**Technology transfer models in the knowledge-based EU**

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**Abstract:** - Technological transfer is undoubtedly one of the most powerful strategic instruments of which economies might benefit either with the purpose of maintaining their competitive positions, or for diminishing development gaps. Our paper intends to highlight the existence within the European Union of some groups of countries characterised by common models of technological transfer starting from the current economic situation existing in the region in correlation with the exigencies of the knowledge-based economy.

**Key-Words:** - innovation, technology transfer models, knowledge-based economy, competitiveness, innovative clusters, development gap, European Union.

1 Overview  
In a permanent process of enlargement and change for better than 20 years now, the European Union faces currently strong development gaps the relative deviations of the GDP/capita against the average EU-27 having at the level of the year 2008 variations comprised between 38.5% in Bulgaria and 140% Ireland (Fig.1).

Fig.1 GDP per capita in Purchasing Power Standards (PPS) (EU-27 = 100)

![GDP per capita in Purchasing Power Standards (PPS) (EU-27 = 100)](image)

Source: own presentation based on Eurostat data  
Despite the efforts and adoption of strategic priorities within the Lisbon process, of the heterogeneity level of EU remains rather high at the innovativeness’ and associated performances’ level. From the viewpoint of the development level of the knowledge-based economy, within EU Denmark is the leader (Knowledge Economy Index, e.g. KEI=9.58), followed by Sweden and the Netherlands (with relatively comparative KEI values). Taking into account the constitutive elements of KEI, it can be found that within the EU the distinction may be made between 4 groups, depending on the distance against the leader (Table 1/ Figure 2).

Table 1. Main EU clusters by Worldbank KEI

<table>
<thead>
<tr>
<th>1st Cluster</th>
<th>2nd Cluster</th>
<th>3rd Cluster</th>
<th>4th Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>Finland, UK</td>
<td>Estonia</td>
<td>Cyprus</td>
</tr>
<tr>
<td>Sweden</td>
<td>Austria</td>
<td>Hungary</td>
<td>Italy</td>
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<tr>
<td>Netherlands</td>
<td>Germany</td>
<td>Czech Rep.</td>
<td>Bulgaria</td>
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<td></td>
<td>Ireland</td>
<td>Latvia</td>
<td>Romania</td>
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<td></td>
<td>Belgium</td>
<td>Greece</td>
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<td></td>
<td>France</td>
<td>Poland</td>
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<td></td>
<td>Slovenia</td>
<td>Portugal</td>
<td></td>
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<tr>
<td></td>
<td>Spain</td>
<td>Slovak Rep.</td>
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</tbody>
</table>

Source: own findings  
Fig. 2 KEI Euclidean distances between EU countries

![KEI Euclidean distances between EU countries](image)

The relationship between the knowledge economy index and the innovativeness for the European economies as a whole estimated based on the Eurostat’s Summary
Innovation Index (SII), is proven as a quite strong one, the value of the coefficient of determination being close to 0.8 (0.78529). The identified dependency model based on the correlation analysis is a linear one (equation 1), the intercept value (5.4579) highlighting the incipient development level of the knowledge-based economy under theoretical conditions of a SII with zero value.

Fig. 3 Scatterplot of KEI against SII

Source: own calculations based on quoted databases

\[ KEI = 5.4579 + 6.3946 \times SII \]  
\[ R^2 = 0.78529 \]

The competitiveness deficit of EU countries in relation to USA and Japan (position 1, respectively 10) remains significant [GCR2008], as there are variation between the third world position – Denmark and the seventy-sixth position – Bulgaria and it is due to a rather large extent to the predominantly low levels of the technological readiness. In this context, we consider as particularly important the study of the technological transfer models consolidated during the last two decades with the purpose of identifying the best-practice models, but also the solutions for attenuating the gaps.

2 Theoretical background

The review of the specialised literature shows that research efforts in the field of technological transfer are not of a recent date and cannot be separated from the researches in the field of innovation and technology diffusion.

Starting from the axiom that diffusion presupposes technical and knowledge transfer from one adaptor to the other, Mansfield uses the contamination model (epidemic of propagation by contact). The adequate mathematical form of this type of propagation is represented by the logistic curves that have as main variables the share of all units in contact with the propagated element, the potential and diffusion speed in time.

A characteristic of all epidemic models consists in the use of approaches regarding balance and saturation, as a certain first post-diffusion level is considered. The majority of experts tend towards an approach based on the hypothesis of saturation because this introduces the time factor and attempts to establish the quantity of new goods and technologies that the economic agents own in case of complete diffusion.

The empirical determination of the mathematical form of the logistic curves may be realised based on the following relationships:

Curve of logistic growth:  
\[ \frac{dn}{dt} = g(t)n_i \left(1 - \frac{n_i}{N_i}\right) \]  
Chew logistic:  
\[ \frac{dn_i}{dt} = g(t)N_i \left(N^r - N_i\right) \]  
Gompertz curve:  
\[ \frac{dn_i}{dt} = h(t)n_i \left(\log n^r - \log n_i\right) \]

Where:
- \( n_i \) – share of users for the new product or process;
- \( n^r \) – post-diffusion level;
- \( N_i \) – absolute users levels;
- \( g(l) \) – an aleatory time function;
- \( h(t) \) – diffusion speed.

