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OPPORTUNITIES AND CHALLENGES OF EASTERN EUROPEAN COUNTRIES TO PARTICIPATE IN THE GLOBAL SEMICONDUCTOR AND ELECTRONIC MARKET

Abstract: *The foundation for the semiconductor industry was laid approximately sixty years ago and represents today a market of more than US$ 300 billion a year. During this period of time, some geographic regions gained a strong position in this market, such as the United States of America, South-East Asia, China, and Western Europe. With the political opening of Eastern Europe, high expectations were set by the industry and national economies to participate in this highly attractive business with research and design, manufacturing and marketing of products and electronic goods. Building on the research and relevant academic doctrine on globalisation, transnational cooperation, a comparative qualitative and quantitative analysis was done on Eastern European countries to evaluate the opportunities and challenges for national and business economies to participate in this market. As a result, this paper summarizes the current situation to what extent Eastern European countries are important to this marketplace. It explores the key success factors and identifies areas for improvements that are needed in order to participate in this industry for enterprise business, national economies, the educational system, institutions and society and provides recommendations to extend the academic doctrine related to globalisation and transnational cooperation. It also offers suggestions and ideas for the education system, institutions, social economies,and political decision makers.*

Keywords: *Eastern Europe, globalisation, transnational cooperation, foreign direct investment, innovation, corruption, semiconductor and electronics industry, technological upscale, global competitive index, European Union, structural indicator, national economies, Lisbon goal, convergence, SWOT, diversity, EU15, EU27.*

JEL: F 13, F 16, M 11, M 15

Introduction

The fascination with technology, innovation, electronic and semiconductor products is unbroken. There is hardly any other industry that enabled so many radical innovations, gave birth to inventions that changed the world, in many cases to a better one. The flight to the moon, modern telecommunications, highly automated industrial manufacturing, advanced automotive system, security as well as infotainment[1] systems, leading edge medical diagnostic system, fixed line and mobile telephony, personal computing, consumer entertainment – video, audio and gaming – would not have been possible without the electronic industry.

Based on a total available world market of estimated approximately US$300 billion in semiconductor and more than US$1,5 trillion in electronic goods production it is also a truly exciting marketplace from a business point of view.

With the political opening of Eastern Europe, tall expectations were set by this industry: as an attractive market place to enter for selling products and services, as a source of capabilities in engineering and design, as a region for manufacturing. During the Cold War period, there was hardly any (official) cooperation between *East* and *West* as semiconductor products were seen (and still are) as a mission critical for communication and other application, therefore being of great interest to military and defence usage, aviation and space programs, in fact, semiconductor products and electronic goods were subject to trade restriction. Technological developments took part in parallel: in the East and West block of the world.

Following the expansion of the European Union towards the EU27 it became quite obvious that the knowledge about the opportunities and the challenges from foreign investors – but also from domestic entrepreneurs – was quite limited. Often, foreign investors did not know a lot about this territory, the market potential, the capabilities and the history. Domestic entrepreneurs did lack in experience of global trading and international standards in terms of quality, product features, marketing and many other aspects. Certainly, the market potential, purely from the need to rebuild the infrastructure, was seen as being a tremendous and unique opportunity in the history. Accessible resources in engineering could be another value.

During the journey of development since the political opening, many questions arose about the prospects of this region, based on significant gaps in the development in the past. Will there be an opportunity for Eastern Europe in this industry? Does it make sense to invest? Can this region compete successfully versus other (emerging) regions, e.g. South East Asian? What will it take to do so? What does it mean for the entire Europe? Can ‘a business development’ be predicted?

It is clear that this is a much broader topic than just analysing the current status of the markets and potential outlooks of market researches in this industry field? There are required investigations related to micro- and macroeconomy thesis, academic doctrine’s related to national economy competitiveness and development,

[1] Infotainment, technologies classified as a combination of information and entertainment.

globalisation and an understanding of what it takes to become successful in this industry from a development and innovation point of view. A subject which is more topical than ever with the latest announcement of Russia aiming to build an own '*silicon valley*' near Moscow within the next few years.[2]

Many questions triggered the interest to do an in-depth research on the subject and investigate the *Opportunities and challenges of Eastern European countries to participate in the global semiconductor and electronic market.*

Summary of Academic Research

The aspects of globalisation do play a major role in this investigation. Numerous theories on *globalisation* and *international business development* can be found. The key essence is related to ***increasing profit*** based on ***better competitiveness*** due to ***local resources***, ***capabilities*** and ***markets***. ***Entering new emerging market*** in order to ***expand the overall business*** is another key motivation factor for local presence in new markets.

The academic literature proof a causal relation to the importance of FDI for the development of a country and as an indicator for the stages of development a country is in.

Industrial upgrading is a necessity in order to maintains growth and economic development. Without such a development, the risk is very high to end up in a negative downward spiral of cost pressure in competing on commodity type products and services. At the same time, as labour cost and wages are increasing the competitive advantage based on lower cost manufacturing is disappearing, and the global manufacturing network is shifting to countries with lower cost.

