The Impacts of European Integration on Efficiency of European Railways

Tae Hun PARK

Abstract— this paper covers main ideas such as the impact on the railways after the introduction of EU directive 91/440/EC, the efficiency improvement of the railways after being members of EU and etc. This paper uses the DEA method to evaluate and compare the efficiency of 7 railways' transport service in European Union. The reason for analyzing 7 railways is that France and Germany are the founding countries since the beginning of the EU and Sweden had a membership of the EU in 1995 on behalf of Western Europe and that Hungary, the Czech Republic, Poland and Slovakia joined the European Union in 2004 on behalf of Central & Eastern Europe. Using data over the period 1997~2009, the results indicate that it cannot be found that the efficiency of EU railways has been improved after EU introduced EU directive 91/440/EC and the railway in Central & Eastern Europe joined the EU. The railway system is mostly considered in terms of not as pure economic aspects, but as political objectives to be managed like the PSO (public service obligations) in strong domestic resistance. And in reality, it seems that the Directive of railway undertaking is not compulsory and only provides for wide-ranging discretion regarding the implementation process at national level.

Index Terms— DEA (Data Envelopment Analysis), Efficiency evaluation, EU directive 91/440/EC, European integration, European policy, European railway, Railway Reform

1 Introduction

In the 19th century, the railway system in Europe was developed as separately and privately owned companies. During the 20th century, railways were organized and run through a country wide organization or nationalization. The organization of railway was vertically integrated as national companies and difficult for private companies to run their trains on the national network.

McCann argues that a kind of network industries such as railways, telecommunications, and energy were heavily protected by national governments and often used as instruments rather than objects of public policy [1]. And, railways are considered to form natural monopolies because the technical requirements for their operation, such as networks of rails, were too costly for potential competitors to duplicate. In consequence, it seems that it was necessary to create a single operator, often publicly owned.

However, back in the 1980s, the combination of technological and political change has transformed this situation [2]. There have been structural changes to occur in the railway industry as response to some points in the political history of the world. Due to high competition with other types of transportation modes, railway industry has been pressured on improvement of efficiency.

The first EU directive for railways is 91/440/EC which requires allowing open access operations on railway lines by companies other than those that own the rail infrastructure. The objective of 91/440/EC directive is to create a more efficient rail network by making greater competition.
However, it does not call for privatization, but does require the separation between infrastructure management and operations. The directive has led to reforms of many national railway systems in EU countries.

Now, this paper will try to answer the following questions: Has the efficiency of EU railways been improved after EU introduced EU directive 91/440/EC? Is there any difference of efficiency improvement between the existed railways of Western Europe and the new coming railways of Central & Eastern Europe in terms of application to EU railway reform? What is the result of whether EU policy of railway reform is successful or not at present and what are main reasons behind the current result?

2 Methodology

This study will measure efficiency by using DEA (Data Envelopment Analysis) which is known as efficiency measuring method and attempts to measure the efficiency while providing the type of efficiency to the production scale for different. DEA has a significant application in evaluating the operation of the public and non-profitable organizations whose price data are not usually available or reliable. DEA uses linear programming which is a non-parametric method that estimates the equal production functions. The advantages of DEA are as followings; no need to explicitly specify a mathematical form for the production function, proven to be useful in uncovering relationships that remain hidden for other methodologies, capable of handling multiple inputs and outputs and of being used with any input-output measurement, the sources of inefficiency can be analyzed and quantified for every evaluated unit.

Debreu (1951) [3], Koopmans (1951) [4] and Farrell (1957) [5] used efficiency analysis in the economic literature and from then on, there have been so many papers and articles dedicated to measurement of efficiency. Efficiency might be defined as an achievement to obtain the highest output possible by preferring a method which uses the input composition in a most productive way. Assuming a Decision Making Unit

• *Tae Hun PARK is currently pursuing PhD program in international relations in University of Warsaw, Poland, PH-0573093715.E-mail:thpark5624 @gmail.com*

(DMU) generates outputs yi (i = 1, 2, . . ., t) from inputs xk (k = 1, 2, . . ., m), equation can be expressed in the following way by the appropriate weights (vi = 1, 2, . . ., t; wk = 1, 2, . . ., m) to be applied to the variables:

$$\sum_{i=1}^{t} v_i y_i \Big/ \sum_{k=1}^{m} w_k x_k$$

Fractional program utilizes the TFP rate. In a sense, DEA should be considered as a conceptual model and the linear model is a practical method in the efficiency calculations. In DEA, weights are determined pertaining to DMUs for each input and output. DEA takes inputs (xk) and outputs (yi) into equation given above and selects weights to maximize performance of DMU "p" related to performances of other units:

$$Max\left(v_i y_{ic} \frac{\sum_{i=1}^{t} v_i y_{ip}}{\sum_{k=1}^{m} w_k x_{kp}} \right)$$

