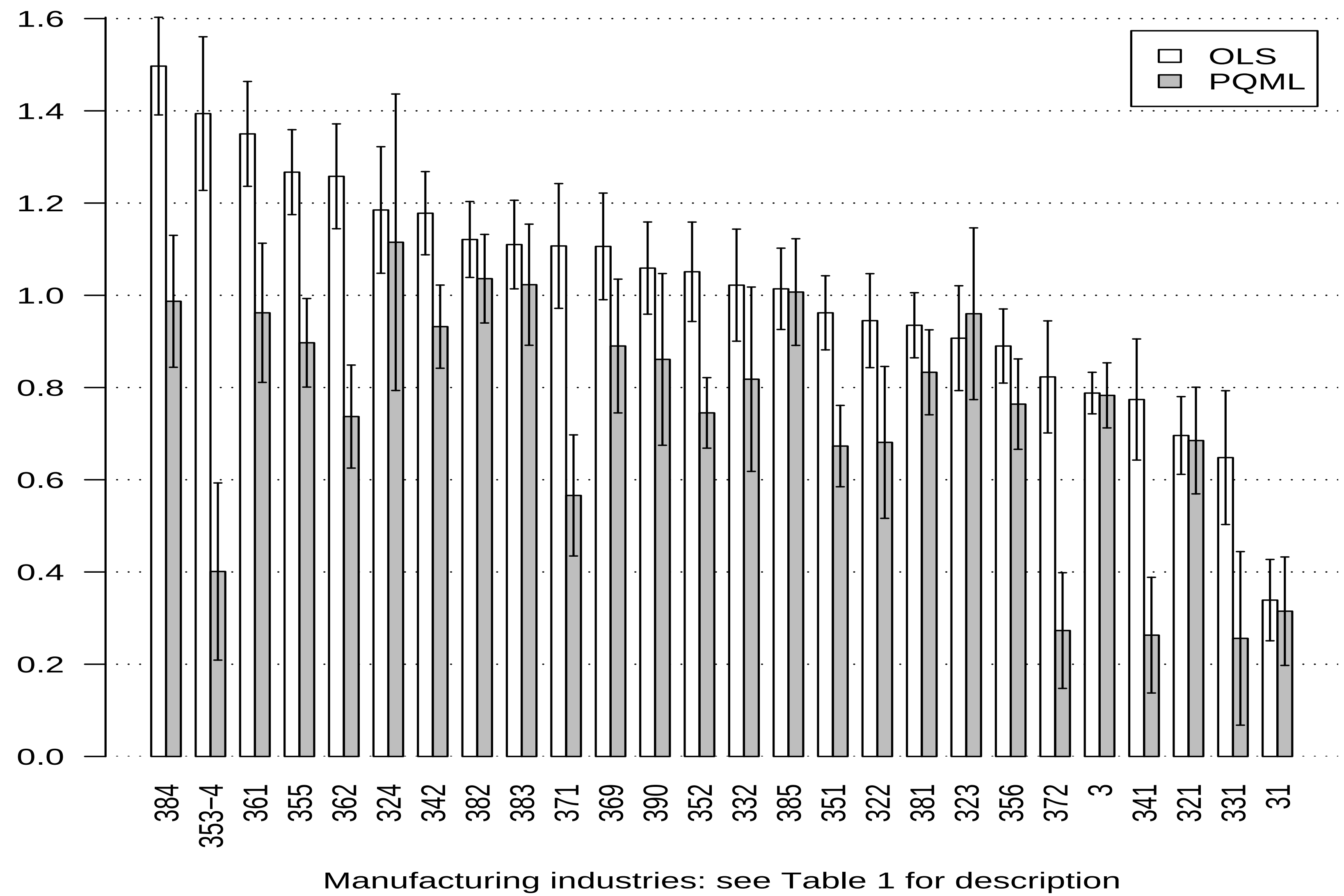

Figure 4: Estimated exporter total income elasticity $\widehat{\beta_1^a}$

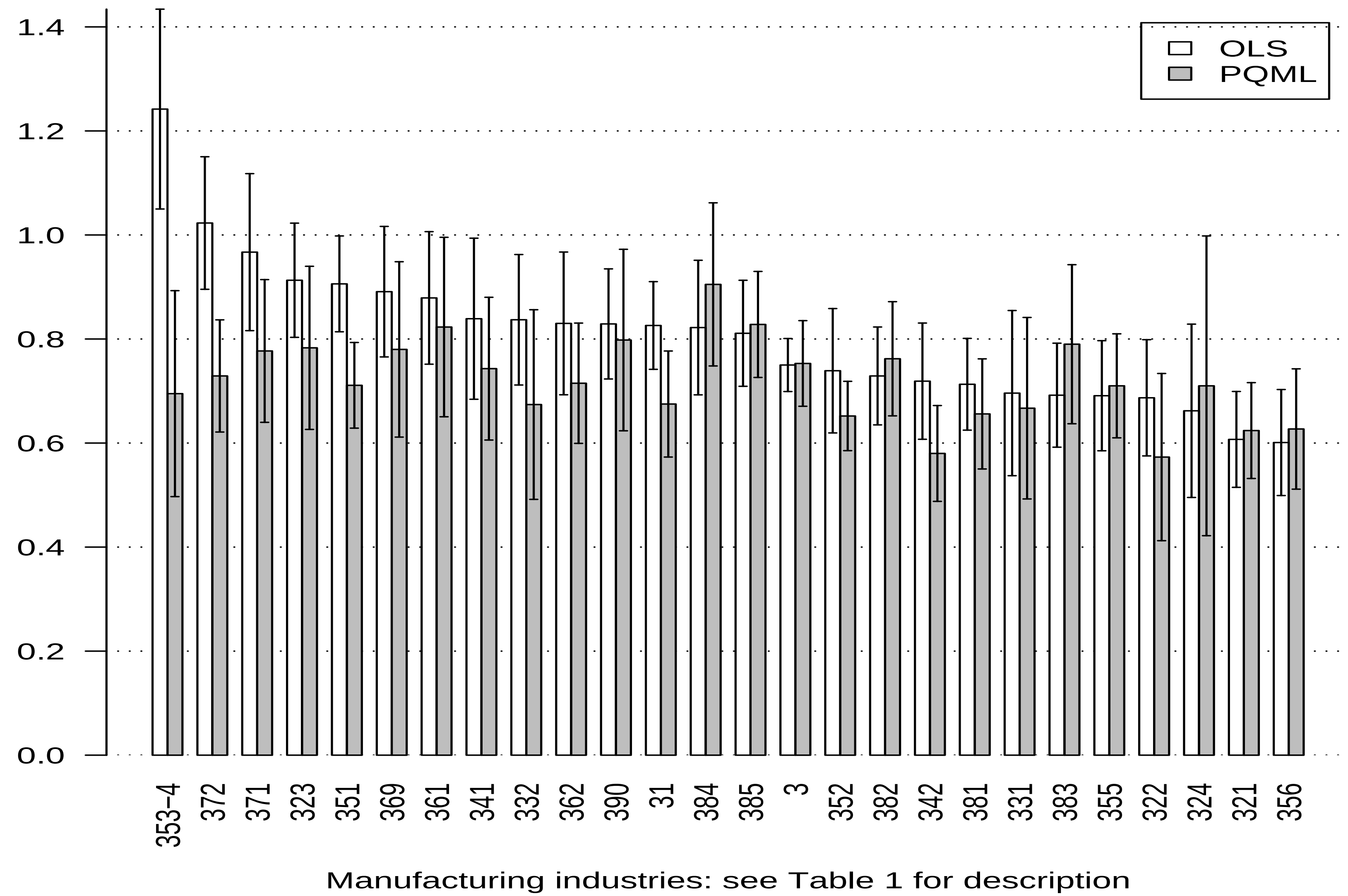

Figure 5: Estimated importer total