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DYNAMIC EFFECTS IN MANUFACTURING OF A POSSIBLE ACCESSION OF UKRAINE TO THE EU

Abstract. *The paper presents quantitative estimates of the dynamic effects of a possible integration of Ukraine into the European Union (E.U.)*[4]*. The examination of the dynamic effects of integration has been made with the utilisation of an ex-ante model. The results found by the application of this model suggest that the accession of Ukraine in the EU would have mixed effects in the various sectors of the region. For thirty manufacturing sectors out of one hundred and twenty six sectors that have been included in the analysis, integration would be beneficial. The sector that would benefit the most from integration is manufacture of electronic valves and tubes. Other sectors where positive integration effects are expected are: publishing of books and other publications, basic chemicals except fertilizers, recycling of metal waste and scrap, basic iron and steel, cocoa, chocolate and sugar confectionery and textile fibre preparation, textile weaving for which, the total product of the region is expected to increase.*

Key Words: EU, Ukraine, Dynamic Integration Effects

1. Introduction.

The possible accession of Ukraine to the E.U. is from an economic perspective, a historic event. It is the first time that a customs union will be formed between the E.U. countries and a large country of the ex-Soviet Union.

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[4] The European Union has the following 27 countries: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom

International trade theory suggests that we can categorise the economic effects of integration in terms of allocation, accumulation and location effects (Baldwin and Venables 1995). Further, there could be also an important effect on technical change and innovation and thus growth, as described in particular by Grossman and Helpman (1992).

The allocation effects (static effects) refer to an increase in real income (welfare) due to a more efficient allocation of factors of production that result from decreasing trade barriers and from the elimination of price distortions in production and consumption (de la Fuente 1995). However, the distribution of welfare gains may be uneven with some larger countries experiencing net welfare losses (Badinger *et.al.* 2006, Badinger *et.al.* 2008).

Another possible source of welfare loss after removing trade barriers, may result from trade diversion as opposed to trade creation. Trade diversion occurs when there is a switch in trade from outside efficient suppliers to less efficient suppliers inside the union. Originally, this literature, on trade diversion/trade creation, was developed by Viner (1950), Meade (1955), Lipsey (1960) and Michaelly (1963) and it was surveyed by Krauss (1972). However, Mundell (1964) and Kemp and Wan (1976) have developed theoretical frameworks which show how member countries can benefit from an economic union even if there is trade diversion.

The above assumes perfectly competitive markets. The allocation effects on income and welfare could probably be larger if we allow for economies of scale (increasing returns) and imperfect competition. (See Krugman and Venables (1994) for an introduction to this literature). This theoretical literature has not however reached unambiguous conclusions. The welfare impact on individual countries is difficult to evaluate *ex ante* and its size depends very much on the assumptions made by the specific model on the relevant importance of supply and demand elasticities, economies of scale, market size, the concentration of industry and other trade distortions. Nevertheless, empirical models show that the welfare

gains are larger under imperfect competition and economies of scale than would have been under situations of perfect competition (de la Fuente, *op.cit.*).

Another source of efficiency gains comes from the reduction of internal organisational slack termed X-inefficiency by Leibenstein (1966). Economic integration increases competition forcing a better (more efficient) allocation of the managerial resources of the firm.

The allocation effects are *static* in the sense that they do not take into consideration the impact of integration on factor accumulation.

The accumulation effects (dynamic effects) of integration can be analysed in terms of factor accumulation through changes in relative efficiency caused by increased competition and the exploitation of economies of scale on one hand and in terms of technical progress on the other and both affect output growth. However, economic theory has not reached to an unequivocal conclusion of whether or not integration effects on output are only temporary or permanent. The neoclassical growth theory argues for the former while the endogenous growth theory with scale effects argues for the latter (for a literature review on this issue see Badinger (2005)).