Here, efficiency value of "z" number of DMUs under one (≤1) constraint is given below:

$$0 \le \sum_{i=1}^{t} v_i y_{ic} \Big/ \sum_{k=1}^{m} w_k x_{kc} \le 1 \left(c = 1, 2, ..., p, ..., z\right)$$

$$v_i, w_k > 0 \left(v_i = 1, 2, ..., t; w_k = 1, 2, ..., m\right)$$

In model, "v" and "w" correspond to weights on inputs and outputs and variables in equation. Solution of model gives us an efficiency value of "p" DMU and a set of necessary weights to reach this value.

3 Empirical findings

3.1 Analysis Data

This paper investigates efficiency of 7 countries' railways operating across Europe as Decision Making Units (DMUs). The evaluation period of 1997-2009 is determined based on the availability of information [6] and management goals of efficiency evaluation.

The reason for investigating a set of data from 7 countries is that France and Germany are the founding countries since the beginning of the EU and Sweden had a membership of the EU in 1995 on behalf of Western Europe and that Hungary, the Czech Republic, Poland and Slovakia joined the European Union in 2004 on behalf of Central & Eastern Europe.

Each country is considered as a single Decision Making Unit which consists of different inputs and output. In fact, each railway uses the inputs to produce its outputs. As a theoretical basis of DEA, the efficiency is the ratio of the total weight outputs to the total inputs. Therefore, the proper determination of inputs and outputs that show the efficiency is of a great importance.

TABLE 1
Overview of Seven Countries in EU

Name	Capital	Member	Population (person)	Area (km²)
France	Paris	Founder	66,352,469	640,679
Germany	Berlin	Founder	81,174,000	357,021
Sweden	Stockholm	1995	9,747,355	449,964
Hungary	Budapest	2004	9,849,000	93,030
Czech Republic	Prague	2004	10,538,275	78,866
Poland	Warsaw	2004	38,005,614	312,685
Slovakia	Bratislava	2004	5,421,349	49,035

Table 1 show a set of data of input and out for efficiency evaluation in this study. An analysis conclusive of 5 inputs and 2 outputs in total is implemented and indicates the necessary improvements when all relevant factors are improved by the same factor.

The abbreviations of countries are as followings; Germany (DE), France (FR), Sweden (SE), Czech Republic (CZ), Hungary (HR), Poland (PL), Slovakia (SK).

The input data include as followings; Total length of Main lines (Line), Number of Locomotives (Loco), Number of Passenger Coaches (P-Car), Number of Freight Wagons (F-CAR), Human Resources (Staffs). The output includes as followings; Passenger Traffic of Railway Operators – PKm in millions (PKm), Freight Traffic of Railway Operators – TKm in millions (TKm).

TABLE 2
Data Sets of Germany

DE	Input					Output	
Year	Line	Loco	P-Car	F-Car	Staffs	PKm	TKm
1997	38,384	8,692	18,435	147,360	233,523	59,628	72,389
1998	38,077	7,978	18,100	136,663	209,602	59,184	73,613
1999	37,476	7,605	20,310	129,159	280,033	72,822	70,948
2000	36,538	7,219	21,007	131,377	181,314	74,015	76,815
2001	35,938	8,295	20,782	125,324	167,891	73,899	74,575
2002	35,755	9,126	21,649	121,488	214,604	69,848	73,971
2003	35,996	9,533	20,918	120,256	249,251	69,596	73,973
2004	34,715	13,293	20,396	180,184	229,711	70,260	84,002
2005	34,211	12,737	20,169	100,851	220,221	72,553	88,015
2006	34,122	8,817	18,174	96,550	228,990	74,788	96,388
2007	33,890	13,890	17,537	95,595	231,356	74,792	98,795
2008	33,855	14,565	18,671	119,916	240,008	77,812	113,633
2009	33,714	15,337	18,607	113,657	239,888	76,772	93,948

Counting units are as followings; Line (kilometer), Loco (unit), P-Car (unit), F-Car (unit), Staffs (person), PKm (million kilometer), Tkm (million kilometer).

