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# STRUCTURAL TRANSFORMATION OF EXPORTS IN A PRODUCT SPACE MODEL

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**CONTENTS**



*ABBREVIATIONS*

Comtrade database – United Nations Commodity Trade database
EU – European Union
EU10 – countries which joined the EU on 1 May 2004
EU15 – EU countries before 1 May 2004
EXPY – level of income of a country's export package
GDP – gross domestic product
PRODY – level of income implicit in export product
RCA – revealed comparative advantage
SITC – Standard International Trade Classification

**ABSTRACT**

The research paper deals with an export structural transformation model providing for a transition from the production and exports of goods with low value added to the production and exports of goods with high value added. It is essential for the improvement of a nation's welfare, as observations show that in a longer perspective the level of economic development is related to the degree of export sophistication. The speed of structural transformation depends on the distance in the product space between the potential export goods and the existing export goods with revealed comparative advantage. Estimations within the research suggest that the relative distance of Latvian export goods to goods with comparative advantage is rather small. Potential of almost all groups of currently produced goods to act as drivers of development has already been exhausted to a large extent. In order to enhance sophistication of Latvia's export structure, the production of goods with their implicit income level exceeding the current average weighted value of the export basket should be augmented. Potential goods for exports include pharmaceutical products, medical, precision and optical instruments as well as chemicals and chemical products. However, it is rather unlikely that comparative advantage in these products can be developed without extra supportive measures taken by the Government.

**KEYWORDS**: *structural transformation, comparative advantage, export sophistication.*

**JEL**: *F14, F19, O33, O40*



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## INTRODUCTION

Economic growth is reflected not only through per capita income levels of a country but also through the quality of products due to the transition from generating goods with lower value added to goods with higher economic value produced in developed countries. This process is called structural transformation. In part, it is associated with changes in the available productive factors, which result from the accumulation of human, physical and institutional capital. The trade theory treats structural transformation of exports only as a passive consequence of changes in factor availability. However, the nature of factor accumulation process is still a matter of discussion.

R. Hausmann, J. Hwang and D. Rodrik (6) point to a positive relationship between per capita GDP of a country and the income level implicit in the goods that this country exports. Assuming that countries are at the same stage of development, the income level implicit in country's exports is a factor underpinning its future growth. Hence the export structure reflects the fundamentals decisive for the country's future growth.

Taking into account the contribution of exports to ensuring the growth of national welfare, this paper aims at studying the indicators underpinning the enhancement of structural sophistication of exports via comparing Latvia's performance with that of selected EU10 countries. It is assumed that an essential difference exists between commencing the production of a new product and augmenting the output of goods in which the country has been specialising. Specific productive factors, e.g. well-trained human resources, access to capital, a solid research basis and adequate infrastructure, regulatory framework (property rights, tax legislation) and public services of high quality, are involved in generating any product. Upon assuming the risk of launching a new product, it is more difficult to secure all necessary resources, e.g. to recruit employees with specific skills and experience or find constant suppliers for a sector. Specifically needed infrastructure, e.g. regional raw material suppliers, or particular legal framework may likewise be absent. However, when a pioneering company has solved all the problems, the newly-created infrastructure becomes available to other entrants into the sector. Thus, costs related to a change in specialisation patterns, if too high relative to expected gains in the future, may have an adverse effect on the process of structural transformation.(7)

The authors of this study maintain that the potential (or productive factors) used in the creation of one product is an imperfect substitute for the potential required for the creation of other goods, but the degree of specificity varies. For instance, the resources required for the production of men's wearing apparel are similar to those required for the production of women's clothing to a larger extent than to those needed for the production of cars. The probability of a nation successfully launching a new product depends on the resources available for production of related or nearby products that can be easily adjusted to the requirements of the new product. In other words, considering differences in the specificity degree of resources, the speed of structural transformation depends on the density of goods in the product space for which the state has developed production potential.

The proximity of products in the product space that indicates the distance between one product and other goods depends on the similarity of resources required for the production of the respective products. It is assumed that product space is the same for all countries. PRODY, an indicator of per capita income implicit in a product, which is based on per capita income of countries that have revealed comparative advantage in this product and used by R. Hausmann, J. Hwang and D. Rodrik (6), has been applied as a measure of value implicit in each product. Structural transformation foresees company reorientation from producing items with small implicit income level to ones with a high implicit income level.

Section 1 presents an overview of methodology and database used in the assessment of structural transformation. Speed indicators of structural transformation are defined in Section 2. Sophistication of export structure is in the focus of Section 3 along with the description of Latvia's potential in the EU and global context. The concluding part comprises the most important conclusions.

## 1. METHODOLOGY AND DATA

The production of each good requires an input of a set of resources – labour, material assets, intermediate products, infrastructure, property rights, etc. Production of any pair of products differs in required capabilities. However, capabilities required in the production of one product are an imperfect substitute for capabilities required for production of another product. The distance between products can be determined in each pair of goods. It is defined as follows: if the process of production requires very similar inputs (resources and skills), the products are "closer" to each other; if, by contrast, capabilities differ cardinally, the distance separating them is larger. This distance is predetermined by production technologies that do not differ across the countries but can change over time.

Formally the product space can be described as a matrix of pairwise distances for all *n* products:

$$\varphi = \begin{bmatrix} 0 & \varphi_{1,2} & \varphi_{1,3} & \cdots & \varphi_{1,n} \\ & \ddots & \varphi_{2,3} & \ddots & \vdots \\ & & \ddots & \ddots & \vdots \\ & & & \ddots & \varphi_{n-1,n} \\ & & & & 0 \end{bmatrix} \qquad [1]$$

where, for instance, $\varphi_{1,2}$ reflects the distance between product 1 and product 2.

In this research, each element of matrix [1] can change depending on specific qualities of the product pair and measures of product similarities.

Defining a measure of distance between products in the product space is a complex methodological task. Using physical properties of products as incorporated in customs classifications would be one of the simplest measures. However, the distance between products cannot be judged on the basis of customs classification, as the latter does not cover specific qualities of products needed for estimation purposes in this research. Also, for the purpose of measuring interrelations between products, input-output tables can be used. If used, these measures disclose similarities of particular products, which may not necessarily always be among the most essential in practice. For instance, one cannot assert that product composition plays a more important role than labour intensity and quality.

This study uses a measure of distance that was introduced by R. Hausmann and B. Klinger.(7) It is based on the assumption that similarity of capabilities (or the distance between products) is heterogeneous but related to the likelihood that states have revealed a comparative advantage of the two products. For a country to reveal a comparative advantage of a product, appropriate resources and capabilities to produce and export successfully are to be in place. In the event two goods need the same capabilities, there should also be higher probability that the country has revealed a comparative advantage in both goods.