This analysis of the effect on factor accumulation and growth of trade liberalisation measures can be expanded to allow for permanent productivity enhancing factor accumulation effects (endogenous growth). The new growth literature initiated by Romer (1986), has made the accumulation of factors of production a ceaseless endogenous process of the economic system. This literature emphasises the micro-foundations of factor accumulation specifying the private costs and gains in new investment in human capital, and technical progress. The conclusion reached by this 'new' literature is that continuous output growth can be achieved by sustained productivity growth generated, for example, by a continuous process of R&D investment and innovations.

Further, the elimination of trade barriers will affect the geographical concentration of economic (industrial) activity as stressed by Krugman (1991a and 1991b) and Krugman and Venables (1990, 1993 and 1994). Two factors

emphasised by this new literature are: a) increasing returns to scale in production that are internal to the firm and b) trade costs such as transport costs, marketing costs and communication costs due to language, and/or cultural differences.

The distribution of economic activity across regions cannot be *a priori* determined. It is true that for those industries that experience increasing returns (due to large fixed costs), the elimination of trade barriers, make it profitable to concentrate production in specific regions. On the other hand, if economies of scale are not large enough relative to regional demand and trade costs are large, then economic activity may spread in many regions. This effect, which may be called the *location effect* of integration, may be reinforced by wage differentials that are due to labour immobility.

Economic integration has a technical progress effect through its impact on the accumulation of technological knowledge. Grossman and Helpman (1992) have identified four mechanisms by which economic integration might affect the accumulation of technological knowledge.

First, economic integration will facilitate the communication of technical information. Second, competition which is the expected result of economic integration forces private agents to implement new ideas and technologies. Third, economic integration increases the size of the market creating more profit opportunities. This can have a positive affect on the innovation process even though increasing competition may have a negative effect on innovation. Fourth, innovation may be encouraged through the specialisation fostered by economic integration.

Baldwin (1992) has also developed a theoretical argument that links the accumulation of human capital (knowledge) to the removal of trade barriers and economic growth. Nevertheless, it is quite possible that the integration impact might negatively affect the incentives to invest in technological innovations and human capital accumulation and this may be so particularly for the relatively less-developed countries. Grossman and Helpman (*op.cit.*) give four reasons why this might be the case. First, more trade implies more competition and national firms

might find that this reduces the anticipated profitability of their investment in knowledge. Second, opening up trade with a technologically advanced country may force the less advanced country to reduce investment in innovation. This might lead to a concentration of technological progress in a few regions that had an advantage in innovation production before economic integration. Third, countries with unskilled (manual) labour endowment may be forced by economic integration to specialise in commodities that are low in technological content. Fourth, countries that invested relatively more in human capital before economic integration will experience a higher reward after economic integration reducing the incentives to invest in research and development.

The above paragraphs present a literature review of theoretical aspects of integration. International trade theory literature is very reach with empirical studies, which try to qualitatively and quantitatively estimate the economic implications of integration. Plummer (1991) and Tsounis (2001, 2002) investigated the static effects of the Greek accession using an *ex-post* import-growth model and a shares in apparent consumption model, respectively. Katos (1982) analysed the possible effects of economic integration of Portugal, Spain and Greece. Other authors have estimated the integration effects of the establishment of the single market in the EU on the structure of trade and production. A short, but not exhaustive, list includes Amiti (1996), Buigues-Sheehy (1995), Italianer (1994), Jacquemin (1990), Jacquemin-Sapir (1988), Neven-Roller (1991), Pelkmans (1993), Sapir (1990, 1992, 1996), Tsounis (1999, 2002, 2003), Landau (1995), Henrekson et al. (1997) and Breuss (2010).

The purpose of this paper is to present quantitative estimates of the welfare effects of the possible entrance of Ukraine into the European Union (E.U.). The dynamic effects on manufacturing are examined; one hundred and twenty six sectors have been included in the analysis. These effects are related to the changes in relative efficiency caused by increased competition and the exploitation of economies of scale on the Community's output of the post-accession area and they are examined with the help of an *ex-ante* model. The structure of the paper is as

follows: in section 2 the model for analysing the dynamic effects is presented. Section 3, describes the estimation procedure of the model, section 4 provides a quantitative estimate of the dynamic effects stemming from the possible accession of Ukraine to the E.U. and section 5 concludes.