Table 2, 3 and 4 show a set of data of input and out for efficiency evaluation in Germany, France and Sweden.

TABLE 3
DATA SETS OF FRANCE

FR		Input				Output	
Year	Line	Loco	P-Car	F-Car	Staffs	PKm	TKm
1997	31,655	5,378	15,696	56,962	175,070	61,573	52,627
1998	31,569	5,335	15,789	51,344	175,326	64,186	52,662
1999	31,423	5,190	15,725	48,330	174,447	66,298	52,112
2000	29,177	5,160	15,656	46,359	175,163	69,571	55,352
2001	29,279	5,835	15,609	45,512	177,685	71,209	50,396
2002	29,186	7,313	15,646	41,602	177,963	73,227	50,036
2003	29,103	7,217	15,514	37,522	175,235	71,937	47,400
2004	29,080	7,125	15,580	37,509	171,134	74,014	45,747
2005	29,120	7,331	15,830	35,456	167,278	76,159	41,327
2006	29,289	6,969	15,943	32,769	168,032	79,474	41,550
2007	29,523	7,129	15,808	31,589	165,114	81,664	40,634
2008	29,054	7,021	16,191	31,845	162,029	86,664	35,932
2009	29,506	6,730	16,460	29,028	159,058	85,687	26,482

Counting units are as followings; Line (kilometer), Loco (unit), P-Car (unit), F-Car (unit), Staffs (person), PKm (million kilometer), Tkm (million kilometer).

TABLE 4
DATA SETS OF SWEDEN

SE		Input				Output	
Year	Line	Loco	P-Car	F-Car	Staffs	PKm	TKm
1997	10,228	643	1,619	11,917	19,435	6,286	14,176
1998	10,065	653	1,571	11,502	18,785	6,997	14,786
1999	9,978	639	1,512	11,168	17,824	7,434	17,924
2000	9,946	88	1,000	10,255	10,146	6,006	18,952
2001	9,865	390	673	10,207	10,091	5,575	-
2002	9,875	869	912	9,900	12,936	-	12,002
2003	9,882	773	1,251	8,500	13,249	6,621	12,829
2004	9,895	622	771	7,594	12,248	5,100	13,120
2005	9,867	622	791	7,594	12,925	5,200	13,120
2006	9,957	644	832	7,000	12,939	6,160	13,120
2007	9,821	648	792	7,000	13,290	6,467	-
2008	9,830	639	879	-	14,317	7,156	-
2009	9,946	632	879	-	13,300	7,038	-

Counting units are as followings; Line (kilometer), Loco (unit), P-Car (unit), F-Car (unit), Staffs (person), PKm (million kilometer), Tkm (million kilometer).

Table 5, 6, 7 and 8 are about a set of data of input and out for efficiency evaluation in Czech Republic, Hungary, Poland and Slovakia respectively.

TABLE 5
DATA SETS OF CZECH REPUBLIC

CZ		Input				Output	
Year	Line	Loco	P-Car	F-Car	Staffs	PKm	TKm
1997	9,336	3,616	5,871	59,694	96,949	7,710	20,732
1998	9,336	3,556	5,748	58,373	91,469	7,001	18,288
1999	9,342	3,507	5,567	53,728	89,220	6,929	16,456
2000	9,342	3,486	5,244	47,768	86,079	7,266	18,983
2001	9,421	3,456	5,215	39,699	84,069	7,262	18,302
2002	9,477	3,275	5,105	36,389	81,771	6,562	17,042
2003	9,478	3,276	5,077	35,615	78,575	6,483	17,069
2004	9,489	3,254	4,977	35,023	73,825	6,553	14,648
2005	9,460	3,159	4,887	34,610	65,830	6,631	14,383
2006	9,473	3,033	4,759	33,354	59,445	6,887	14,731
2007	9,460	2,917	4,558	32,809	57,328	6,855	15,287
2008	9,464	2,754	4,553	31,656	59,137	6,759	14,363
2009	9,445	2,742	4,545	29,194	48,876	6,462	11,253

Counting units are as followings; Line (kilometer), Loco (unit), P-Car (unit), F-Car (unit), Staffs (person), PKm (million kilometer), Tkm (million kilometer).