Institutions, macroeconomic stability, trust in policy makers and legislation and judiciary stability are ***key factors for FDI***. ***Social economic factors*** and ***rigorous ethic business factors*** and active ***measures against corruption*** are also very important attributes for economies in order to develop and upgrade in its industrial importance.

Innovation is the key for industrial upgrading and development. Innovation is a highly complex matter. A scale of innovation according to the level of the importance of the innovation is described from gradual towards radical innovation. The ***foundation for innovation*** is set for the ***quality of the educational system*** and the environment to foster and allow creativity, with the application of life-long learning and a strong cooperation between the academic system such as universities and the industries. Last but not least, it is ***supported by a trustworthy financing system*** such as venture capitals.

And finally, one has to be cautious that with all the findings, there may be no ‚one single solution', the uniqueness of the situation of each country has to be considered.

[2] See Frank Nienhysen, Nobelpreisträger, bitte melden. Sueddeutsche Zeitung, March 25th, 2010.

Research Methodology and Methodology of Investigation

The level of electronic goods and semiconductor production varies quite heavily among the Eastern European countries and in comparison globally. In order to find criteria why some countries and regions tend to be more successful than others in this industry, a *comparative quantitative* and *qualitative analysis* on the national economies and their specific values in terms of market competitiveness is meaningful. A comparison of economies is not a trivial thing to do. Researchers have tried over a long time to define common parameters to be looked at in order to allow a fair comparison. Meaningful data is provided by the *European Commission* with the structural indicators. They were set in order to compare the development of the EU countries. The world economic forum has developed the *Global Competitive Index (GCI)*, with its 12 pillars of measurement criteria's. There is some overlap or commonality of the parameters. Both set of data do have their justification as the GCI allows a universal comparison and is comparing on peer level country groups, whereas the structural indicators are primary focused for a European analysis.

This research summary will also provide an overview on the current status of the semiconductor and electronics industry based on industry market research reports. Further interesting source of information is provided by the *World Bank, the United Nations* and organizations such as *transparency international*.

Sources of Investigated Data

- Market research data from various industry research companies.
- Structural Indicators from the European Commission, generated in order to allow a comparison of the countries of the European Union and its progress towards the convergence goals according to the Lisbon criteria set in 2000 and 2005.
- The Annual country-specific recommendations from the European Union, accompanying the quantitative data form the structural data this recommendation allows a qualitative comparison based on the recommendations from the European Union.
- The Global Competitive Index (GCI), done by the World Economic Forum. The yearly GCI report created by the world economic forum allows a good comparison of the economic competitiveness of 134 countries worldwide. The countries are grouped in peers according to their level of development, which is intended to allow a fairer comparison of countries.
- Research data and publications by the World Bank
- Academic research on transnational cooperation, Prof. Sanjay Lall Prof. Lall's research work on transnational cooperation was chartered by the world bank. Some of the data became the basis for some of the pillars in the GCI ranking. The research was primary done for South-East Asia and its development within the semiconductor and electronics industry.

- Research data and publications by Transparency International. Transparency international provides a ranking on a yearly basis related to corruption and trustworthy of economies.
- Research data from the United Nations
- Own case studies on selected companies Apple and Google. Apple and Google were ranked as the Top 10 most innovative companies worldwide by the w*ired magazine*.

The case studies are based on own investigation in order to find some correlation on what it takes to become extraordinary successful as it is been the case for both companies over the last years.

Eastern Europe within the European Union

The market liberalization and the transformation of former communist countries towards a free open market combined with the expansion of the European community, resulted in a unique opportunity for the new EU countries for economic growth and development. The high-technology electronics industry offers various possibilities to participate in this market: through electronic manufacturing services (EMS), through research and development (R&D), through semiconductor design and manufacturing and through electronic product design and manufacturing or other engineering and consultancy services. Due to the nature of international businesses, there is high competition on foreign direct investments for domestic products and solutions. In addition to established market places such as the United States of America, Western Europe, South-East Asia, and Japan, many other emerging countries and regions are lining up aiming to participate in this market place.

Lisbon Goals

At the 2000 Lisbon European Council a strategic goal was set by the country's leaders for the European Union: '*becoming the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion' within one decade until the year 2010*. The Lisbon goals got streamlined in 2005 with the major focus remaining on *growth* and *employment*. The initial goal of 2000 is to develop the European Union (EU) within 10 years to the most dynamic, competitive information based economic region within the world by developing the member countries. The main goals of the criteria for the EU members are: reformation of the Macro economy to achieve and secure a sustainable growth, increasing number of employment, increasing and stronger social cooperation among the countries, and overall efficient stability for the community by the 2010. It shall foster the convergence of the different social status of the EU member countries in the fields of employment, innovation, research and development, sustainable economic growth, social unification, protect the environment.[3]

[3] See European Commission, http://europa.eu/lisbon_treaty/index_de.htm

Country-specific goal alignment and goal achievement shall be based on growth, competitiveness and employment based on a benchmarking between the countries and an analysis of the strength and weaknesses. This method is based on a control mechanism of the countries without penalties and the idea to learn from the best, and to avoid mistakes. This method is also called the method of open coordination.[4] This provides especially a unique advantage for the emerging countries within the European Union such as the new member states in Eastern Europe.