2. The Model.

To examine the dynamic effects of economic integration on each sector of a region which will potentially integrate, the 'normal' products of each sector of the region in the case of being integrated are compared with the 'normal' products of each sector of each individual country in the absence of economic integration. The 'normal' products are functions of the regional income, the market size and the level of efficiency of a sector in terms of the overall efficiency in the economy. The 'normal' products for the economy as a whole and for the various sectors individually of a country are given by[5]:

$$Q_{Tj} = A_T \, Y_j^{a_T} \, P_j^{b_T}; \; j = 1, \ldots, m \qquad (1)$$

$$Q_{ij} = A_i \, Y_j^{a_i} \, P_j^{b_i} \, D_{ij}^{c_i} \; ; j = 1, \ldots, m, i = 1, .., n \qquad (2)$$

where the subscripts T, j and i denote all sectors of economy j taken together, country j and sector i, respectively. The variables Q, Y, P and D denote output, per capita income, population and relative rate of efficiency. The relative rate of efficiency is defined as the efficiency of a sector in terms of the overall efficiency in the economy (the full description of the variables and the method of calculation of the relative efficiency variable is given in section 3); A is a constant term and a, b and c are elasticities. Thus, a_i is the income elasticity of output of sector i, b is the population elasticity of output of sector i and c is the elasticity of output of sector i with respect to the sector's relative degree of efficiency.

[5] The model used here has been developed by the UN (1963) and Sakamoto (1969) and refined by Katos (1982) and Tsounis (2002, 2003, 2004). The full description and explanation of equations 1-2 is given in Tsounis (2003).

Assume now that a region R is composed by two blocks: the twenty seven E.U. countries and Ukraine, with per capita incomes $Y_{EU} = (\Sigma_j Y_j P_j)/(\Sigma_j P_j)$; j=1,…,27 and Y_U and population $P_{EU}=\Sigma_j P_j$; j=1,…, 27 and $P_{U,}$ respectively.

Equations (1) and (2) express relationships in which -given income, population and relative efficiency- it is possible to determine the 'normal' product of the different sectors. Therefore, we can define the integration of the two regions as beneficial according to a Pareto criterion as the situation in which the regional product of at least one of the sectors is larger than the sum of the respective product of the two regions, and where the regional product of the remaining sectors is not smaller than the sum of the products of the two regions (Tsounis 2003, 2004).

To formalise the above, the 'normal' equations of each block, in our case, of the E.U.-27 and Ukraine, corresponding to the sector i, would be:

$$Q_{iEU} = A_i \, Y_{EU}^{a_i} \, P_{EU}^{b_i} \, D_{iEU}^{c_i} \qquad (3),$$

and

$$Q_{iU} = A_i \, Y_U^{a_i} \, P_U^{b_i} \, D_{iU}^{c_i} \qquad (4).$$

Assume now that Ukraine integrates with the E.U.. The per capita income of the twenty eight countries will be $Y_R=(\Sigma_j Y_j P_j)/(\Sigma_j P_j)$; j=1,…,28 and the population of the region $P_R=\Sigma_j P_j$; j=1,…,28. The 'normal' equations for each of the i sector of the region would be:

$$Q_{iR} = A_i \, Y_R^{a_i} \, P_R^{b_i} \, D_{iR}^{c_i} \qquad (5).$$

According to the above, integration would be beneficial for the i sector, if $Q_{iR}>Q_{iEU}+Q_{iU}$ or it would not be beneficial if $Q_{iR}<Q_{iEU}+Q_{iU}$. Alternatively, an 'integration index' can be defined as:

$$I_i = \frac{Q_{i\,R}}{Q_{i\,EU} + Q_{i\,U}} \qquad (6),$$

for each sector i (Tsounis *op.cit*). If I_i>1 integration is beneficial for the i sector, if I_i<1 then integration will not be beneficial for the i sector. It is noted, however, that the 'integration index' indicates only whether integration is beneficial or not for a specific sector i and no conclusion can be derived for all the sectors taken together, if in some of them I_i is greater than unity and in some others less than unity. Additionally, it should be noted that the analysis is only applicable if the 'normal' equations are a good approximation to the actual products of the sectors of the countries considered. Otherwise the results would be subject to an overestimation or an underestimation. In our case 'normal' products were found to be very good approximations to the actual products since the value of their correlation coefficient[6] was over 0.70 and there were statistically different from zero at a less than 5% level of statistical significance.

3. The Estimation Procedure.

For the calculation of the 'normal' products given by the equations (3), (4) and (5), the coefficients a_i, b_i and c_i should be estimated first. This can be done by estimating equations (1) and (2) in a double logarithmic form. The estimation of (1) is necessary for the calculation of the D_{ij} variable.

Output data was extracted from the UNIDO database (UNIDO 2012) for the period 2000 to 2007 for one hundred and twenty six manufacturing sectors (ISIC, rev. 3 classification). The description of sectors is given in Appendix A. For the choice of the period, data availability was taken into account for the EU-27 countries and Ukraine. The data on population variable and on per capita income (in constant prices and PPP[7]s) were extracted from the IMF (2012) database.

[6] Pearson correlation coefficient.
[7] For the use of PPPs see (Officer 1976).

The data and for each sector was pooled and a dummy variable for each country was included in the estimating equation to allow for the different intercepts of the same industry in the different countries.

The final form of (1) and (2) that was estimated is the following:

$$\log Q_{Tjt} = \log A_T + a_T \log Y_{jt} + b_T \log P_{jt} + d_1\, Dummy_1 + \ldots + d_{27}\, Dummy_{27} \quad (7),$$

$$\log Q_{ijt} = \log A_i + a_i \log Y_{jt} + b_i \log P_{jt} + c_i \log D_{ijt} + d_1\, Dummy_1 + \ldots + d_{27}\, Dummy_{27} \quad (8);$$

The variables Q, Y, P, and D denote output (in constant 2005 prices), per capita income (in constant 2005 prices and PPPs), population and relative efficiency, respectively; i=1, … , 126 sectors, j=1, …, 28 countries, t = 2000, …, 2007 and T denotes all sectors of economy j taken together.

The number of dummies included is equal to the number of the EU countries plus Ukraine minus one. The dummy variables were included in the model to control for the heterogeneity of the different countries. It would be incorrect not to include the dummy variables when estimating the model, even if they are not statistically significant, because this would cause bias to the estimates (Maddala 1988, pp.263-264). The residuals of equations (7), (8) are expected to be subject to heteroskedasticity because of the different variances of the data sets of the different countries. To test for the presence of heteroskedasticity the Breush-Pagan test was used. The test statistic has approximately a x^2 distribution with j-1 degrees of freedom. From the statistical tables we find that x^2_{27}=46.96 at 1% level of statistical significance. Therefore, if $x_i^2 > x_{27}^{2(0.01)}$ we reject the null hypothesis of no-heteroskedasticity and we adopt the alternative one. The results of the heteroskedasticity test for (8) are reported in Appendix B.

For all sectors the null hypothesis of no-heteroskedasticity was rejected and the two-stage least squares (2SLS) estimation procedure has been used to make the

estimated coefficients best (with minimum variance). The coefficients found in the final step have the minimum variance. The correction of heteroskedasticity has increased the values of the t-statistic of the coefficients.

