Evaluating European Railways Deregulation Using Different Approaches

Pedro Cantos

Universitat de València and ERI-CES

José Manuel Pastor

Lorenzo Serrano

Universitat de València and Ivie

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Outline of the presentation

- 1.- Aims
- 2.- Literature
- 3.- Methodology
- 4.- Data
- 5.- Results
- 6.- Conclusions

Motivation, Aims and Contribution

- Recent and generalized deregulation and restructuring in the European railway systems.
- Analyze the effects of these processes on efficiency.
- Using different approaches to measure efficiency:
  - ✓ Are the estimated effects sensitive to the particular technique used?
- Updated data: 23 European national railway systems from 2001 to 2008.

Recent reestructuring and deregulating measures

	VERT	PASS	FREIGHT
Austria	-	-	-
Belgium	-	-	-
Bulgaria	2003		2005
Czech Rep.	2006	-	-
Denmark	1997	2001	2000
Finland	1995	-	-
France	1997		2006
Germany	-	1997	1997
Greece			
Hungary	2007	-	2007
Ireland	-	-	
Italy	-	-	2001
Luxembourg			
Netherlands	1998	1999	1998
Norway	1996	-	-
Poland	-	-	-
Portugal	1997	-	-
Romania	2005	-	2005
Slovak Rep.	2002	-	-
Slovenia	-	-	-
Spain	2005	-	-
Sweden	1989	1989	1996
Switzerland	-	-	2000

VERT: the year indicates the time where full vertical separation was implemented.

PASS: the year indicates the time where a franchising system was introduced in the rail passenger industry.

FREIGHT: the year indicates the time where new freight operators entered in the system.

Source: 'Railway time-series data UIC', Nash and Rivera-Trujillo (2004), Driessen et al. (2006), IBM and Humboldt University of Berlin (2004) and Cantos et al (2010)

Recent reestructuring and deregulating measures

Vertical separation is the most controversial measure (see Drew and Nash, 2011) :

Advantages:

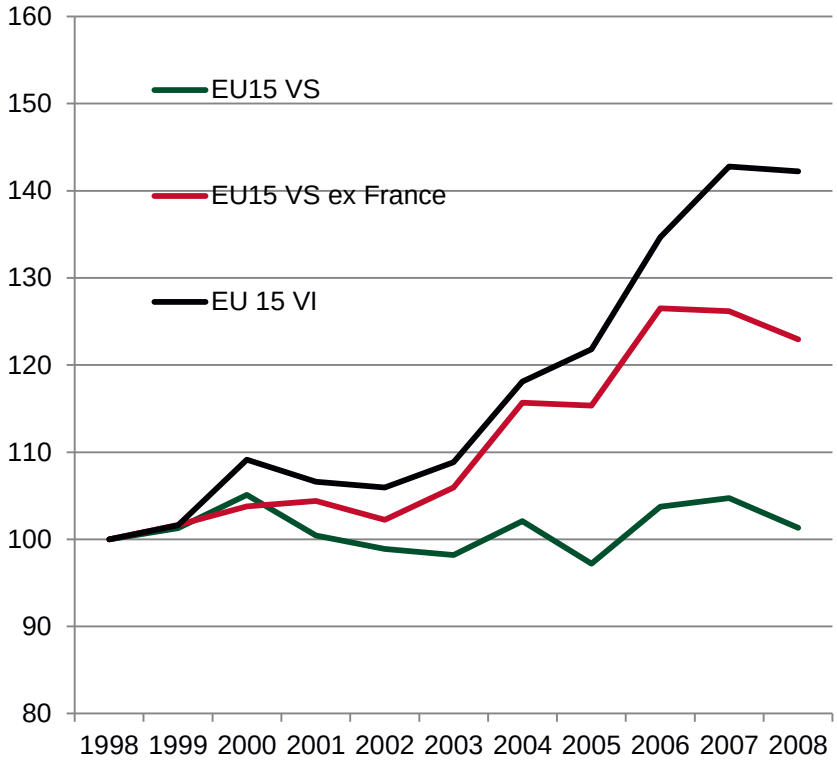
- Eliminate discrimination in gaining access to infrastructure
- Foster competition?