Summary of the Semiconductor and Electronics Market

The analysis of key market research data predicts a further moderate growth for Eastern European countries for the semiconductor market to consume approximately 5.2 % of the world demand in 2012 versus 4.21 % in 2006 and 4.91 % of the world market in total electronics in 2012 versus 4.44 % in 2006. In terms of production, Eas tern Europe counted for 1.23% of the world semiconductor production in 2006 and 1.37 % in 2009, which basica lly does not play a role in this market, only serving niche market or supporting legacy products. In terms of electronic total production Eastern Europe counts for 3.08 % in 2006 and 3.55 % in 2009. Further moderate growth is expected mainly based on manufacturing shifts from Western European countries and OEM‘s transferring manufacturing from South-East Asia to Europe to enter the European market, due to benefits in logistic and lower cost in transport. Moreover, the development of the infrastructure in telecommunication, medical and the transfer in manufacturing in the automotive industry helped some Eastern European countries to grow in the electronic industry supported by relevant subsidies from the European Union.

China is by far the strongest growing country in terms of semiconductor demand and electronic manufacturing.

At the current stage, the analysis indicates that none of the countries may be in a position to be seriously considered for investments in the semiconductor industry in terms of design or manufacturing. For contract manufacturing (EMS) several countries do already play a role such as Hungary, Poland, with a minor importance the Czech Republic and Slovakia. EMS manufacturing is a fairly dynamic market, as the EMS companies operate generally global and shift production towards countries with the lowest cost which is a threat as soon as wages rise due to a rising standard of living, and competition for labour forces, inflation is also a common threat, especially for the Baltic countries, Bulgaria and Hungary at the moment. Due to the big population and potential market size, it is unlikely that Russia, Romania and Ukraine will not have some attractiveness for investors although the basis needs improved in many aspects. However, this is more related to lower technology investment as the high

[4] See Bauer; Knöll; Die Methode der offenene Koordinierung: Zukunft europäischer Politikgestaltung oder schleichende Zentralisierung? In: Aus Politik und Zeitgeschichte (B01-02/2003).

technology industry is operating globally and the marketing of the produced products is not necessarily happening in the producing country.

The investment in fabrication of Nokia in Romania is a good example for shifting production driven by substitutions from the European Union. Other industries such as the automotive industry, which is expected to grow locally in Russia, and Ukraine will have side effects and will foster some electronic manufacturing to a certain extend into these countries. As long as the overall business climate does not get improved in these countries, they will not play a significant role in designing own products and solution. Table 1 gives an overview on the semiconductor and electronics *production* by East European country in 2006 and 2009.

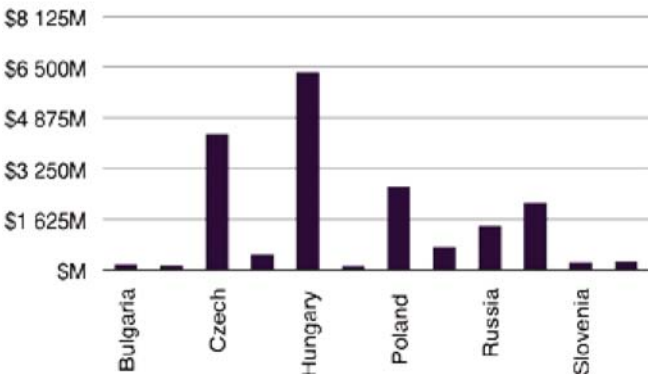
Table 1

Production of Eastern European Countries in 2006 and 2009 [5]

Country	Semi 06	Total 06	Semi 2009	Total 09
Bulgaria	$56	$309	$62	$348
Croatia	$71	$329	$102	$388
Czech Republic	$1.165	$9.626	$1.168	$11.944
Estonia	$99	$1.146	$77	$801
Hungary	$1.635	$15.534	$1.707	$15.533
Lithuania	$86	$335	$61	$316
Poland	$513	$6.383	$507	$7.734
Romania	$170	$1.058	$172	$1.386
Russia	$540	$3.360	$576	$4.101
Slovakia	$200	$4.649	$232	$6.760
Slovenia	$168	$701	$187	$765
Ukraine	$178	$906	$179	$1.024
East Europe total	$4.881	$44.336	$5.030	$51.100
TOTAL world	$395.303	$1.440.846	$366.759	$1.438.243
East/World %	1.23%	3.08%	1.37%	3.55%

Figure 1

Total Eastern European Semiconductor Market (consumption, semiconductor) [6]



[5] See: structural indicator from the European Commission. http://epp.eurostat.ec.europa.eu/

[6] See [11] Source: Own representation.