income elasticity $\widehat{\beta_3^a}$

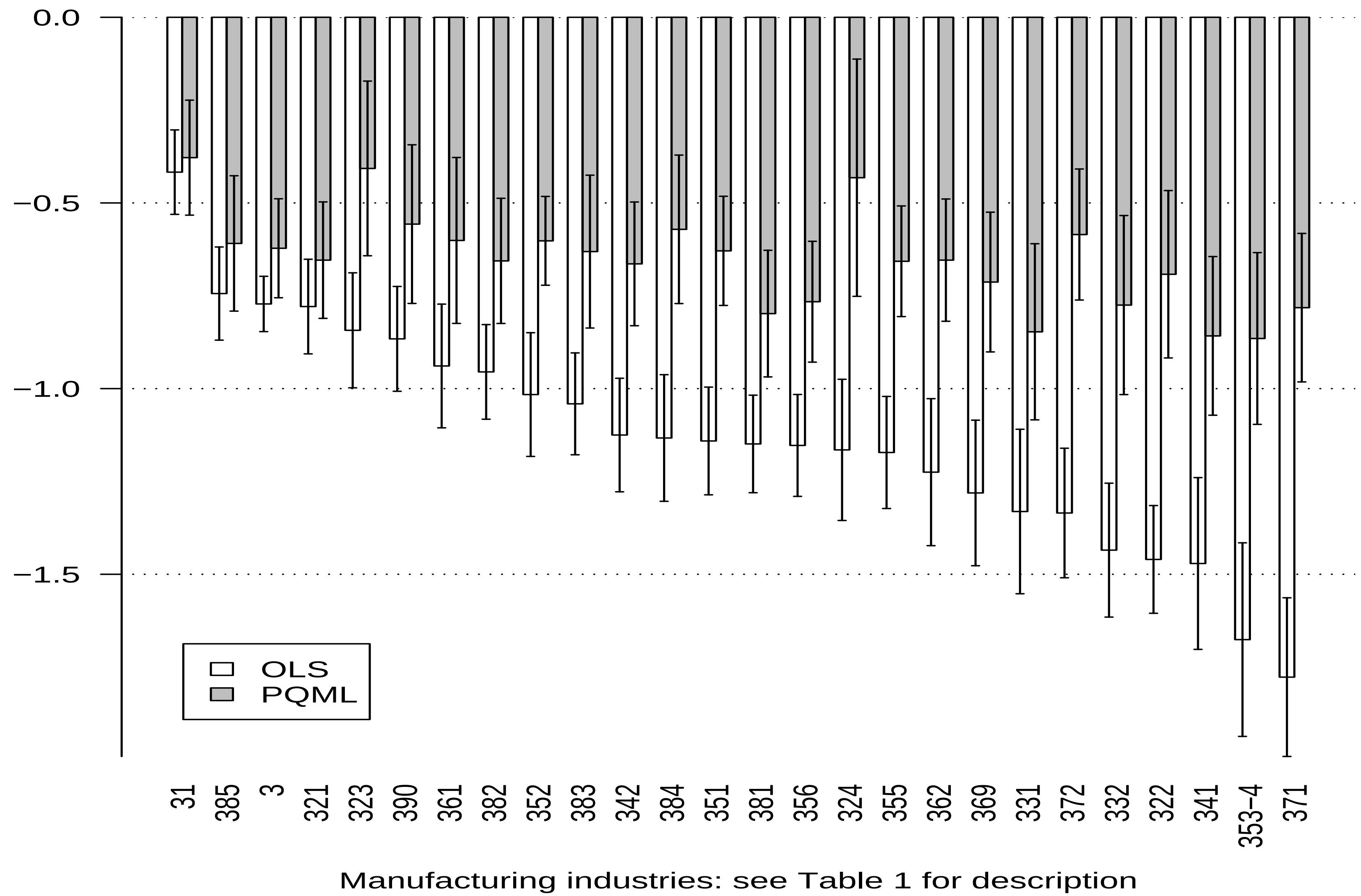

Figure 6: Estimated