First, a probability measure is to be chosen. One approach is to calculate a joint probability of both goods to be exported, i.e. P(A∩B). However, this measure relates

the similarity between both products to their general place in the global market, which implies that if a country exports, e.g. wood, it exports also furniture and both products seem very similar. On the other hand, if only three countries in the world export the same two goods, the joint probability for any of these exporting countries would rather be small, not large. That is why a distance measure to distinguish the degree of similarity between a pair of goods from their total place in different countries is needed.

The conditional probability $P(A|B)$ would ensure the needed distinction. However, it is not symmetrical, i.e. $P(A|B) \neq P(B|A)$, whereas the distance measure dealt with in this paper is symmetrical. Moreover, with the number of exporters of product A decreasing, the conditional probability of exporting another product under the condition that the country is exporting product A becomes a dummy variable, which is equal to 1 for any other good exported by the respective country and is 0 in all other cases. In such a way, it represents country specificity rather than similarity of the goods. For instance, if Latvia were the only wood exporting country in the world, then all other products exported by it (metals and mineral products, machinery and equipment) would be very close to wood in the product space, despite these products being different.

That is why the authors of this research, following the approach of R. Hausmann and B Klinger, have opted to use the least of the two inverse conditional probabilities $\min\{P(A|B), P(B|A)\}$ as a measure of distance. It suggests that the probability of exporting food along with engaging also in oil exports is strong. On the other hand, the probability of exporting oil along with exporting also food is weak. For instance, Latvia does not export oil, but it does export food. In case these goods were very close, all countries exporting food would export also oil. It is not so in reality, and the given distance measure captures this peculiarity by using the least conditional probability (probability to export oil provided food is also exported, in this example).

In order to capture products with a substantial relative share, a restriction that a country has revealed comparative advantage of a particular product is imposed. It implies that a country's export share of a particular product exceeds the respective product's export share of all countries taken together. Formally it is expressed by B. Balassa's definition (2):

$$RCA_{c,i,t} = \frac{xval_{c,i,t} \Big/ \sum_{i} xval_{c,i,t}}{\sum_{c} xval_{c,i,t} \Big/ \sum_{i}\sum_{c} xval_{c,i,t}} \qquad [2]$$

where $xval_{c,i,t}$ denotes exports of product *i* from country *c* in period *t*;

$\sum_{i} xval_{c,i,t}$ is total exports of country *c* in period *t*;

$\sum_{c} xval_{c,i,t}$ is total exports of product *i* from all countries in period *t*;

$\sum_{i}\sum_{c} xval_{c,i,t}$ is total world exports.

As specificity of export structure is high across countries, this measure covers all relatively important export goods, while excluding relatively less important ones.

Hence the measure of distance between products *i* and *j* in period *t* (hereinafter, proximity) can be defined as follows (7):

$$\varphi_{i,j,t} = \min\left\{P\left(x_{i,t}\middle|x_{j,t}\right), P\left(x_{j,t}\middle|x_{i,t}\right)\right\} \quad [3]$$

where for any country *c*

$$x_{i,c,t} = \begin{cases} 1, & \text{if } RCA_{i,c,t} > 1 \\ 0, & \text{if } \mathrm{RCA}_{\mathrm{i,c,t}} \le 1 \end{cases} \quad [4]$$

and conditional probability is computed using products with comparative advantage of all countries in period *t*.

Data from *Comtrade* database are used in this study. Export data of 95 countries and territories for 1996 and 2005 were used; SITC Rev. 3 four-digit classification incorporating 1 031 product groups was taken as the basis.

In order to better understand the essence of product proximity, Table 1 shows the proximity of men's shirts to other products. The higher the proximity value, the larger the similarity between products is. The data suggest that the proximity values of shirts and other clothing are higher than those of shirts and agricultural products, ores or medicaments.[1]

*Table 1*
**Proximity of men's knitted shirts (code 8437)**

| Code | Product | Proximity |
|---|---|---|
| 8432 | Suits, jackets, trousers, etc | 0.73 |
| 8447 | Women's blouses, shirts and chemises of knitted or crocheted textiles | 0.70 |
| 8442 | Suits, dresses, skirts, etc | 0.70 |
| 8428 | Underwear, nightwear, etc | 0.68 |
| | | |
| 6724 | Ingots of iron or steel | 0.09 |
| 2227 | Safflower seeds | 0.05 |
| 2861 | Uranium ores and concentrates | 0.00 |
| 6812 | Platinum | 0.00 |
| 5422 | Medicaments, hormones, etc | 0.00 |

[1] It should be noted that the largest distance is limited, i.e. it cannot be below zero. Consequently, it is not possible to present 2–3 arranged groups of the largest distance if there are several tens of groups the distance to which is also zero.

An alternative way of describing the location of goods in the product space is grouping them by density, i.e. considering goods that are closer to each other (have highest density) and goods that are far away from each other. Adding up the proximities of the respective product to all other products in the proximity matrix, R. Hausmann and B. Klinger (7) obtained an indicator which they called the "paths" and defined as follows:

$$paths_{i,t} = \sum_{j} \varphi_{i,j,t} \qquad [5].$$

This indicator is applied to export data, and products with the highest and lowest density are listed in Table 2.

*Table 2*
**Products in product space with the highest and lowest density**

| Code | Product | Paths |
|---|---|---|
| 6795 | Tube or pipe fittings of iron or steel | 278.96 |
| 7478 | Taps, cocks, valves and similar appliances n.e.s. | 272.49 |
| 6996 | Articles of iron or steel n.e.s. | 269.96 |
| 7212 | Harvesting, etc machines | 268.27 |
| 8121 | Boilers, radiators, etc non-electric | 265.88 |
| | | |
| 2862 | Thorium ores and concentrates | 28.46 |
| 2861 | Uranium ores and concentrates | 13.14 |
| 3341 | Motor gasoline, light oils | 12.08 |
| 3342 | Kerosene, medium oils | 7.22 |
| 3343 | Gas oils | 0 |

Table 2 shows that the densest part of product space is occupied by heavy industry output, whereas energy generation related mineral resources are in the sparsest part of the product space.