A moderate growth in production from 1.23% in 2006 to 2.37% of world total in semiconductors and 3.08% in 2006 to 3.55% in 2009 in electronic systems.

Table 2

Summary of Key Selected Structural Indicators of the European Commission [7]

geo	HICP - 2008 in %	GDP per capita in PPS	Labour productivity 2008	LCG - 2008	EPO patent 2006	Spend HR-2006	Youth education 2008	STG 2007	CPL 2008	TWLC 2007
European Union (27 countries)	3.7	100.0	100.0	0.4	114.91	5.05	78.5	13.4	100	40.5
Belgium	4.5	114.6	124.8	2.2	137.92	6.00	82.2	14.0	110.7	49.6
Bulgaria	12.0	40.1	36.4	4.3	3.48	4.24	83.7	8.4	51	32.3
Czech Republic	6.3	80.4	72.4	2.7	10.8	4.61	91.6	12.0	72.4	40.5
Denmark	3.6	118.3	101.1	3.0	207.81	7.98	71.0	16.4	141	39.3
Germany	2.8	116.0	107.5	0.7	290.92	4.41	74.1	11.4	103.9	47.4
Estonia	10.6	68.1	64.6	7.2	7.12	4.80	82.2	13.3	76.7	38.7
Ireland	3.1	139.3	134.2	7.4	65.33	4.86	87.4	18.7	126.9	15.0
Greece	4.2	95.3	103.4	2.8	10.94	:	82.1	8.5	94.1	36.7
Spain	4.1	103.9	104.9	0.4	33.43	4.28	60.0	11.2	95.7	35.6
France	3.2	107.3	121.1	0.3	134.69	5.58	83.7	20.5	111.1	44.4
Italy	3.5	100.4	108.3	1.3	85.21	4.73	76.5	8.2	105.3	42.0
Cyprus	4.4	94.6	86.2	-1.8	25.04	7.02	85.1	4.2	89.6	11.9
Latvia	15.3	55.6	51.2	7.0	9.84	5.07	80.0	9.2	74.7	41.2
Lithuania	11.1	61.2	61.5	0.3	3.24	4.84	89.1	18.1	66.8	41.3
Luxembourg	4.1	252.8	161.0	5.5	231.79	3.41	72.8	:	116.2	31.4
Hungary	6.0	62.9	69.5	1.8	13.7	5.41	83.6	6.4	69.7	45.9
Malta	4.7	75.4	86.5	1.5	33.75	:	54.2	7.1	78.4	18.6
Netherlands	2.2	134.9	115.4	0.2	205.75	5.46	76.2	8.9	103.4	40.2

[7] See Spending on research and development as a % of GDP by country. Source: Eurostat, European Commission, Key figures on Europe 2009 edition. ISSN 1830-7892.

geo	HICP - 2008 in %	GDP per capita in PPS	Labour productivity 2008	LCG - 2008	EPO patent 2006	Spend HR-2006	Youth education 2008	STG 2007	CPL 2008	TWLC 2007
Austria	3.2	123.1	113.4	0.9	185.73	5.44	84.5	11.0	104.6	44.1
Poland	4.2	57.5	62.8	3.1	3.41	5.25	91.3	13.9	68.6	41.6
Portugal	2.7	75.4	70.7	1.6	13.15	5.25	54.3	18.1	86.7	32.6
Romania	7.9	45.8	47.6	0.2	1.59	:	78.3	11.9	62.1	41.8
Slovenia	5.5	90.6	84.2	2.3	57.6	5.72	90.2	9.8	83	40.9
Slovakia	3.9	71.8	78.9	2.3	6.09	3.79	92.3	11.9	69.5	35.6
Finland	3.9	115.0	109.6	4.1	247.34	6.14	86.2	18.8	124.6	38.2
Sweden	3.3	121.4	111.6	-0.5	269.55	6.85	87.9	13.6	114.4	43.3
United Kingdom	3.6	116.9	110.8	-0.3	85.94	5.48	78.2	17.5	99.4	30.8
Croatia	:	63.0	76.6	1.4	7.1	4.11	95.4	6.8	74.7	:
Former Yugoslav Republic of Macedonia	:	32.5	58.0	1.0	:	:	:	4.6	46.7	:
Turkey	10.4	45.5	64.0	:	2.72	2.86	47.8	6.7	72.8	41.7
Iceland	12.8	118.7	99.3	:	93.27	7.55	53.6	10.2	117.3	23.6
Liechten-stein				-2.5	705.63	2.06		10.5		
Norway	3.4	190.0	157.4	-2.5	111.38	6.55	70.0	9.3	139.1	34.2
Switzerland	2.3	141.4	112.3	:	430.65	5.50	:	17.9	130.4	26.8
United States	3.8	154.3	144.7	:	:	5.51	:	10.1	80.3	27.8
Japan	1.4	110.9	100.0	:	:	3.47	:	14.4	101.2	:

Findings

Summary on structural indicator

HICP = Harmonised Indices of Consumer Prices

GDP = Gross Domestic Profit in PPS

LCG = Labour Cost Growth

EPO = European Patent Office
STG = Science Technology Graduates
CPL = Comparative Price Level
TWL = Tax Wedge Labour Cost

Source: Own representation. The Colour scheme indicates: lighter – better than the EU27 average; darker – worse than the EU27 average.