The variable D_{ij} is the relative efficiency of the ith sector of the j economy and it has been calculated as $D_{ij} = R_{ij}/E_j$, where the efficiency variable E_j of the jth economy is defined as the ratio of the actual over 'normal' values of Q_{Tj}, *i.e.*, $E_j = Q_{Tj}^*/Q_{Tj}$ (the asterisk indicates actual values) and R_{ij} is the efficiency variable of the i sector of the jth economy defined as the ratio of the actual over the 'normal' values of Q_{ij}, *i.e.* $R_{ij} = Q_{ij}^*/Q_{ij}$. Q_{Tj}^* is the total manufacturing output for economy j in EUROs in constant 2005 prices; j=1,…,28,Y_j is the per capita income in economy j in EUROs and in purchasing power parities (PPP) and P_j is the total population of economy[8].

The explanatory power of the independent variables is very high, as it was observed by the high (adjR^2) coefficients; for all sectors they are over 0.90.

The income coefficients can be called, growth elasticities rather than income elasticities, since in the long-term, with rising income, factor proportions as well as demands vary. Similarly, the population coefficients are market size elasticities and represent the effects of the increase in the market size.

The relative efficiency variable was introduced into the model to capture the effects of the changes in the relative efficiency of a sector on its output. It is interesting to note that the introduction of the relative efficiency variable left unchanged the values of the regression coefficients of the other two explanatory variables and also of the constant terms of equation (8), but it improved the value of their t-statistic. Thus, it can be regarded as a 'correction' term in the equation, in the sense that it is used to increase the stability of the estimates and to capture a part of the unexplained part of the dependent variable, since its t-values for all sectors are high (it is statistically significantly different from zero at 1% level of significance for all sectors). Its estimated coefficient can be interpreted as the relative efficiency elasticity of output showing the effects of a percentage change

[8] Data was extracted from the UNIDO database (2012).

of the efficiency of a sector relative to the overall efficiency of the economy on the percentage change of output, the other variables remaining unchanged.

The population variable was for all sectors statistically significantly different from zero at 1% level of significance. It is observed that for the sectors of dairy products (1520), bakery products (1541), wines (1552), tobacco products (1600), processing/preserving of fruit & vegetables (1513), prepared animal feeds (1533), other food products (1549), other textiles (1729), publishing of books and other publications (2211), non-refractory clay and ceramic products (2693), articles of concrete, cement and plaster (2695), other non-metallic mineral products (2699), other special purpose machinery (2929) and recycling of metal waste and scrap (3710) the population (size) elasticity is close to unity showing a constant relation of changes in the sectors' products caused by the changes in the population, in these sectors.

Sixty two sectors[9] have a population elasticity less than unity, showing that production growth in these sectors does not keep pace with the market size growth. This result may seem surprising for the sectors of wearing apparel, except fur apparel (1810), soap, cleaning & cosmetic preparations (2424), TV and radio receivers and associated goods (3230), watches and clocks (3330) since one would expect a population elasticity of at least one for those sectors.

On the other hand, the remaining 48 sectors have a population elasticity greater than one. These sectors will benefit from the expansion of the size of the market alone, (the other independent variables remaining unchanged), occurring after the integration of two regions, and their relative position in the economy of the region will improve.

Regarding the growth (income) elasticities, they indicate the changes in economic structure of the region under investigation. The highest growth elasticity is that for the sector of footwear (1920), while other sectors with high growth

[9] These sectors are 1512, 1514, 1542, 1544, 1553, 1712, 1722, 1723, 1810, 1820, 1911, 1920, 2010, 2029, 2109, 2213, 2221, 2230, 2424, 2430, 2511, 2519, 2520, 2691, 2692, 2694, 2720, 2731, 2732, 2812, 2813, 2891, 2893, 2899, 2911, 2913, 2914, 2921, 2922, 2925, 2926, 2927, 3130, 3140, 3150, 3190, 3220, 3230, 3311, 3313, 3320, 3330, 3410, 3520, 3530, 3591, 3592, 3599, 3691, 3693, 3694, 3699.

elasticities are rubber products (2519), tanks, reservoirs and containers of metal (2812), lighting equipment and electric lamps (3150), plastic products (2520), office, accounting and computing machinery (3000), finishing of textiles (1712) and articles of paper and paperboard (2109). All growth coefficients are statistically significantly different from zero at, at least, 1% level of significance.