distance elasticity $\widehat{\beta_5^a}$

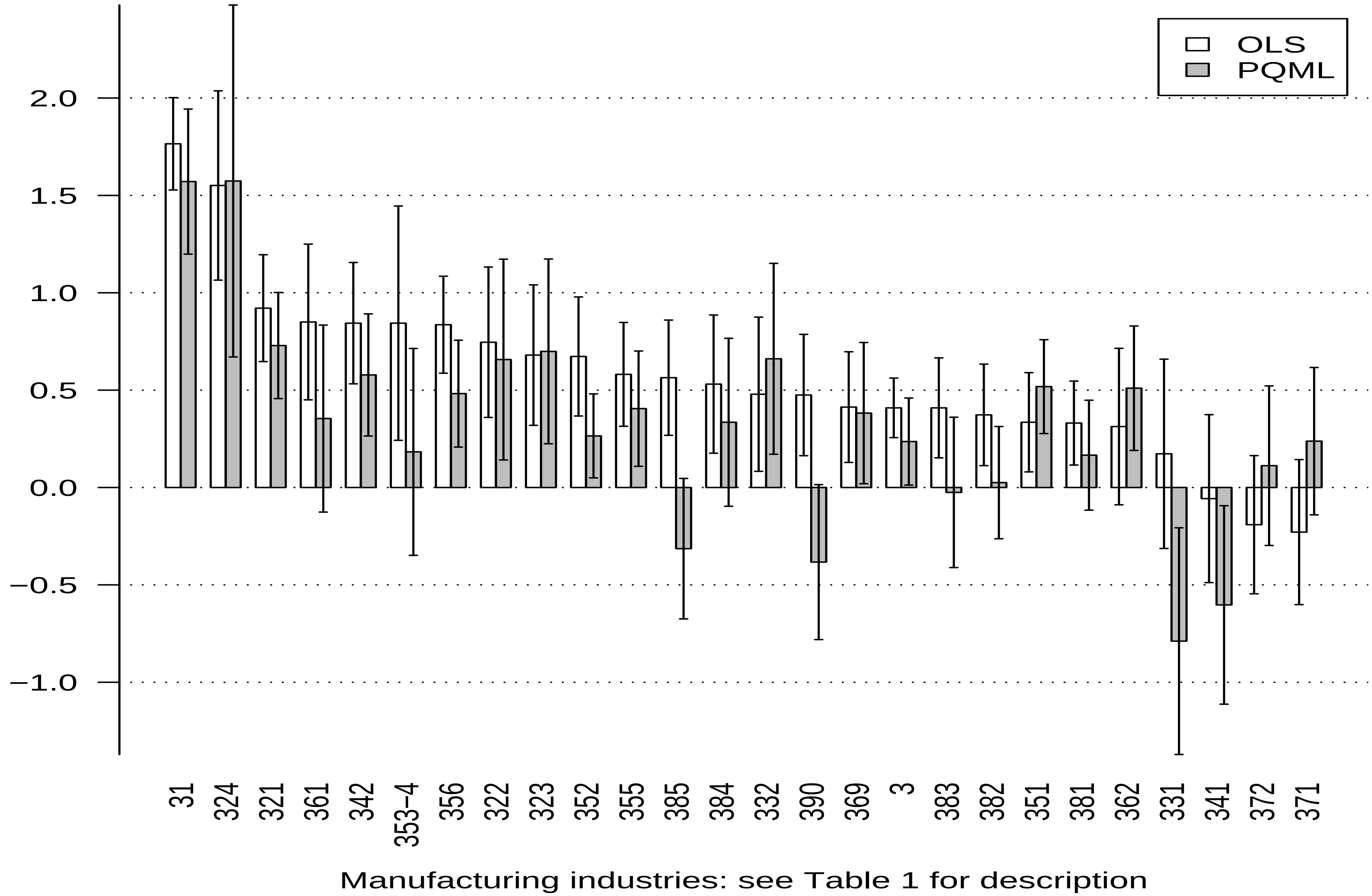