Costs:

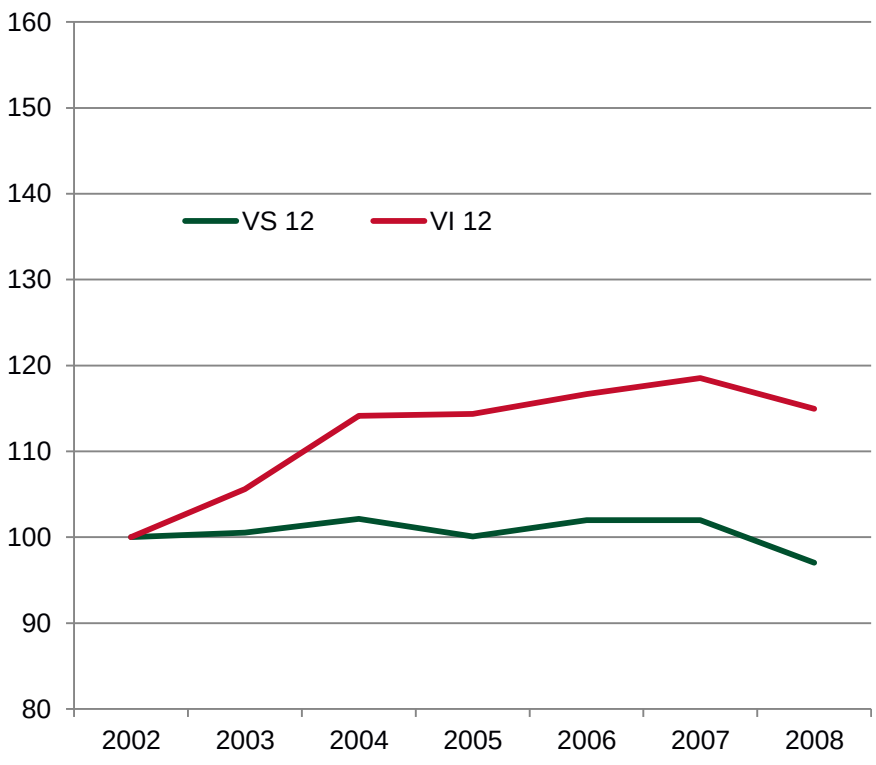
- Increasing transaction costs (for instance, track access contracts may be greater)
- Loss of economies of scope (loss of coordination between infrastructure management and rail operations).
- Leading to poor decisions, for instance on investment, due to asymmetry of information and misalignment of incentives

Recent reestructuring and deregulating measures: does VS improve competition?

Indices of tonne km: EU15 (1998=100)



Indices of tonne km: EU 12 (2002=100)