## 2. SPEED OF STRUCTURAL TRANSFORMATION

The structural transformation process can be tested with the help of the distance measure. R. Hausmann, J. Hwang and D. Rodrik (6) created $PRODY_{i,t}$, an indicator calculated as a weighted mean of per capita GDP of countries producing a particular product, using the relative share of this product in total exports of the country as weights:

$$PRODY_{i,t} = \sum_{c} \left[ \frac{\left( xval_{c,i,t} \Big/ \sum_{i} xval_{c,i,t} \right)}{\sum_{c} \left( xval_{c,i,t} \Big/ \sum_{i} xval_{c,i,t} \right)} \times GDPpercapita_{c,t} \right] \quad [6]$$

where the numerator comprises the share of product *i* in exports of country *c* in period *t*, the denominator represents the sum of product *i* shares in exports of each country *c*, $GDPpercapita_{c,t}$ is per capita GDP of country *c* based on purchasing power parity (PPP) in period *t* (according to the World Bank data). This indicator aggregates practices of all countries relative to a given product and reflects the weighted mean per capita GDP in countries producing it. This indicator is further used in computing the degree of export structural sophistication $EXPY_{c,t}$ of a country, which is obtained by multiplying $PRODY_{i,t}$ of each export good with its share in export structure of country *c*:

$$EXPY_{c,t} = \sum_{i} \left( \frac{xval_{c,i,t}}{\sum_{i} xval_{c,i,t}} \times PRODY_{i,t} \right) \quad [7].$$

The assumption on the similarity of production technologies in all countries is essential, yet these technologies may change over time.

The probability to develop a comparative advantage for a product in the future depends on the ease with which capabilities existing in the country can be adjusted to the needs of launching the new product. Hence it is important how close the new product is to the existing export structure. In order to determine it, the ratio of paths of the new product to export goods with comparative advantage to paths of the new product to all goods is calculated. R. Hausmann and B. Klinger (7) called this ratio the density. It shows how densely the respective product is incorporated in the country's current export structure. Density values can range from 0 to 1, with the highest margin corresponding to the closest products and hence pointing to a larger probability that respective products will be included in the country's exports in the future. Formally it is calculated as follows:

$$\text{density}_{i,c,t} = \left( \frac{\sum_{k} \varphi_{i,k,t} x_{c,k,t}}{\sum_{k} \varphi_{i,k,t}} \right) \quad [8]$$

where the numerator is the sum of proximities to the respective product of all the goods with comparative advantage, whereas the denominator shows the sum of proximities to the respective product of all goods.

Density is a more appropriate measure than the paths, for it captures relative proximity of the given product to the goods with comparative advantage in the overall export structure.

Companies are more likely to launch new products if the distance indicator is low or, in other words, the density is high. Following the approach of R. Hausmann and B. Klinger (7), this hypothesis is tested on export data for 95 countries and Latvia's export structure, constructing a density diagram for goods that did not have comparative advantage in 1996 (see Chart 1 and 2). Goods with $x = 0$ in 1996 were selected and divided into two product groups (with $x$ equalling 0 and 1 for Group 1 and Group 2 respectively in 2005). As the size of both groups differs notably, the vertical axis in Chart 1 and 2 shows relative frequency. Chart 1 shows that in the global export structure a higher density is characteristic for goods with revealed comparative advantage ($x = 1$; right-hand distribution). Although this tendency is less pronounced for Latvia's export indicators (see Chart 2), overall it supports the hypothesis put forward by the authors of this paper regarding the dependence of structural transformation process on the distance measure (defined herein).

*Chart 1*

**Density of goods in global goods exports in 1996 depending on changes in comparative advantage**

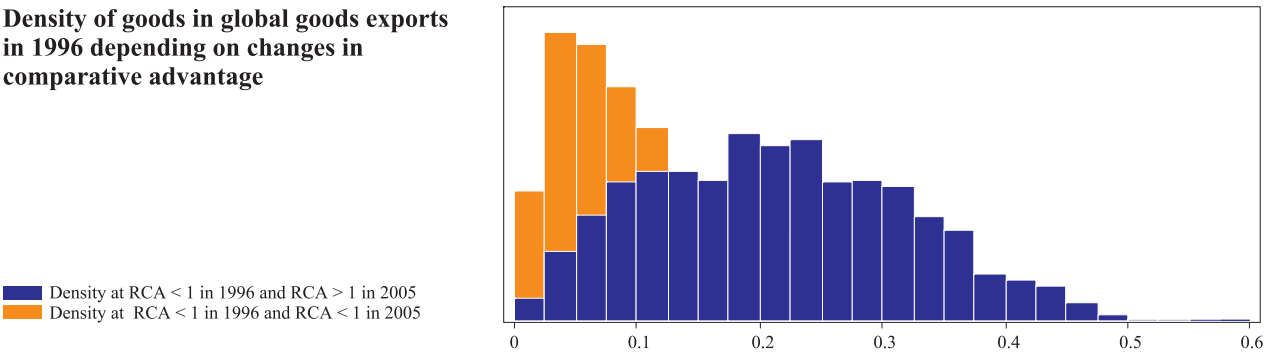
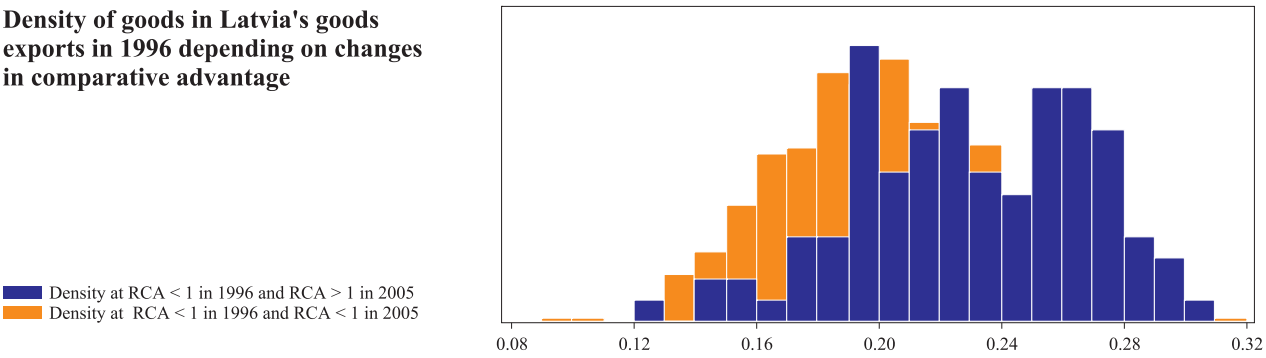



*Chart 2*

**Density of goods in Latvia's goods exports in 1996 depending on changes in comparative advantage**




Densities computed for goods in Latvia's export structure are rather low. For instance, in 1996 and 2005, the highest density indicators were obtained for such Latvia's export product group as fish preserves (0.334 and 0.383 respectively).

Moreover, the average product density growth is somewhat moderate (0.223 in 1996 and 0.255 in 2005).

To capture product groups with highest densities in Latvia's export structure, all products were arranged by the first two digits of SITC classification codes (total of 62 groups), average density indicators of groups computed and their PRODY and EXPY differentials for 2005 obtained. Table 3 shows that wood and natural cork, wearing apparel and food display the highest densities in Latvia's export structure. However, the PRODY and EXPY differential is negative for almost all product groups, with their value falling behind the average weighted indicator of the existing export structure. It implies that the potential for the development of these product groups has been exhausted to a large extent. Dairy and fish products, paper and paper products, prefabricated structures, sanitary and sewage appliances are among the product groups with a positive PRODY and EXPY differential.