The advantages of *Bulgaria* are low comparative price level as well as in low tax wedges whereas its challenges lie in productivity, inflation and relative high labour cost growth.

Besides a low number of patent filing and a relative high inflation rate, the *Czech Republic* does have fairly high productivity, good educational data, at attractive comparative price levels.

The Baltic countries Estonia, Lithuania and Latvia are challenged with high inflation, low productivity, high labour cost growth. The data indicates good position in terms of education.

Hungary has a relatively high inflation and an interesting low productivity, given the fact that there are lots of semiconductors and electronic manufacturing in Hungary.

Poland and Romania are also challenged with relative high inflation and low productivity. Offers overall cost advantages due to lower than average comparative price level.

Slovenia has fairly high productivity and the highest activity in patent filing. At the same time, the inflation is relatively low. Spending on education also seems quite good.

Slovakia has a relative high productivity at relative low inflation with good data on the education system. The challenges are in the low number of patent filing and relatively high labour cost growth. The overall advantage on comparable price level is still very good.

The comparison on key selected economic parameters of EU27 countries as well as to Japan, and the United States of America shows areas of improvements needed across all selected Eastern European countries in the area of *Labour Productivity* and the need to manage *Labour Cost growth*. Another key area is innovation where basically all selected Eastern European countries are clearly behind the EU27 average as well as in comparison to Japan and the United States of America. Youth Education and Science and technology graduates are more or less in line with the EU27 average, which is a very promising fact. The advantage can be seen in the comparative price level. However, this is a parameter which is in danger due to low labour productivity and above average growth in labour cost growth. The fundamental challenge that can be seen is the fact that innovation is significantly behind the average. Innovation is needed for an industrial up scaling; otherwise the economic growth is in danger as it is currently primarily being based on lower cost in terms of manufacturing, which will disappear over time.

The analysis of selected emerging Eastern European countries in comparison to chosen countries worldwide indicate that key prerequisite for a stronger positioning in this industry is the improvement of innovation and business sophistication. Improvements are also needed in efficiency enhancements, mainly higher education, training and life-long learning, which has a direct effect on innovation. Improvements are also needed in financial market sophistication, access to financing, labour market efficiency, and goods market efficiency. Basic requirements need improvements in the institutions, in some cases such as Poland and Romania in the infrastructure and macroeconomic stability. Alarming is the fact that the perceived level of corruption is still relatively high, namely in Russia.

The meaning of innovation for national economies and the wealth of its population is also of high importance. Looking at the structural country indicators of the Lisbon goal, a clear correlation between R&D investment and intellectual properties generated can be found in the statistical data from the European Commission, the World Economic Forum. Table 3 gives an overview on the current share of the R&D spending in % of the GDP by country of the European Union in comparison to the USA and Japan.

Sweden and Finland are already above the EU Lisbon criteria of 3% of the GDP spending in R&D by 2010.

Table 3

Spending on Research and Development as a % of GDP by Country [8]

	Share of GDP in %	Business Enterprise	Government	Abroad
EU-27	1.84	54.6	34.2	8.9
Euro area	1.86	56.7	35.0	6.8
Belgium	1.83	59.7	24.7	12.4
Bulgaria	0.48	27.8	63.9	7.6
Czech Republic	1.54	56.9	39.0	3.1
Denmark	2.43	59.5	27.6	10.1
Germany	2.53	67.6	28.4	3.7
Estonia	1.14	38.1	44.6	16.3
Ireland	1.35	59.3	30.1	8.9
Greece	0.57	31.1	46.8	19.0
Spain	1.20	47.1	42.5	5.9
France	2.09	52.2	38.4	7.5
Italy	1.09	39.7	50.7	8.0
Cyprus	0.42	16.8	67.0	10.9

[8] See Bundesminiterium für Bildung und Forschung. Forschung und Innovation in Deutschland 2007.