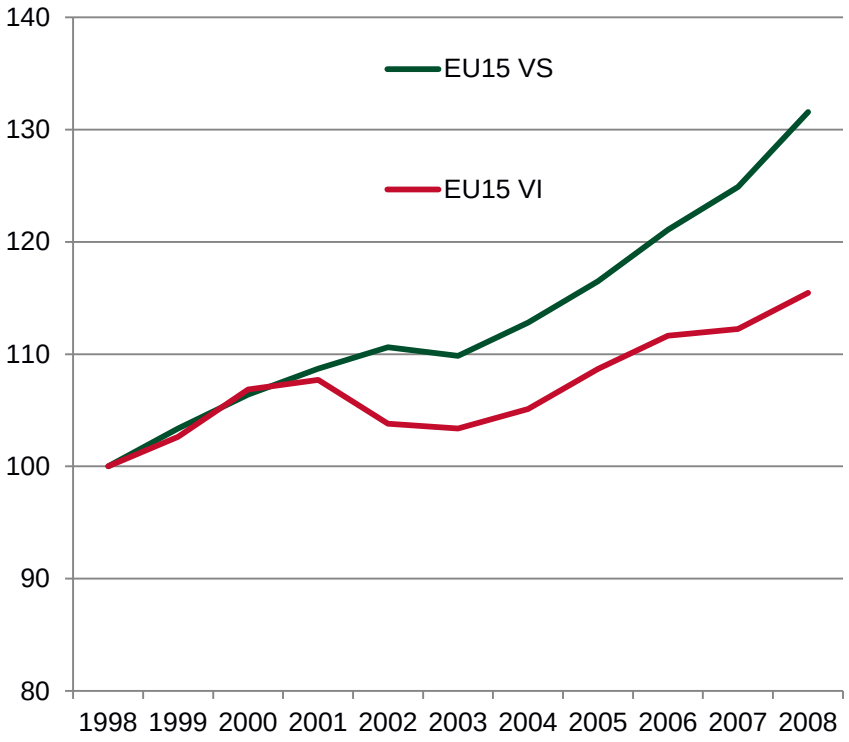
Source: Drew and Nash, 2011

For both EU15 and EU 12, rail freight growth has been faster for vertically integrated railways than for vertically separated ones.

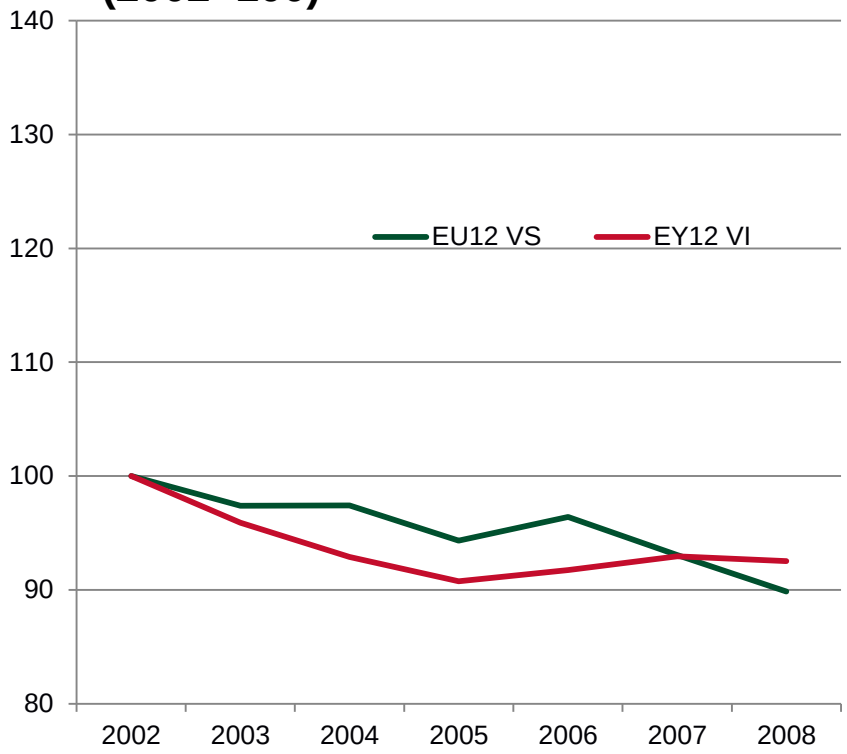
EU15 = EU12+Austria+Finland+Sweden

Recent reestructuring and deregulating measures: does VS improve competition?

Indices of passenger km: EU15 (1998=100)



Indices of passenger km: EU 12 (2002=100)



Source: Drew and Nash, 2011

In contrast, for passengers in EU15, vertically separated railways have grown faster than integrated ones – for EU12, both groups have declined

Previous literature

- Driessen, Lijesen and Mulder (W-P, 2006): unconclusive effects of vertical separation, tendering increases efficiency, period 1990-2001, DEA
- Wetzel (JTEP, 2009): no effect from vertical separation; competition on passenger transport increases efficency; but competition on freight transport doesn't affect efficiency, 1994-2005, Stochastic Frontier Analysis (SFA).
- Friebel, Ivaldi and Vibes (Economica, 2010): efficiency increases when reforms such as third-party network access, introduction of an independent regulator, and vertical separation are implemented (sequential reforms are more effective promoting efficiency). Period 1985-2003, SFA.
- Asmild et al (Transportation, 2010): reform initiatives generally improve technical efficiency, although variable for complete separation is not statistically significant. Period 1995-2001, DEA