*Table 3*

**20 product groups with the highest density in Latvia's export structure in 2005**

| Code | Product group | Density | Product export potential |
|---|---|---|---|
| S3-24 | Wood and natural cork | 0.342 | –4 608 |
| S3-11 | Beverages | 0.341 | –6 769 |
| S3-84 | Wearing apparel | 0.339 | –5 487 |
| S3-82 | Furniture | 0.328 | –303 |
| S3-63 | Wood and products of wood and cork, excluding furniture | 0.320 | –1 536 |
| S3-03 | Fish and fish products | 0.310 | 1 124 |
| S3-81 | Prefabricated structures, sanitary and sewage appliances | 0.307 | 2 965 |
| S3-12 | Tobacco products | 0.295 | –7 866 |
| S3-02 | Dairy products | 0.295 | 3 997 |
| S3-05 | Fruit, vegetables, processing and preservation | 0.291 | –5 816 |
| S3-64 | Paper and products of paper | 0.290 | 3 108 |
| S3-56 | Mineral fertilisers un nitrogenous compounds | 0.288 | –2 926 |
| S3-04 | Grain mill products | 0.288 | –3 578 |
| S3-00 | Animal production | 0.286 | –1 902 |
| S3-55 | Soap, cleansing preparations, cosmetic preparations, perfumery | 0.284 | –1 751 |
| S3-08 | Animal food | 0.283 | –1 496 |
| S3-65 | Textile articles | 0.279 | –2 310 |
| S3-01 | Meat and meat products | 0.272 | 2 290 |
| S3-69 | Articles of metal | 0.263 | 1 716 |
| S3-66 | Non-metallic mineral products | 0.260 | 1 498 |

In order to identify products with a potential to reveal comparative advantage in Latvia, all products with $x = 0$ in 2005 (without comparative advantage) were grouped by density in descending order. Table 4 shows 20 products with the highest density in Latvia's export structure in 2005. According to the table, wearing apparel, textile articles and food are goods with the highest, albeit not much differing, density. Meat, edible offal, convertible seats and mattresses, articles of pulp, paper and paperboard are with the highest PRODY values. High specificity of product groups due to the use of particularly detailed SITC Rev. 3 classification should be accounted for. It refers to products which, given the existing structure of production

factors, are likely to be produced and exported by Latvia in the future. The scenario of export perspective is based on the assumption of the passive stance of the government in enhancing the export potential.

*Table 4*

**20 products with $x = 0$ and the highest density in Latvia in 2005**

| Code | Product | Density | RCA | PRODY | PRODY-EXPY |
|---|---|---|---|---|---|
| 6612 | Portland cement, etc | 0.357 | 0.377 | 7 588 | –8 335 |
| 8447 | Blouses, shirts and shirt-blouses, women's or girls', knitted or crocheted | 0.352 | 0.682 | 8 330 | –7 593 |
| 6581 | Sacks, bags, textile fabrics | 0.351 | 0.184 | 7 299 | –8 624 |
| 8415 | Shirts | 0.347 | 0.341 | 8 853 | –7 070 |
| 8122 | Ceramic plumbing fixtures | 0.337 | 0.184 | 10 020 | –5 903 |
| 5621 | Nitrogenous chemical fertilisers | 0.334 | 0.551 | 9 294 | –6 629 |
| 0129 | Meat, edible offal, n.e.s. | 0.328 | 0.190 | 18 295 | 2 372 |
| 7711 | Transformers, electrical | 0.326 | 0.198 | 14 181 | –1 742 |
| 0019 | Live animals, n.e.s. | 0.325 | 0.051 | 9 045 | –6 878 |
| 8211 | Convertible seats, parts | 0.325 | 0.842 | 16 973 | 1 050 |
| 6582 | Tarpaulins, sails, awnings | 0.324 | 0.203 | 11 912 | –4 011 |
| 0011 | Bovine animals, live | 0.324 | 0.154 | 6 602 | –9 321 |
| 8212 | Mattresses, etc | 0.322 | 0.278 | 16 215 | 292 |
| 6973 | Domestic cooking and heating appliances, electrical | 0.320 | 0.621 | 15 542 | –381 |
| 6114 | Other bovine, equine leather | 0.320 | 0.265 | 10 692 | –5 231 |
| 8428 | Underwear, nightwear, etc | 0.320 | 0.185 | 8 951 | –6 972 |
| 0567 | Prepared and preserved vegetables n.e.s. | 0.320 | 0.671 | 13 226 | –2 697 |
| 6429 | Articles of pulp, paper and paperboard | 0.319 | 0.601 | 16 368 | 445 |
| 0545 | Other fresh and chilled vegetables | 0.312 | 0.417 | 7 905 | –8 018 |
| 8997 | Baskets, brooms, brushes, etc | 0.312 | 0.334 | 11 324 | –4 599 |

Table 5 presents 20 product groups with the strongest export potential in Latvia's exports in 2005, whereas Table 6 captures 20 individual products of the same quality ($x = 0$ in 2005). The table data leads to two principal inferences. First, the export potential of products in Table 5 and 6 is substantially above that of respective products in Table 3 and 4. Consequently, the world export products with the highest implicit income level are much more valuable than export goods of Latvia with the highest density whose production and exports could be developed under the scenario of passive stances. Second, the density of products with the strongest export potential in Table 5 and 6 in Latvia's export structure is lower than the density of goods given in Table 3 and 4. Hence it is rather unlikely that the comparative advantage can be developed in goods with higher implicit income level (pharmaceutical materials, medical, precision and optical instruments, as well products of the chemical industry) without extra supportive measures and involvement of the government. Furthermore, the research leads to a conclusion that in other export producing sectors resources are not used for the purpose of generating high value added, i.e. no support from other sectors in the areas of technologies, infrastructure and research is to be expected.