TABLE 6
DATA SETS OF HUNGARY

HU		Input				Output	
Year	Line	Loco	P-Car	F-Car	Staffs	PKm	TKm
1997	7,393	1,156	2,969	24,581	59,229	6,154	7,368
1998	7,556	1,409	2,985	23,857	57,252	6,794	7,393
1999	7,513	1,370	3,136	21,969	58,048	6,835	7,107
2000	7,530	1,324	3,156	20,653	57,033	9,732	7,721
2001	7,267	1,389	3,061	19,630	56,251	7,387	7,641
2002	7,474	1,310	3,294	18,670	55,145	7,548	7,703
2003	7,475	1,376	2,934	18,404	49,969	7,469	7,990
2004	7,475	1,292	3,314	15,974	52,199	7,380	8,904
2005	7,475	1,365	2,711	15,965	46,347	7,133	9,172
2006	7,420	1,363	2,722	13,175	42,909	6,923	10,093
2007	7,402	1,378	3,296	11,719	45,579	6,726	9,679
2008	7,352	490	3,188	11,776	32,433	5,892	9,178
2009	7,352	1,439	3,071	11,775	28,708	5,712	8,979

Counting units are as followings; Line (kilometer), Loco (unit), P-Car (unit), F-Car (unit), Staffs (person), PKm (million kilometer), Tkm (million kilometer).

TABLE 7
DATA SETS OF POLAND

PL		Input				Output	
Year	Line	Loco	P-Car	F-Car	Staffs	PKm	TKm
1997	21,643	5,514	10,808	104,615	226,369	19,928	67,660
1998	21,491	4,247	10,086	98,739	217,797	20,553	60,937
1999	21,347	3,843	9,877	93,925	203,987	21,518	55,065
2000	21,032	3,762	9,565	92,566	182,784	19,706	54,008
2001	19,505	4,936	9,334	95,186	158,763	18,208	47,651
2002	19,618	4,916	8,965	95,379	143,292	17,310	46,560
2003	19,327	4,885	8,818	79,679	138,230	19,643	47,394
2004	19,036	4,799	8,658	76,785	134,364	18,626	47,847
2005	18,965	4,549	7,725	75,164	127,745	16,742	43,791
2006	18,887	4,459	7,416	74,146	125,894	16,971	42,651
2007	18,877	4,481	7,255	73,993	123,472	17,081	43,548
2008	19,085	4,513	7,224	74,408	121,663	17,958	39,200
2009	19,219	4,482	6,945	72,725	113,107	16,454	29,941

Counting units are as followings; Line (kilometer), Loco (unit), P-Car (unit), F-Car (unit), Staffs (person), PKm (million kilometer), Tkm (million kilometer).

TABLE 8
DATA SETS OF SLOVAKIA

SK		Input				Output	
Year	Line	Loco	P-Car	F-Car	Staffs	PKm	TKm
1997	3,507	1,511	2,499	29,723	49,426	3,095	12,367
1998	3,511	1,474	2,490	28,022	49,435	3,116	11,756
1999	3,512	1,483	2,451	25,241	48,913	2,968	9,859
2000	3,512	1,417	2,247	22,175	46,713	2,870	11,234
2001	3,512	1,096	1,915	19,537	44,508	2,805	10,929
2002	3,507	1,340	2,189	18,604	43,608	2,682	10,679
2003	3,507	1,331	1,939	17,470	41,562	2,316	10,117
2004	3,510	1,238	1,768	16,328	39,082	2,227	9,675
2005	3,477	437	1,782	16,370	36,546	2,166	-
2006	3,477	1,146	1,671	17,920	32,135	2,194	9,703
2007	3,480	1,163	1,713	18,115	33,889	2,148	9,331
2008	3,473	1,127	1,649	17,536	33,250	2,279	8,912
2009	3,474	1,065	1,586	17,241	32,330	2,247	6,485

Counting units are as followings; Line (kilometer), Loco (unit), P-Car (unit), F-Car (unit), Staffs (person), PKm (million kilometer), Tkm (million kilometer).

3.2 Result of DEA Analysis

Table 9 gives the result of efficiency evaluation in 7 countries of European Union. Germany shows that the efficiency in the period of 1997-2001 continuously increased and then decreased at 2002. After 2004, the efficiency increased. France had a little bit been in a stable situation and steadily increased from 2005. Sweden considerably improved the efficiency from 1997 to 2001, dropped sharply at 2002 and steadily improved the efficiency from then on.

In case of Central & Eastern Europe, Czech Rep. shows that the efficiency fluctuated from 1997 to 2003. After 2004, it had an experience with increasing the efficiency. Hungary remained below 90% except for 2000 and showed the steady increase from 2004 at the efficiency over 100%. Poland showed that it had remained stable efficiency over 100% in the period of 1997-2000. After 2005, Poland experienced the fall of efficiency and recovered the efficiency from 2007. Slovakia had been in a very stable situation of efficiency during the research period.