4. The Results.

In Table 1 the 'integration index' calculated from (6) is presented. It is observed that integration will not be beneficial for all sectors since the sectoral integration indexes are not all higher than unity: 30 sectors are found to have $I_i>1$. The highest integration index is reported in the sector of manufacture of electronic valves and tubes (sector 3210), while relatively high values of the index are also reported for publishing of books and other publications (sectors 2219, 2211), basic chemicals except fertilizers (2411), recycling of metal waste and scrap (3710), basic iron and steel (2710), cocoa, chocolate and sugar confectionery (1543) and textile fibre preparation and textile weaving (1711).

Table 1:

Dynamic Effects of Integration

ISIC	Integration Index	ISIC	Integration Index	ISIC	Integration Index
1511	0.988	2221	0.880	2921	0.854
1512	0.809	2222	0.794	2922	0.701
1513	0.909	2230	0.726	2923	1.163
1514	0.814	2320	0.790	2924	1.002
1520	0.863	2330	1.005	2925	0.761
1531	1.057	2411	1.393	2926	0.736
1532	1.090	2412	1.116	2927	1.098
1533	1.099	2413	1.189	2929	1.019

1541	1.051	2421	1.019	2930	0.709
1542	0.707	2422	0.852	3000	0.776
1543	1.249	2423	1.131	3110	0.858
1544	0.849	2424	0.814	3120	0.746
1549	1.031	2429	1.028	3130	0.919
1551	0.897	2430	1.015	3140	0.836
1552	0.898	2511	0.852	3150	0.778
1553	0.805	2519	0.756	3190	0.709
1554	0.820	2520	0.782	3210	1.584
1600	1.042	2610	0.780	3220	0.703
1711	1.238	2691	0.800	3230	0.780
1712	0.845	2692	0.824	3311	0.885
1721	0.755	2693	0.931	3312	1.009
1722	0.817	2694	0.868	3313	0.731
1723	0.783	2695	0.932	3320	0.794
1729	0.756	2696	1.041	3330	0.980
1730	0.723	2699	1.173	3410	0.978
1810	0.798	2710	1.251	3420	0.767
1820	0.837	2720	0.829	3430	0.705
1911	0.936	2731	0.724	3511	0.819
1912	0.812	2732	0.778	3512	0.715
1920	0.711	2811	0.722	3520	0.753
2010	0.710	2812	0.746	3530	0.908
2021	0.735	2813	0.748	3591	1.010
2022	0.738	2891	0.769	3592	0.774
2023	0.661	2892	0.705	3599	0.716
2029	0.928	2893	0.917	3610	0.716
2101	0.700	2899	0.868	3691	0.763
2102	0.765	2911	0.729	3692	0.796
2109	0.796	2912	0.792	3693	0.700

2211	1.491	2913	0.820	3694	0.788
2212	1.112	2914	0.728	3699	0.811
2213	0.718	2915	0.769	3710	1.312
2219	1.528	2919	0.733	3720	1.083

Source: Authors' calculations

The sectors that exhibit the lowest integration indexes are watches and clocks (3330), machine tools (2922), motor vehicles (3410), pulp - paper and paperboard (2101), TV/radio transmitters; communication apparatus (3220), steam generators (2813), wearing apparel, except fur apparel (1810). Integration would not be beneficial for the region for these sectors.

5. Conclusion.

The purpose of the paper is to present estimates of the dynamic (changes in relative efficiency) effects of a possible accession of Ukraine into the E.U. utilising an *ex-ante* model. The results found by the application of this model suggest that the entrance of Ukraine into the E.U. would have mixed effects in the various sectors of the region. For thirty manufacturing sectors out of one hundred and twenty six sectors that have been included in the analysis, integration would be beneficial. The sector that would benefit the most from integration is manufacture of electronic valves and tubes. Other sectors where positive integration effects are expected are: publishing of books and other publications, basic chemicals except fertilizers, recycling of metal waste and scrap, basic iron and steel, cocoa - chocolate - sugar confectionery and textile fiber preparation and textile weaving, for which, the total product of the region is expected to increase. Integration would not be beneficial for the sectors of watches and clocks, machine tools, motor vehicles, pulp- paper and paperboard, TV/radio transmitters and communication apparatus, steam generators, wearing apparel, except fur apparel for which, the total product of the region is expected to decrease.