Figure 7: Estimated effect of EU membership

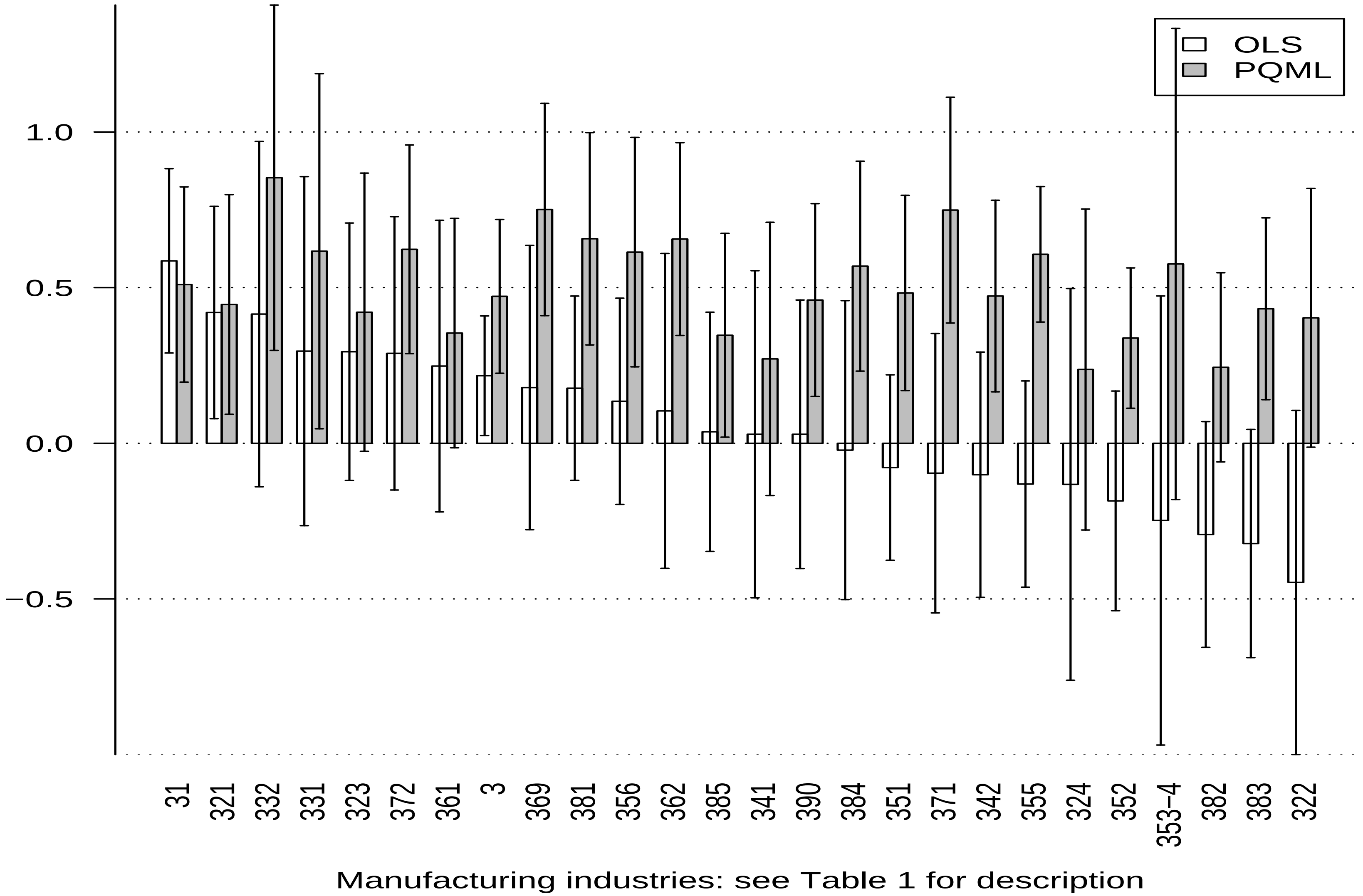

Figure 8: Estimated