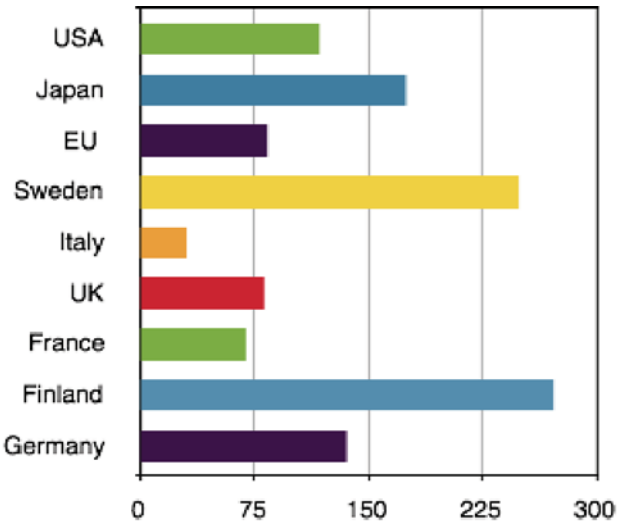
	Share of GDP in %	Business Enterprise	Government	Abroad
Latvia	0.70	32.7	58.2	7.5
Lithuania	0.80	26.2	53.6	14.3
Luxembourg	1.47	79.7	16.6	3.6
Hungary	1.00	43.3	44.8	11.3
Malta	0.54	52.1	34.4	13.5
Netherlands	1.67	51.1	36.2	11.3
Austria	2.55	45.9	36.8	15.2
Poland	0.56	33.1	57.5	7.0
Portugal	0.83	36.3	55.2	4.7
Romania	0.45	30.4	64.1	4.1
Slovenia	1.59	59.3	34.4	5.8
Slovakia	0.46	35.0	55.6	9.1
Finland	3.37	66.6	25.1	7.1
Sweden	3.73	65.7	23.5	7.7
United Kingdom	1.78	45.2	31.9	17.0
Croatia	0.87	34.6	55.8	6.8
Turkey	0.58	46.0	48.6	0.5
Iceland	2.77	48.0	40.5	11.2
Norway	1.52	46.4	44.0	8.0
Switzerland	2.90	69.7	22.7	5.2
Japan	3.32	76.1	16.8	0.3
United States of America	2.61	64.9	29.3	:

Source: Own representation.

There is an interesting correlation between R&D spending and filed patents of relevance for the world market according to Figure 2. Sweden and Finland do have the highest number of patents filed in 2004. Swedish and Finish companies are strong in the information and telecommunication high technology market with world market leading companies such as Ericsson, Sony Ericsson, and Nokia. But also the split in spending between business enterprises and the government is of interest. Sweden and Finland do have approximately 66 % each spent by business enterprises and only about 25.1 % (Finland) and 23.5 % (Sweden) spent by the government on R&D investment. In addition, there is low investment from approximately 7 % from abroad. Japan shows the highest rate of R&D spending by business enterprises with 76.1%, and only 16.8 % invest by the government.

Figure 2

Patents of Relevance for the World Trade Market by Country in 2004.[9]



Source: Own representation.

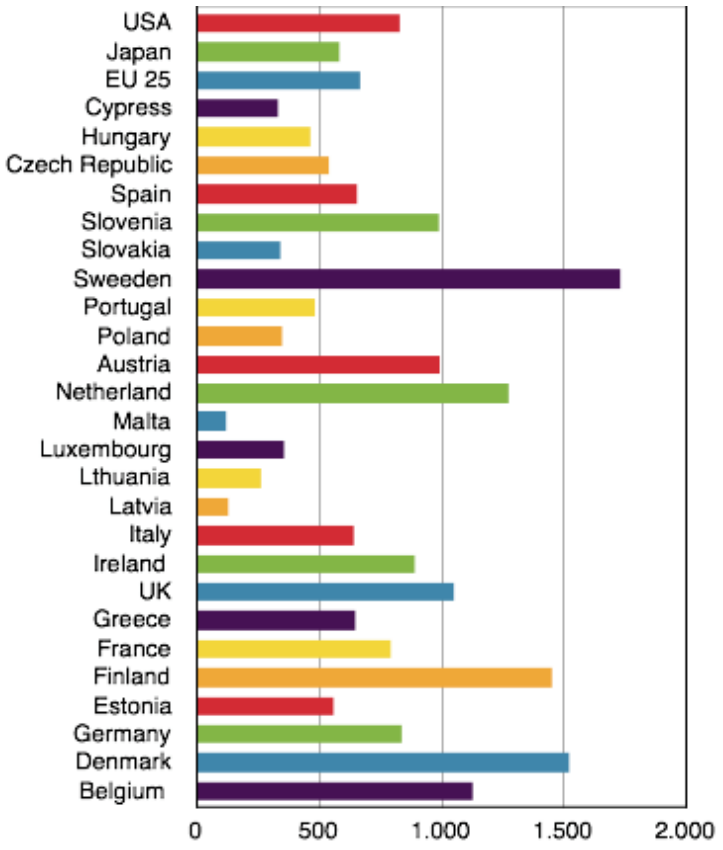
Compared to the USA, Japan, Finland and Sweden, the average spending of the EU27 countries is 54.6% R&D spent by business enterprises and 34.2% by government, which un-derlines the recommendation by the European Commission to encourage spending by enterprises stronger than it is currently done.

National economies such as the USA and Germany show similar indicators and still – at least within the electronics industry and information high technology industry – it seems that the USA is based on leading companies that are more successful in introducing highly innovative products and solutions as the ranking of the top innovative companies done by wired magazine shows.

[9] See Bundesminiterium für Bildung und Forschung. Forschung und Innovation in Deutschland 2007.