Appendix A:

Description of Sectors[10]

ISIC Descpription	ISIC Descpription
1511 Processing/preserving of meat	2694 Cement, lime and plaster
1512 Processing/preserving of fish	2695 Articles of concrete, cement and plaster
1513 Processing/preserving of fruit & vegetables	2696 Cutting, shaping & finishing of stone
1514 Vegetable and animal oils and fats	2699 Other non-metallic mineral products n.e.c.
1520 Dairy products	2710 Basic iron and steel
1531 Grain mill products	2720 Basic precious and non-ferrous metals
1532 Starches and starch products	2731 Casting of iron and steel
1533 Prepared animal feeds	2732 Casting of non-ferrous metals
1541 Bakery products	2811 Structural metal products
1542 Sugar	2812 Tanks, reservoirs and containers of metal
1543 Cocoa, chocolate and sugar confectionery	2813 Steam generators
1544 Macaroni, noodles & similar products	2891 Metal forging/pressing/stamping/roll-forming
1549 Other food products n.e.c.	2892 Treatment & coating of metals
1551 Distilling, rectifying & blending of spirits	2893 Cutlery, hand tools and general hardware
1552 Wines	2899 Other fabricated metal products n.e.c.
1553 Malt liquors and malt	2911 Engines & turbines (not for transport equipment)

[10] International Standard Industrial Classification (ISIC), Rev. 3.

1554 Soft drinks; mineral waters	2912 Pumps, compressors, taps and valves
1600 Tobacco products	2913 Bearings, gears, gearing & driving elements
1711 Textile fibre preparation; textile weaving	2914 Ovens, furnaces and furnace burners
1712 Finishing of textiles	2915 Lifting and handling equipment
1721 Made-up textile articles, except apparel	2919 Other general purpose machinery
1722 Carpets and rugs	2921 Agricultural and forestry machinery
1723 Cordage, rope, twine and netting	2922 Machine tools
1729 Other textiles n.e.c.	2923 Machinery for metallurgy
1730 Knitted and crocheted fabrics and articles	2924 Machinery for mining & construction
1810 Wearing apparel, except fur apparel	2925 Food/beverage/tobacco processing machinery
1820 Dressing & dyeing of fur; processing of fur	2926 Machinery for textile, apparel and leather
1911 Tanning and dressing of leather	2927 Weapons and ammunition
1912 Luggage, handbags, etc.; saddlery & harness	2929 Other special purpose machinery
1920 Footwear	2930 Domestic appliances n.e.c.
2010 Sawmilling and planing of wood	3000 Office, accounting and computing machinery
2021 Veneer sheets, plywood, particle board, etc.	3110 Electric motors, generators and transformers
2022 Builders' carpentry and joinery	3120 Electricity distribution & control apparatus

2023 Wooden containers	3130 Insulated wire and cable
2029 Other wood products; articles of cork/straw	3140 Accumulators, primary cells and batteries
2101 Pulp, paper and paperboard	3150 Lighting equipment and electric lamps
2102 Corrugated paper and paperboard	3190 Other electrical equipment n.e.c.
2109 Other articles of paper and paperboard	3210 Electronic valves, tubes, etc.
2211 Publishing of books and other publications	3220 TV/radio transmitters; line comm. apparatus
2212 Publishing of newspapers, journals, etc.	3230 TV and radio receivers and associated goods
2213 Publishing of recorded media	3311 Medical, surgical and orthopaedic equipment
2219 Other publishing	3312 Measuring/testing/navigating appliances,etc.
2221 Printing	3313 Industrial process control equipment
2222 Service activities related to printing	3320 Optical instruments & photographic equipment
2230 Reproduction of recorded media	3330 Watches and clocks
2320 Refined petroleum products	3410 Motor vehicles
2330 Processing of nuclear fuel	3420 Automobile bodies, trailers & semi-trailers
2411 Basic chemicals, except fertilizers	3430 Parts/accessories for automobiles
2412 Fertilizers and nitrogen compounds	3511 Building and repairing of ships
2413 Plastics in primary forms; synthetic rubber	3512 Building/repairing of pleasure/sport. boats
2421 Pesticides and other agro-chemical	3520 Railway/tramway locomotives &