Throughout the period, it can be seen that the railways of Germany, France and Sweden had same trends of efficiency evaluation. On the other hand, Czech, Hungary, Poland and Slovakia railways did not show particularly similar pattern of efficiency evaluation among them. After they joined the EU in 2004, it seems that there has not been the efficiency improvement.

Although the European railways faced serious financial crisis, neither the efforts of the individual members states nor European reform proposals helped improve the situation significantly [7].

TABLE 9
EFFICIENCY EVALUATION OF 7 COUNTRIES IN EU

Year	DE	FR	SE	CZ	HU	PL	SK
1997	79.71	95.13	82.54	109.28	92.11	110.25	105.32
1998	84.75	95.05	93.31	92.34	81.46	104.73	102.21
1999	98.18	95.07	111.80	92.35	80.45	107.44	98.46
2000	113.78	112.83	121.85	102.79	130.15	104.79	99.52
2001	107.83	98.43	129.16	105.39	89.64	93.74	123.79
2002	90.95	99.77	95.93	99.24	90.37	93.01	101.42
2003	88.05	102.12	99.07	102.38	89.85	103.75	99.43
2004	90.07	98.28	95.59	93.52	99.31	104.29	101.12
2005	97.28	96.02	94.78	95.18	98.76	97.37	102.25
2006	127.47	99.48	106.95	99.88	116.51	98.03	109.66
2007	104.30	103.89	100.30	107.95	109.23	104.27	94.56
2008	115.14	105.58	102.88	104.37	100.81	105.43	101.48
2009	100.02	108.47	105.87	110.57	110.53	98.56	102.25

The unit is percent (%).

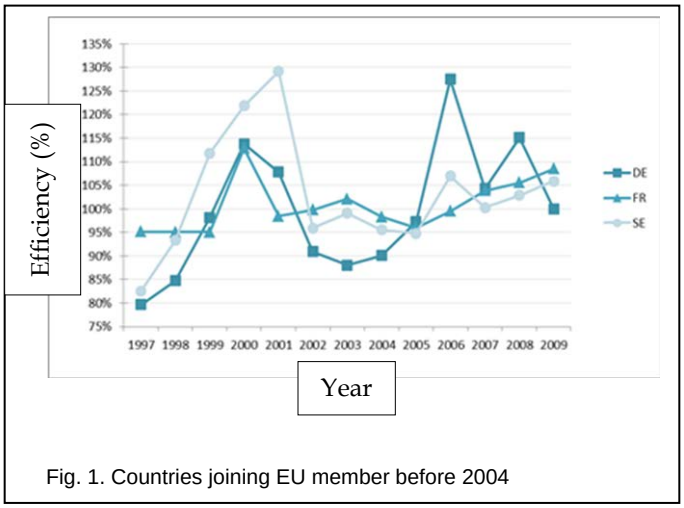

Fig. 1. Countries joining EU member before 2004

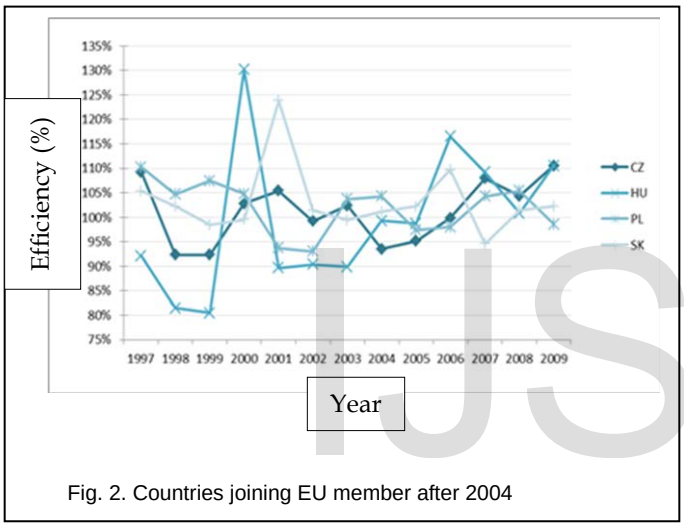

Fig. 2. Countries joining EU member after 2004

4 Conclusion

There cannot be found that the efficiency of EU railways have been improved after EU introduced EU directive 91/440/EC. The railway system is mostly considered in terms of not as pure economic aspects, but as the PSO (public service obligations) that had to be managed for political purposes. Therefore, there was much resistance to any attempt to change the domestic railway policy.