Figure 3

Scientific Publication by Country per Million Inhabitants in 2005.[10]



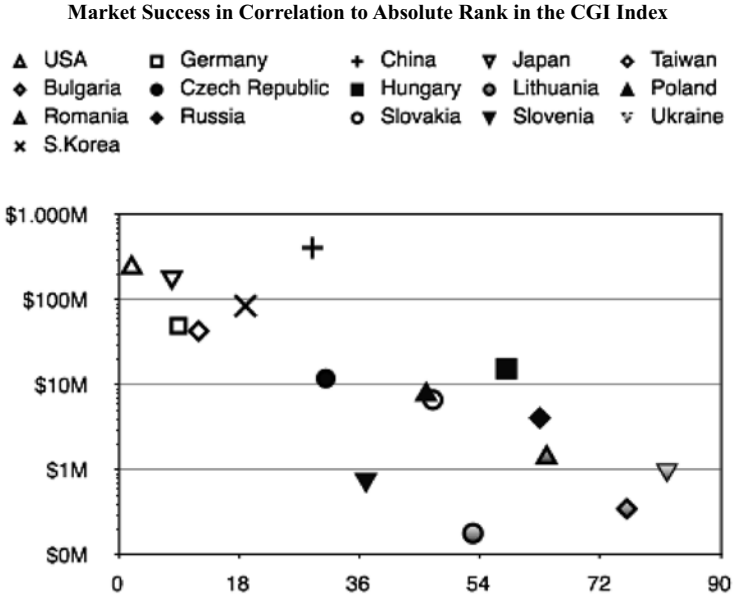
Source: Own representation.

Figure 4 shows a correlation of the revenues in relation to the absolute position of the GCI. Besides China and Japan, the highest revenues are with countries with the highest rank in the CGI. China is – together with Japan – a little the exception. In case of China, there are several factors influencing these results. Low labour and a huge local market in China are driving factors for the success of China in this industry. Another key factor is the need for foreign companies to provide so-called local content. This means that some of the value chain has to be done in China in order to be allowed to sell products in China. Therefore, basically all leading electronics brands do have their manufacturing in China. Similar relations can be found for efficiency, innovation and low corruption.

[10] [11]` see http://www.weforum.org/

Figure 4

Correlation of Revenue in US$ in Mio and GCI Absolute Score, Selected Countries.



Source: Own representation.

Business Enterprises

A change is needed especially in larger organizations to improve the awareness of the importance of innovation and make improvements in communication management. The corporate culture needs to allow and encourage creativity resulting in innovation ideas. Working on innovation shall not be seen as yet another task. Scientific research highlight that the awareness of innovation is missing and criteria for selecting innovation ideas are missing or are insufficient. Failures and mistakes need to be accepted within clear guidelines and limits. Diversity of its employees, a liberal climate and a strong personal identification with the company and its products are attributes, which differentiate successful companies such as Google and Apple from other large companies. Large organizations need to focus more on integrating the young generation without forming them according to their internal – often very strict – rules, procedures and principles which were good in the past may not be good anymore.

System solution ideas, high quality, ease of use, simplicity, customer focus, and user experience are attributes for the product portfolio.

The academic literature offers recommendations on how to improve tactical problems especially related to improvement innovation such, e.g. time and project management, working with ventures, risks and barriers of innovation.

National Economies

Increase in R&D spending, education, life-long learning and a much stronger university and industry researches cooperation is especially of high importance to emerging countries. Current researches are mainly measuring the science education of the school and university system. As innovation and even more – radical innovation – is a highly creative process, a change is needed to stronger foster also talents in arts and philosophy of scientists and vice versa. The educational system shall avoid silo‘s of faculties, stimulate creativeness in order to encourage people to think out of the box, think about a system philosophy rather than a pure product development approach.

Politicians need to provide an infrastructure which allows start ups and foreign investors to start a business in an informal way. The finance system needs to get stronger encouraged to support start up‘s providing venture capital. The Silicon Valley in the United States is probably the best in-class example to learn from. Tax and other benefits can also help to attract start up‘s. Reduce bureaucratic burdens and increase trust in the institutions may sound obvious but is still seen as biggest problems, especially of emerging economies. Whether a common goal of 3% of GDP investment in education is the right target for all European Countries is questionable as the situation between established economies to emerging economies is quite different. New ways of thinking are required; specialization and the focus on niches and future technologies may be a way to differentiate. The alternative energy sector, energy storage and distribution, medical, food production and distribution may be areas offering such opportunities.

Although there are quite some differences in the scoring of the CGI and the data from the European Union, a common theme can be found as weaknesses of the analysed Eastern European countries in comparison to other countries within the same peer groups which are:

- Access to financing
- Inefficiency of the government bureaucracy
- Labour market regulations
- Infrastructure
- Political and institutional stability and trust
- Corruption
- Inflation
- Tax rate and regulation

More country specific weakness can be seen in:

- Market size
- Education
- Goods and market efficiency
- Work ethic

Access to financing is a key prerequisite to the economic development supporting entrepreneurship. Trust and ease of doing business are key prerequisites for investment. High level of corruption is concerning as well as the low level of innovation despite the fact that some countries are seen to offer a good level of education.