products	rolling stock
2422 Paints, varnishes, printing ink and mastics	3530 Aircraft and spacecraft
2423 Pharmaceuticals, medicinal chemicals, etc.	3591 Motorcycles
2424 Soap, cleaning & cosmetic preparations	3592 Bicycles and invalid carriages
2429 Other chemical products n.e.c.	3599 Other transport equipment n.e.c.
2430 Man-made fibres	3610 Furniture
2511 Rubber tyres and tubes	3691 Jewellery and related articles
2519 Other rubber products	3692 Musical instruments
2520 Plastic products	3693 Sports goods
2610 Glass and glass products	3694 Games and toys
2691 Pottery, china and earthenware	3699 Other manufacturing n.e.c.
2692 Refractory ceramic products	3710 Recycling of metal waste and scrap
2693 Struct.non-refractory clay; ceramic products	3720 Recycling of non-metal waste and scrap

Source: UN (2012)

Appendix B:

Breush-Pagan heteroskedasticity test

Sector	x^2 statistic	Sector	x^2 statistic	Sector	x^2 statistic
1511	150.29	2221	198.89	2921	103.64
1512	124.22	2222	123.88	2922	137.74
1513	130.48	2230	171.28	2923	47.12
1514	186.34	2320	173.88	2924	99.20
1520	78.56	2330	138.94	2925	119.33

1531	87.04	2411	145.30	2926	105.77
1532	78.86	2412	84.70	2927	70.57
1533	134.81	2413	197.26	2929	173.59
1541	113.82	2421	155.19	2930	135.27
1542	129.77	2422	133.54	3000	190.29
1543	165.69	2423	159.42	3110	174.06
1544	145.95	2424	191.11	3120	143.15
1549	133.97	2429	159.34	3130	155.51
1551	177.80	2430	64.99	3140	127.54
1552	136.98	2511	119.63	3150	174.08
1553	120.17	2519	185.51	3190	177.15
1554	151.11	2520	140.04	3210	160.82
1600	142.12	2610	140.94	3220	102.33
1711	105.12	2691	99.09	3230	184.37
1712	144.89	2692	127.30	3311	144.77
1721	136.53	2693	58.39	3312	147.33
1722	204.29	2694	156.69	3313	133.90
1723	135.10	2695	96.25	3320	139.17
1729	173.08	2696	198.09	3330	114.41
1730	76.10	2699	175.90	3410	132.45
1810	94.68	2710	174.68	3420	122.00
1820	160.39	2720	175.69	3430	120.40
1911	130.66	2731	108.23	3511	143.09
1912	179.91	2732	158.16	3512	184.24
1920	158.90	2811	119.92	3520	129.16
2010	142.13	2812	199.34	3530	147.94
2021	146.11	2813	197.87	3591	107.91
2022	138.31	2891	176.87	3592	189.46
2023	133.51	2892	127.50	3599	105.80

2029	146.50	2893	177.04	3610	183.77
2101	163.60	2899	181.69	3691	186.91
2102	134.88	2911	96.70	3692	169.74
2109	149.17	2912	145.05	3693	178.26
2211	167.91	2913	145.94	3694	168.94
2212	208.54	2914	152.84	3699	184.06
2213	178.20	2915	86.51	3710	149.72
2219	187.26	2919	127.83	3720	100.38

Souce: Authors' calculations

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