*Table 5*

**20 product groups with the largest export potential and their density in Latvia's exports in 2005**

| Code | Product group | Density | Export potential |
|---|---|---|---|
| S3-54 | Pharmaceutical preparations | 0.225 | 10 003 |
| S3-87 | Medical and precision instruments | 0.210 | 7 517 |
| S3-88 | Optical instruments, photographic equipment, watches and clocks | 0.177 | 7 063 |
| S3-73 | Machinery and equipment | 0.224 | 6 964 |
| S3-51 | Organic chemical substances | 0.200 | 6 525 |
| S3-41 | Animal oils and fat | 0.246 | 6 480 |
| S3-74 | Machinery and equipment n.e.s. | 0.227 | 6 216 |
| S3-72 | Equipment specialized for agriculture and forestry | 0.231 | 5 555 |
| S3-57 | Manufacture of plastic primary forms | 0.214 | 5 476 |
| S3-25 | Pulp (pulp of wood) | 0.233 | 4 668 |
| S3-71 | Mechanical drive machinery | 0.234 | 4 356 |
| S3-75 | Office equipment | 0.195 | 4 114 |
| S3-02 | Dairy products | 0.295 | 3 997 |
| S3-58 | Plastic plates, sheets, pipes and profiles | 0.268 | 3 714 |
| S3-59 | Chemical substances n.e.s. (pesticides, explosives, glues, gelatine, etc) | 0.224 | 3 232 |
| S3-64 | Paper and paper products | 0.290 | 3 108 |
| S3-81 | Prefabricated structures, sanitary and sewage appliances | 0.307 | 2 965 |
| S3-77 | Electrical motors, generators, transformers | 0.243 | 2 825 |
| S3-53 | Colouring materials and pigments | 0.242 | 2 749 |
| S3-76 | Radio, TV and communications equipment | 0.208 | 2 687 |

*Table 6*

**20 products with $x = 0$ and the highest PRODY value in global exports and their density in Latvia's exports in 2005**

| Code | Product | Density | Comparative advantage | PRODY | Export potential |
|---|---|---|---|---|---|
| 5157 | Other hetero cyclical compounds nucl. | 0.164 | 0.112 | 35 175 | 19 252 |
| 5415 | Hormones, etc, except group 542 | 0.176 | 0.563 | 32 604 | 16 681 |
| 5514 | Flavours, industrial use | 0.186 | 0.198 | 32 413 | 16 490 |
| 5155 | Other organo-inorganic compounds | 0.160 | 0.035 | 32 184 | 16 261 |
| 8964 | Postage or revenue stamps, stamp-postmarks, first-day covers, postal stat | 0.200 | 0.691 | 31 510 | 15 587 |
| 7311 | Machinery, tools, metal removal | 0.133 | 0.000 | 31 400 | 15 477 |
| 5158 | Sulphonamides | 0.179 | 0.000 | 31 160 | 15 237 |
| 5422 | Medicaments, hormones, etc | 0.202 | 0.128 | 31 036 | 15 113 |
| 0161 | Pig meat, dry, salted, smoked | 0.216 | 0.037 | 30 534 | 14 611 |
| 0354 | Fish liver and roes, dried, smoked, salted or in brine | 0.246 | 0.024 | 30 516 | 14 593 |
| 5416 | Glycosides; glands, etc | 0.188 | 0.055 | 30 413 | 14 490 |
| 8996 | Artificial aids, disabled | 0.194 | 0.077 | 30 395 | 14 472 |
| 2123 | Fur pcs., etc, furrier use | 0.185 | 0.000 | 30 110 | 14 187 |
| 5145 | Amine-function compounds | 0.213 | 0.025 | 30 010 | 14 087 |
| 5147 | Carboxyamide-function compounds | 0.194 | 0.045 | 29 638 | 13 715 |
| 8826 | Photographic plates and films, exposed and developed, other than cinematographic | 0.118 | 0.000 | 29 192 | 13 269 |
| 8962 | Original engravings, prints and lithographs | 0.148 | 0.000 | 29 119 | 13 196 |
| 7811 | Vehicles specially designed for travelling on snow; golf cars and similar | 0.166 | 0.544 | 28 977 | 13 054 |
| 8813 | Photo, cinematographic equipment n.e.s. | 0.136 | 0.096 | 28 896 | 12 973 |
| 7916 | Railway or tramway coaches, vans and trucks, self-propelled | 0.184 | 0.000 | 28 598 | 12 675 |

## 3. SOPHISTICATION OF EXPORT STRUCTURE

As stated above, the degree of sophistication and the value of a country's structural transformation are characterised by EXPY. The larger the given indicator, the more valuable goods are exported. In order to investigate changes in the degree of Latvia's export basket sophistication in the last decade, all products were arranged in 14 groups, with EXPY in 1996 and 2005 calculated for each group.[2] Table 7 shows the calculation results, and, for the sake of comparison, the share of each product group in total exports of Latvia is indicated. Overall, the sophistication of Latvia's export structure in 2005 compared with 1996 increased by 56%. Real GDP and per capita GDP increased by 86% and 98% respectively in this period. It leads to an inference that so far the contribution of exports to the GDP growth has been moderate.

In the course of the decade, the EXPY value grew for almost all product groups due to GDP-related PRODY being involved in the EXPY computations (GDP is on a constant upward trend). The EXPY growth was substantial in metals and products of metals, machinery and equipment, wood and paper as well as medical, precision and optical instruments. The global average unweighted GDP growth (in 95 countries under review) was around 52%. Consequently, the growth, for instance, of 46% in product group "Non-metallic mineral products" should not be taken as an impressive achievement. At the same time, the EXPY for leather and rubber products and textile products decreased.

*Table 7*

**EXPY changes in Latvia's exports by product group**

| Product group | Code | Export share in 1996 (changes in 2005; in basis points) | Year | | EXPY changes (%) |
|---|---|---|---|---|---|
| | | | 1996 | 2005 | |
| Food, beverages | 001–122, 411–431 | 15.6 (–3.2) | 1 512 | 1 676 | 10.8 |
| Crude materials | 211–351 | 21.2 (+3.2) | 2 008 | 3 476 | 73.1 |
| Chemicals and products thereof | 511–598 | 6.8 (+0.2) | 897 | 1 455 | 62.2 |
| Leather and rubber manufactures | 611–629 | 1.3 (–0.6) | 143 | 116 | –18.7 |
| Wood manufactures, paper articles, pulp | 633–642 | 7.3 (+2.1) | 663 | 1 333 | 101.2 |
| Textile products | 651–659 | 9.1 (–3.9) | 791 | 734 | –7.2 |
| Non-metallic mineral products | 661–667 | 1.3 (–0.3) | 125 | 183 | 46.4 |
| Metals and metal manufactures | 671–699 | 5.6 (+0.6) | 519 | 1 130 | 117.9 |
| Machinery and equipment | 711–749 | 3.5 (+1.1) | 470 | 993 | 111.4 |
| Electrical equipment | 751–778 | 6.5 (–1.0) | 878 | 1 012 | 15.2 |
| Transport equipment | 781–793 | 4.1 (+0.1) | 498 | 842 | 69.1 |
| Wearing apparel, footwear, bags | 831–851 | 9.6 (–3.0) | 982 | 1 377 | 40.3 |
| Medical, precision, optical instruments | 871–885 | 0.3 (+0.7) | 164 | 301 | 83.7 |
| Manufactures n.e.s. | 811–821, 891–971 | 7.7 (+4.0) | 566 | 1 295 | 128.8 |
| **Total** | **001–971** | **N/A** | **10 215** | **15 923** | **55.9** |

Table 8 and 9 present the comparison of EXPY changes in product exports of Latvia, Estonia, Lithuania, Hungary, the Czech Republic and Slovakia. Data in Table 8 suggest that export EXPYs of almost all countries, except Lithuania, were above that of Latvia in 1996 and 2005. In the reviewed decade, the growth in

[2] Classification of products is presented in Appendix 1.