The railways in Western Europe have been quite similar pattern of efficiency among three countries. The commitment of some West European states to protecting and enhancing market competition in the post-war period was partial, at best. Administrative or licensing requirements were frequently exploited to favor domestic over foreign firm [8].

However, the 4 countries railways have been quite different efficiency through the period. European railway policy under EU can be said that EU do neither propose a concrete institutional model and that do not put emphasis on the influence to relative distribution of power and resources between actors at the domestic level, but are geared to change the political climate at the domestic level in order to increase support for domestic railway reforms that may facilitate future steps towards integration [9].

In reality, it seems that 91/440/EC Directive is not compulsory and only provides for wide-ranging discretion regarding the implementation process at national level. The regulation requires only a change in national accounting on access of third countries is limited to joint international companies in the transport of goods rather than be granted to individual companies.

Intergovernmentalism represents a way for limiting the conferral of powers upon supranational institutions, halting the emergence of common policies. in the current institutional system of the EU, the European Council and the Council play the role of the institutions which have the last word about decisions and policies of the EU, institutionalizing a de facto intergovernmental control over the EU as a whole, with the possibility to give more power to a small group of states [10].

However, every country has applied to different extents and with different steps after the introduction of the mandates. In 2004, something like the United Kingdom had gone far beyond the original proposal of the privatization of the railway system in Britain. Some countries like France and Finland had created full of the separate companies from the railways and infrastructure of state companies, while others like Germany have created separate subsidiaries of subsidiaries and infrastructure services different providers [11].

Since the end of the 1980s, EU Commission has changed its policy emphasis of reforms of organization and regulation including the autonomy of management of the railways by the restriction of state interference, contracts of the regulation of the financial relationship between the state administration and the railways, the separation of network operation and infrastructure and the rules governing the operation and market access [12].

European policies can provide the additional legitimacy to the national leaders to justify the application and content of national reform policies. In case of the reform of the British Rail, especially domestically driven reform went far beyond the European requirements and represents the most radical reorganization and far-reaching in Europe.

Considering the high level of political uncertainty and economic one associated with the experimental environment of the reform of the railways, the European legislation seems to be the most important legitimacy for each government to implement its programme of radical railway reform.

References

[1] McCann, Dermot (2010). The Political Economy of the European Union. Cambridge: Polity Press.

[2] Thatcher, M. (2004). Varieties of Capitalism in an Internationalized World: Domestic Institutional Change in European Telecommunications 1979-2000', Comparative Political Studies, 37/7: 751-80.

[3] Debreu, G. (1951). The coefficient of resource utilization. Econometrica 19(3): 273–292

[4] Koopmans, TC (1951). An analysis of production as an efficient combination of activities. New Jersey: Wiley

[5] Farrell, MJ (1957). The measurement of productive efficiency. J R Stat Soc 120(3): 253–281

[6] UIC (2011) Railway time-series data 1997–2009. http://extranet.uic.org /index.php?tg=addon%2F42%2Flogin&msg=You+must+be+logged+in+to+ access +this+page.&err=. Accessed 01 April 2016

[7] Knill, C and Lehmkuhl, D (1999). How Europe Matters. Different Mechanisms of Europeanization. European Integration online Papers (EIoP), Vol. 3, No. 7, June 15, 1999. Available at SSRN: http://ssrn.com/abstract=302746

[8] McCann, Dermot (2010). The Political Economy of the European Union. Cambridge: Polity Press.

[9] Knill, C and Lehmkuhl, D (1999). How Europe Matters. Different Mechanisms of Europeanization. European Integration online Papers (EIoP), Vol. 3, No. 7, June 15, 1999. Available at SSRN: http://ssrn.com/abstract=302746

[10] Matteo Laruffa (2014). "The European Integration and National Interests: from an intergovernmental model to a Constitutional Agreement". Hungarian Academy of Social Sciences

[11] Elburg, Jan-Coen van, Holvad, Torben (2004). Towards a single European railway market? The slow process of implementing European railway standards Authors:, Publication : Association of European Transport, www.etcprocee dings.org

[12] Kerwer, D. and Teutsch, M. (1999b). 'The Dynamics of the EC's Common Transport Policy', in A. Heritier (ed.), Differential Europe.