A common strength of emerging Eastern European countries versus e.g. China are shorter distances to the Western market, better supply chain and closer cooperation to mother organizations in western Europe. Communication, ease of doing business in similar time zone is another benefit.

The opening of the markets and the investments of the European Union to foster convergence across the new EU27 states according to the Lisbon goals is a tremendous help to start building stronger economies but will not be good enough to establish a leading position in a higher technology industry over time. Examples from the United States, Japan prove that private investment, venture, and free capital market need to be available to stimulate entrepreneurship and allow start-up companies. Higher education, a stronger cooperation between universities and the industries can help. Although the education in sciences and mathematics is the key for a high technology industry, the education system needs to avoid narrow minded education resulting in silo thinking of technologist‘s or philosophic faculties and arts. Innovation, which is a key for a high-technology industry is a highly creative process and requires a much broader basis for future development as selected case studies of Apple and Google show. Diversity of the human resource of a company is another important aspect to foster creativity resulting in innovation.

And last but not least, an open minded, liberal free climate of the population is desired to allow entrepreneurship.

Conclusions

This investigation has attempted to analyse the, Opportunities *and challenges of Eastern European countries to participate in the global semiconductor and electronic market.*

The findings clearly show that the selected investigated Eastern European companies do not play a significant role within the electronics and semiconductor industry based on currently approximately less than 5% of the total global semiconductor and electronic market. The forecast from leading market research companies does not predict a significant gain in market share over the next years to come. Moreover, the current activities are mainly related to manufacturing services and less to design and innovation. Global acting electronic manufacturing companies do invest in Eastern European countries. This effect can be well described by the existing theories of globalisation and transnational corporation. The main reason for FDI is - as with all the engagements of enterprise economies - return of invest resulting in company profit.

On a high level view, this can be well described by the thesis of Dunnig and Zhang, concluding that the engagement in **FDI is a function of resources,**

capabilities, markets and institutions. Although this is quite basic, it can be confirmed to be true.

Based on the findings of this paper the theories on FDI described in this dissertation it can be confirmed to be true, but most likely do not fully explain the success factors for investments in a high-technology industry. It seems clear that in order to determine the opportunities it requires a more complex theory, taking also into account socio-economic factors and institutional trustworthy besides macro- and micro economic data. This is obvious as innovation is the dominant prerequisite to enable own development compared to just EMS capabilities and services, which is considered being in danger anyway due to raising labour cost wages and/ or overall low efficiencies.

Socio-economic factors are heavily influenced by a free and liberal climate, ease of doing business, easy access to venture capital and a rewarding system for entrepreneurial talents, which could be based on tax and stock market benefits.

Innovation does not come for free. Education is absolutely critical. The challenge is to not only to ‚produce' engineers and ‚technicians' but more importantly foster cross faculty cooperation among engineering, economists, art sciences and social behaviours.

Fostering diversity and attracting students globally could help to fill the gaps in some of these areas.

Private and corporate engagement to enable local venture capital is another key aspect that needs improvement.

Last but not least, high anti-corruption standards are a must as they do play a very significant role to help develop an open minded society and competitiveness which – in return – is a key prerequisite to foster innovation, technological up scaling and competitiveness resulting ultimately in profit.

In order to maintain a competitive position in manufacturing, efficiency enhancements are needed, higher education, training and lifelong learning are essential. Basic requirements need improvements in the institutions and the infrastructure in the majority of the countries; measures need to be taken to secure micro- and macroeconomic stability and to keep inflation under tight control.

At the current stage, the analysis indicates that none of the countries may be in a position to be seriously considered for investments in the semiconductor industry in terms of design or expanding manufacturing.

The corporate cultures need to allow and encourage creativity resulting in innovation ideas. The data indicate that the awareness for innovation is missing.

Trust in institutions, rigorous standards for fighting against corruption, trust in the political system, measures to improve micro- and macroeconomic standards, and to take measures to keep inflation under control are the main critical tasks for national economies. This can be achieved only to a certain level by the programs of the European Union. Examples from the United States of America and Japan show that private engagement is much stronger needed to establish an environment that allows entrepreneurship and competitiveness.

Conclusion for the Academic Doctrine

The successes of companies based in the selected Eastern European countries trying to participate in the semiconductor and electronic market is fairly complex. There is not a 'one single formula' to calculate the possibility for the success of investments.

Based on the findings of this work, it is suggested to add another element to the theories of globalisation and FDI and TNC taking much stronger into consideration the socio-economic factors:

Success = f (R;C;M;I;Sef)

Whereas
R = resources
C = capabilities
M = markets
I = institutions
Sef = socio economic factors

Whereas
Sef = f (C;D;E;F)

Whereas
C = high anti corruption standards
D = diversity
E = education, cross faculty, internationality
F = financing, ease of doing business, rewarding system

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