Hungary's export EXPY was the steepest both in absolute and relative terms. At the same time, the increase (in %) in Estonia's export EXPY, which exceeded that of Latvia in 1996, continued to be more buoyant than in Latvia also in 2005. Changes in EXPYs of various countries differ in the breakdown by product group. In Estonia, the export basket value of electrical appliances, machinery and equipment, base metals and products thereof rose markedly, whereas that of food, beverages, chemical substances and textile articles declined. Lithuanian exports of goods record a steep rise in the value of base metals and products thereof, wearing apparel, footwear, transport equipment and electrical appliances. EXPY of exports of leather and rubber products, crude materials and textile articles decreased. In Hungary, the upward trend in export basket sophistication was mainly determined by a rise in the value of machinery and equipment, electrical appliances and transport equipment, while EXPY of food, wearing apparel and crude materials deteriorated notably. Similarly, export EXPY growth in the Czech Republic and Slovakia was primarily on account of rising EXPY of electrical appliances and transport equipment. Regarding export structure it may finally be noted that a trend common for all countries is an upward movement in the value of electrical appliances, machinery and equipment, and a downward movement in the value of textile articles.

*Table 8*

**Export EXPY of individual EU10 countries in 1996 and 2005**

| Country | Estonia | | Lithuania | | Hungary | | Czech Republic | | Slovakia | | Latvia | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1996 | 2005 | 1996 | 2005 | 1996 | 2005 | 1996 | 2005 | 1996 | 2005 | 1996 | 2005 |
| EXPY | 10 751 | 17 269 | 10 471 | 15 747 | 11 228 | 18 858 | 12 267 | 18 548 | 11 746 | 17 736 | 10 215 | 15 923 |

*Table 9*

**EXPY changes for export product groups in individual EU10 countries**

(in 2005 compared with 1996; %)

| Product group | Estonia | Lithuania | Hungary | Czech Republic | Slovakia | Latvia |
|---|---|---|---|---|---|---|
| Food, beverages | –38.7 | 19.1 | –57.2 | –1.9 | 25.1 | 10.8 |
| Crude materials | 24.7 | –2.7 | –33.9 | –24.0 | 21.0 | 73.1 |
| Chemicals and products thereof | –22.1 | 19.3 | 13.8 | 5.2 | –17.9 | 62.2 |
| Leather and rubber products | 40.5 | –17.8 | 20.6 | 98.8 | 45.4 | –18.7 |
| Wood, paper products, pulp | 31.2 | 54.1 | –20.2 | 0.5 | –6.1 | 101.2 |
| Textile products | –41.8 | –0.2 | –17.5 | –3.0 | –13.6 | –7.2 |
| Non-metallic mineral products | 20.3 | 18.1 | –26.3 | –11.3 | –39.7 | 46.4 |
| Metals and metal products | 89.5 | 129.5 | –18.6 | 21.4 | 18.4 | 117.9 |
| Machinery and equipment | 127.1 | 58.5 | 258.7 | 42.1 | 46.3 | 111.4 |
| Electrical equipment | 205.4 | 87.6 | 232.1 | 206.7 | 294.8 | 15.2 |
| Transport equipment | 33.7 | 97.5 | 178.6 | 125.3 | 161.4 | 69.1 |
| Wearing apparel, footwear, bags | 33.2 | 108.9 | –42.3 | 15.4 | 21.1 | –0.5 |
| Medical, precision, optical instruments | 29.5 | 10.5 | 7.4 | –1.5 | 1.6 | 355.5 |
| Manufactures n.e.s. | 619.6 | 276.0 | 274.7 | 71.4 | 21.7 | 112.4 |
| **Total** | **60.6** | **50.4** | **68.0** | **51.2** | **51.0** | **55.9** |

Further it is researched whether the EXPY growth across countries is affected by capabilities of existing production structure, which, in turn, depend on the location in the product space. Using proximity and PRODY assessment in the product space,

we can arrive at the option value of unused capabilities. If we know the set of products currently produced in the country, country's potential capabilities can be computed as the average weighted value of all products to be potentially produced, using proximity as weights and PRODY as value indicator. Formal calculation of $\Omega_{c,t}$ is as follows (7):

$$\Omega_{c,t} = \sum_i \sum_j \left[ \frac{\varphi_{i,j,t}}{\sum_i \varphi_{i,j,t}} \left(1 - x_{c,j,t}\right) x_{c,i,t} PRODY_{j,t} \right] \quad [9].$$

$\Omega_{c,t}$ is a potential capability to render export structure more complex. Put simply, it means that the indicator of potential capabilities captures weighted $PRODY_{j,t}$ of those product groups that currently do not have comparative advantage ( $x_{c,j,t} = 0$ ), which is determined by the existing structure of comparative advantages ( $x_{c,i,t} = 1$ ), with density used as weights. In this case, $\frac{\varphi_{i,j,t}}{\sum_i \varphi_{i,j,t}}$ is weights showing relative proximity of products *j* (without comparative advantage) to products *i* (with comparative advantage). This relation is larger if $\varphi_{i,j,t}$, i.e. interrelation between products *i* and *j*, is larger but $\sum_i \varphi_{i,j,t}$ interrelation with other products is smaller. $\left(1 - x_{c,j,t}\right) x_{c,i,t}$ is an index that identifies only those combinations of *i* and *j* groups, where comparative advantage currently is present in product *i* group but absent in product *j* group ( $x_{c,j,t} = 0$ and $x_{c,i,t} = 1$ ). When these weights are applied to all product *j* groups, weighted $PRODY_t$ is obtained for each product *i* group (derived from the country's current export structure and density); when $PRODY_t$ for all product *i* groups are summed up the resulting single indicator describes potential capabilities of the country.