From the analyses performed from the viewpoint of epidemic approaches it may be concluded that technological diffusion varies depending on companies, industry and technology due to the differences of targeted profitability, the functioning duration of the capital stock and the phase of the economic cycle, and to the fact that innovation profitability has a positive effect on diffusion speed.

Stoneman and Ireland (1980) introduce in the intra-branch diffusion analysis also the role of the innovation industry. They build a model starting from the hypothesis that a company adopts a new technology up to the moment \( t \), if its actual size exceeds a certain critical level. In the analysis they start with the assumption that the new technology implies the purchase of capital goods at the price \( p \). This diminishes the labour force needs (relatively to the old technology) by \( \Delta L \) per output unit. Taking into account the interest rate \( r \), the wage rate \( w \) and ignoring wear, Stoneman and Ireland assume that the shift to the new technology takes place when the savings regarding wage expenditures exceed the cost of using it. Because the output level of the company is expressed in its size \( S \), the critical dimension satisfies the relationship:  
\[ S^* w \Delta L = pr \]  
from here:  
\[ S^* = \frac{pr}{w \Delta L} \]  
Therefore, at any given moment on the time axis only companies with the current size higher than \( S^* \) shall turn into users of the new technology.

Depending on the moment in which the adoption decision of the new technology is made, Rogers (1985)
distinguishes between five categories of adopters: innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%), distributed after a normal distribution (figure 4). Rogers shows that within the economic process the big winners are represented by the companies from the first two categories, to the extent in which these benefit a longer period of time from Schumpeter’s temporary monopoly. Early majority group loses the monopoly advantage, but the loss is diminished by experimentation advantage and by the diminished failures associated to the homogenisation period of technologies pertaining to different technological generations.

3 Is there a European model of technology transfer?
One of the great challenges of the knowledge-based economy is represented precisely by the requirement of transferring and putting to good use knowledge. These can be incorporated in written documents, or non-incorporated, consisting in experience, intuition, behaviour, etc. Objects are easier transferable than documents, to the extent in which the latter require the additional process of decoding and, as result, can be affected by interpretation and/or translation. On the other hand, decoding in itself implies a certain loss (sacrifice) of data which generates a certain asymmetry between what existed at the origin of information (in the individual’s mind) and what could be diffused. When the codification of tacit knowledge presupposes a consistent loss of original information, which makes practically impossible the adoption and efficient use by transfer, the direct interaction is imposed between the knowledge owner and adopter.
An important role in obtaining efficient interaction between the source and adopter is held by the adequacy degree of professional training, but also the cultural-educational model to which they belong.

For evaluating the cultural-educational model we decided to use as proxy variable the Economist Intelligence Unit’s Democracy Index (GDI). The results of testing partial links (fig.5) lead to the conclusion that GDI strongly influences the whole level of KEI (R²=0.7965) and innovativeness (R²=0.7075), yet having an insignificant influence (R²=0.1855) on technology balance of payments (TBP).

The exigencies of the knowledge-based economy, as well as the challenges of economy’s globalization have lead to the consolidation of a much more dynamic innovation model than the linear one. The non-linear model presents next to the advantage of accelerated dynamic also the advantage of a transversal character allowing for technological leaps, and for the valuing of latent innovative assets as well, that characterise particularly lagging economies.

Based on putting to good use the advantages provided by de-linearity complex, trans-border innovation systems were created which allowed for the inclusion of the new member countries in the value chains of competitive innovation in partnership. Within these systems it is pursued with priority to increase the intensity of technological and knowledge transfers. From the size perspective a distinction can be made between the large inno-competitive chains represented in general by the trans-national companies and small chains formed from SME networks, research institutes and universities. A particular construction and with...
outstanding performances with respect to innovativeness and competitiveness is represented by clusters. As opposed to networks, clusters presuppose certain restrictions of the spatial type – entities pertaining to the clusters are found some in the immediate vicinity of the others, so that they can also put to good use the proximity effects.

For evaluating in assembly the volume and intensity of the technology transfer at EU level we have used as proxy variable a changed variable of technology achievement index (TAI_M) which we considered more adequate for the purposes of the present paper. Hence, against the original formula proposed and used by UNDP we considered as more relevant the use of the information volume transacted in bandwidth and the use of internet for businesses.

The outcomes of the correlation analysis prove extremely strong connections between the technology transfer and the development level of the knowledge-based economy (fig. 7).

Source: own calculations based on quoted databases

For identifying the transfer model/models of technology characteristic to EU countries (Fig.8) the FDI inward index (FDI_II) and FDI outward index (FDI_OI) [WIR, 2008], KEI, TAI_M were considered, as well as the export bias of clusters [...].

In our opinion the distinction can be made between four categories of technology transfer models: technology transfer innovators (TTI identified with red in Fig.8), technology transfer leaders (TTL), technology transfer followers (TTF) and technology transfer laggards (TTIg).

Table 2 Main characteristics of technology transfer models

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<th>TTF</th>
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<td>Very high</td>
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<td>Medium</td>
<td>Low</td>
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<tr>
<td>TT</td>
<td>Very high</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Innov</td>
<td>Very high</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
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Source: own conclusions

4 Conclusion

We consider that within these groups of countries, an increased attention should be given on one hand to the model adopted by innovators in the field of technology transfer (Denmark, Finland and Ireland), and on the other hand to the laggards (Cyprus, Romania and Bulgaria), as net technology absorbers and as potential losers of competitive positions on the market.

References:

[*], World Investment Report 2008, UNCTAD