common border effect

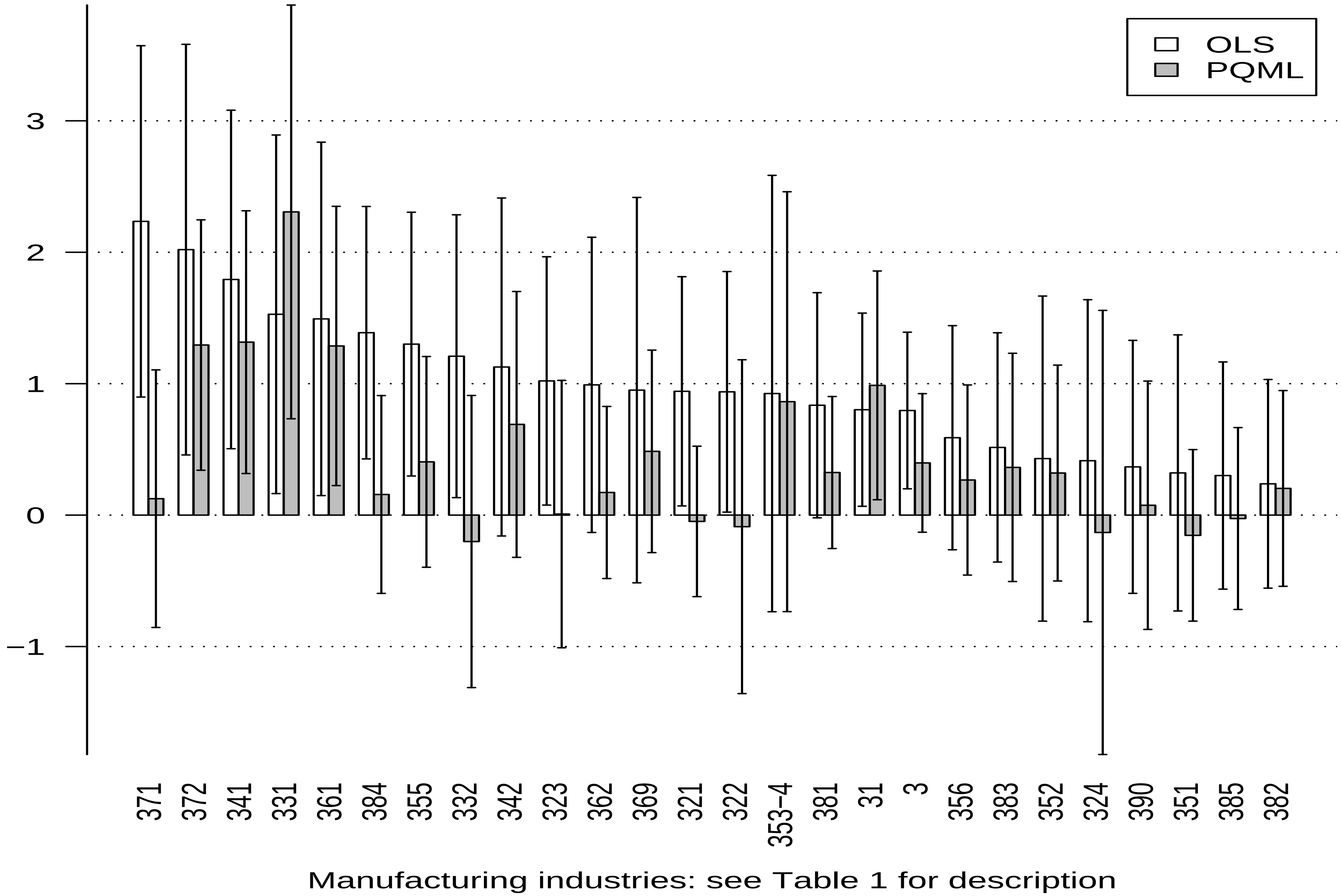

Figure 9: Estimated effect of historical ties