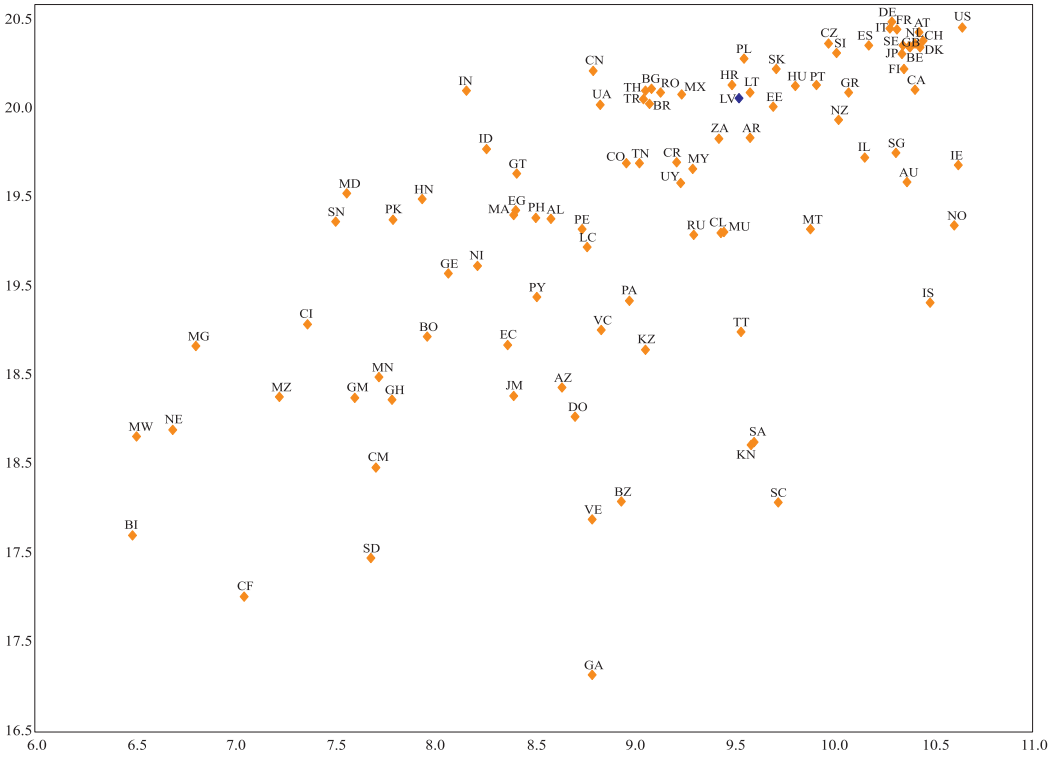
Chart 3 provides a comparison between Latvia's data and those of individual EU countries and selected EU10 countries. In the global structure of goods exports, the developed countries (i.e. the majority of EU15 countries, the US, Switzerland and Japan) occupy a denser part of the product space. Such buoyantly growing economies as China and India are almost at the same level as the group of developed countries. Compared with the EU10 countries (e.g. the Czech Republic, Poland and Slovakia), potential capabilities of Latvia are weaker. A relatively lower per capita GDP in Romania and Bulgaria notwithstanding, the production potential in these countries is somewhat above that in Latvia. However, the deficiencies of the method of calculation of production potential should not be neglected: countries with their export structure highly concentrated on particular product groups are ranked in a lower position than countries with a more relaxed export structure. As more concentrated export structures are typical for some high-income countries, their potential is biased downwards. Therefore, using this indicator, the potential of

Norway and Iceland is underestimated most likely due to the high concentration of export structure in these countries.

*Chart 3*

**Potential capabilities and per capita GDP in 2005**

(potential capability to render export structure more complex; log; per capita GDP; log)




Latvia's data marked in blue.
*Source*: authors' calculations.

## CONCLUSIONS

Structural transformation provides for a transition from the production and exports of goods with low value added to the production and exports of goods with high value added. It is essential for the improvement of national welfare, for observations suggest that in a longer perspective the level of economic development is related to the degree of export sophistication.

The speed of structural transformation of exports depends on the proximity of potential export goods to the existing export goods bundle. The denser the product space of a particular product relative to the basket of export goods with revealed comparative advantage, the stronger the likelihood of the country exporting this product in the future.

Estimations within this paper suggest that in Latvia in 2005 product density or relative proximity of export goods to goods with comparative advantage was rather small. Export potential is negative for almost all currently produced product groups. It seems to suggest that capabilities of almost all groups of currently produced goods to act as drivers of development have been exhausted to a certain extent. As of product groups without comparative advantage, wearing apparel, textile articles and food account for the largest density; the respective export potential is negative suggesting that products of these groups are mainly produced in countries that lag behind Latvia in terms of development levels.

An active export promotion strategy implies that the production of goods with the strongest positive export potential is developed and enhanced, or goods whose implicit income level exceeds the average weighted value of the current export basket are generated. When all products with comparative advantage below 1 in 2005 are grouped by their PRODYs (in descending order) and their density in Latvia's export structure is analysed, it may be concluded that global exports are of higher value than Latvian products that are in relatively close proximity to products with comparative advantage and whose production and export could be developed under passive strategy. Pharmaceutical preparations, medical, precision and optical instruments as well as chemical products rank among goods with the largest implied income level to be exported in the future. Yet the density of such goods in Latvia's export structure is rather moderate. Hence it is rather unlikely that comparative advantage in these goods can be developed without extra measures and support of the government.

The method used in the paper is unlikely to offer immediate economic policy recommendations or action plan recipes; yet it is useful in aggregating global practices, which is a difficult task, for they are not homogeneous due to the effects of government policies, and historic and geopolitical factors that cannot be captured by purely mathematical manipulations. The indicators obtained in this paper can be regarded as the first attempt to throw light on Latvia's export structure in the context of global practices. It is probable that a product typical for low income countries or very far from the existing bundle of available factors of production can still have a growth potential in Latvia. Be it so, the identification and analysis of the factors that underpin the difference are needed. It may be a proposition for further research.

## APPENDICES

*Appendix 1*

### 14 product classification groups

All products are classified according to SITC Rev. 3 classification in the following groups (first three digits of product code in parenthesis).

1. Food, beverages – processed and unprocessed food, beverages, tobacco (001–122, 411–431).

2. Crude materials – raw hides, seeds, wood, fibres, crude minerals, crude vegetable materials (211–351).

3. Chemicals and related products – chemicals, pesticides, dyeing materials, pharmaceutical and medical products, cleansing, polishing and cosmetic preparations (511–598).

4. Leather, rubber manufactures (611–629).

5. Wood manufactures (excluding furniture), pulp, paper products (633–642).

6. Textile products (651–659).

7. Non-metallic mineral products (661–667).

8. Manufactures of metals (671–699).

9. Machinery, equipment (711–749).

10. Electrical equipment (751–778).

11. Transport equipment (782–793).

12. Wearing apparel, footwear, bags (831–851).

13. Medical, precision, optical instruments, clocks and watches (871–885).

14. Goods not classified elsewhere (n.e.s.) – radiators, sinks, furniture, paper and cardboard articles, publishing, printing, photographic and recording goods, games, gambling, musical instruments, etc (812–821, 891–971).

*Appendix 2*

**Potential capability and per capita GDP in 2005**

| Country code | Name of country | Potential capabilities (log) | Per capita GDP (log) |
|---|---|---|---|
| IT | Italy | 2.39 | 10.28 |
| FR | France | 2.33 | 10.31 |
| ES | Spain | 2.32 | 10.17 |
| DE | Germany | 2.30 | 10.29 |
| US | US | 2.30 | 10.64 |
| CN | China | 2.29 | 8.79 |
| CZ | Czech Republic | 2.26 | 9.97 |
| GB | UK | 2.22 | 10.37 |
| NL | Netherlands | 2.21 | 10.40 |
| AT | Austria | 2.21 | 10.42 |
| BE | Belgium | 2.20 | 10.38 |
| PL | Poland | 2.19 | 9.55 |
| IN | India | 2.18 | 8.16 |
| CH | Switzerland | 2.12 | 10.44 |
| SI | Slovenia | 2.09 | 10.01 |
| JP | Japan | 2.08 | 10.34 |
| TR | Turkey | 2.08 | 9.02 |
| SE | Sweden | 2.07 | 10.34 |
| DK | Denmark | 2.04 | 10.43 |
| TH | Thailand | 2.03 | 9.05 |
| PT | Portugal | 1.98 | 9.91 |
| SK | Slovakia | 1.94 | 9.71 |
| BG | Bulgaria | 1.91 | 9.08 |
| RO | Romania | 1.91 | 9.13 |
| LK | Sri Lanka | 1.88 | 8.43 |
| MX | Mexico | 1.87 | 9.23 |
| GR | Greece | 1.87 | 10.07 |
| HU | Hungary | 1.87 | 9.80 |
| HR | Croatia | 1.87 | 9.49 |
| CA | Canada | 1.87 | 10.40 |
| ID | Indonesia | 1.85 | 8.25 |
| ZA | South Africa | 1.85 | 9.42 |
| FI | Finland | 1.84 | 10.35 |
| LV | Latvia | 1.82 | 9.52 |
| EE | Estonia | 1.81 | 9.69 |
| LT | Lithuania | 1.80 | 9.57 |
| BR | Brazil | 1.78 | 9.07 |
| UA | Ukraine | 1.71 | 7.33 |
| SG | Singapore | 1.69 | 10.31 |
| MY | Malaysia | 1.68 | 9.29 |
| NZ | New Zealand | 1.66 | 10.02 |
| BY | Belarus | 1.61 | 8.97 |
| JO | Jordan | 1.58 | 8.54 |
| TN | Tunisia | 1.57 | 9.53 |
| IL | Israel | 1.57 | 10.15 |
| BA | Bosnia Herzegovina | 1.56 | 8.94 |
| GT | Guatemala | 1.56 | 8.40 |
| CO | Colombia | 1.55 | 8.96 |
| AR | Argentina | 1.52 | 9.58 |

*Appendix 2 (cont.)*

| Country code | Name of country | Potential capabilities (log) | Per capita GDP (log) |
|---|---|---|---|
| AU | Australia | 1.48 | 10.36 |
| PK | Pakistan | 1.46 | 7.78 |
| CR | Costa Rica | 1.44 | 9.21 |
| LU | Luxembourg | 1.40 | 11.22 |
| IE | Ireland | 1.36 | 10.62 |
| MA | Morocco | 1.33 | 8.39 |
| PH | Philippines | 1.31 | 8.50 |
| HN | Honduras | 1.31 | 7.93 |
| MD | Moldova | 1.27 | 7.55 |
| MU | Mauritius | 1.26 | 9.43 |
| SY | Syria | 1.21 | 8.25 |
| NA | Namibia | 1.21 | 8.96 |
| AL | Albania | 1.18 | 8.58 |
| UY | Uruguay | 1.17 | 9.23 |
| RU | Russia | 1.17 | 9.30 |
| EG | Egypt | 1.13 | 8.40 |
| PE | Peru | 1.10 | 8.74 |
| CL | Chile | 1.08 | 9.44 |
| FJ | Fiji | 1.06 | 8.69 |
| SN | Senegal | 1.05 | 7.50 |
| NO | Norway | 1.03 | 10.60 |
| TZ | Tanzania | 0.97 | 6.59 |
| LC | Saint Lucia | 0.88 | 8.76 |
| MT | Malta | 0.85 | 9.88 |
| GE | Georgia | 0.80 | 8.06 |
| IR | Iran | 0.77 | 8.98 |
| AM | Armenia | 0.72 | 8.52 |
| MG | Madagascar | 0.70 | 6.80 |
| NI | Nicaragua | 0.67 | 8.21 |
| PY | Paraguay | 0.57 | 8.51 |
| EC | Ecuador | 0.54 | 8.36 |
| CI | Cote d'Ivoire | 0.52 | 7.36 |
| CV | Cape Verde | 0.46 | 8.78 |
| GY | Guyana | 0.46 | 8.42 |
| VC | Saint Vincent and the Grenadines | 0.44 | 8.83 |
| SA | Saudi Arabia | 0.43 | 9.60 |
| BO | Bolivia | 0.40 | 7.96 |
| KZ | Kazakhstan | 0.37 | 9.05 |
| MW | Malawi | 0.31 | 6.50 |
| PA | Panama | 0.31 | 8.97 |
| TT | Trinidad and Tobago | 0.26 | 8.99 |
| IS | Iceland | 0.21 | 10.48 |
| GH | Ghana | 0.20 | 7.78 |
| MN | Mongolia | 0.07 | 7.72 |
| JM | Jamaica | 0.06 | 8.39 |
| DO | Dominica | 0.05 | 8.70 |
| GM | Gambia | 0.05 | 7.60 |
| AZ | Azerbaijan | 0.01 | 8.63 |
| BJ | Benin | –0.06 | 7.02 |
| NE | Niger | –0.06 | 6.68 |
| MZ | Mozambique | –0.06 | 7.22 |

*Appendix 2 (cont.)*

| Country code | Name of country | Potential capabilities (log) | Per capita GDP (log) |
|---|---|---|---|
| KN | Saint Kitts and Nevis | –0.07 | 9.58 |
| VE | Venezuela | –0.15 | 8.78 |
| CM | Cameroon | –0.39 | 7.70 |
| BZ | Belize | –0.59 | 8.93 |
| BI | Burundi | –0.72 | 6.48 |
| CF | Central African Republic | –0.94 | 7.04 |
| SC | Seychelles | –1.15 | 9.72 |
| GA | Gabon | –1.19 | 8.78 |
| SD | Sudan | –1.56 | 7.67 |

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