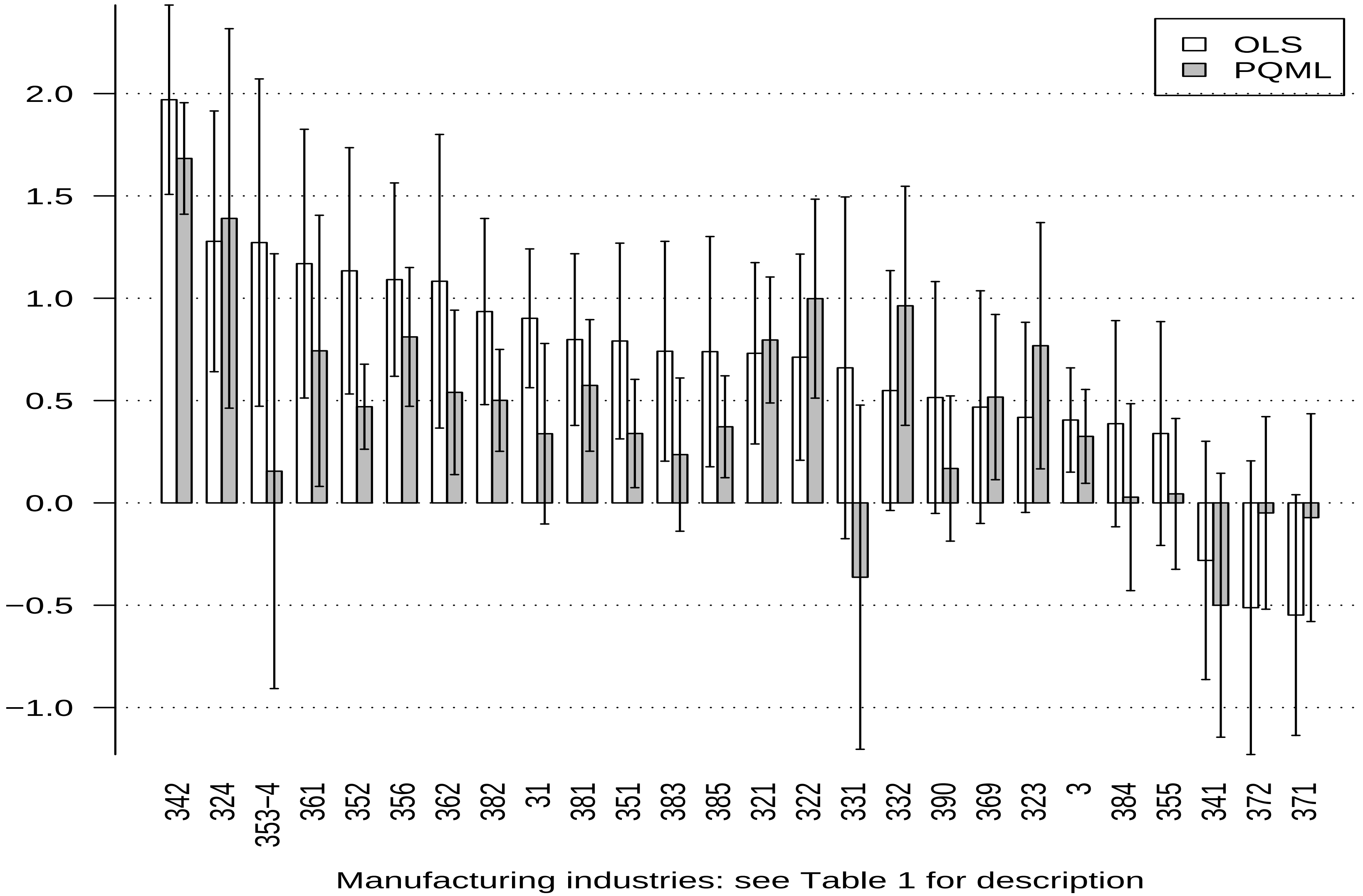

Figure 10: Estimated effect of common language