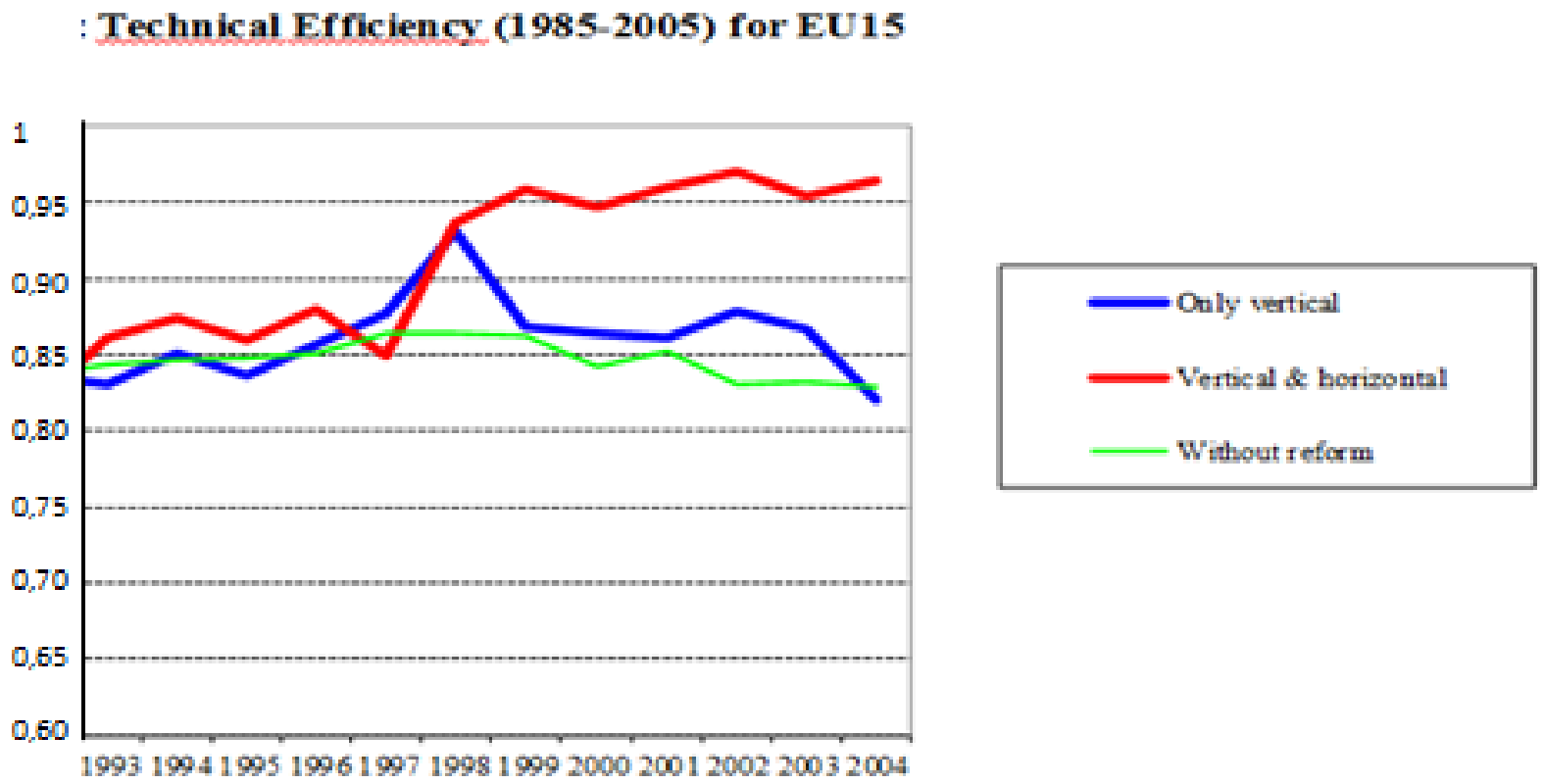
Previous literature

- Cantos, Pastor and Serrano (JTEP, 2010): vertical separation increases effiency very slightly, more if combined with more competition in the freight sector, period 1985-2005, DEA.

At a particular level:

- Lalive and Schmutzler (IJIO, 2008): there are positive effects of regional franchising systems in Germany.
- Mulder et al (2005) for the Dutch case obtain that separating the industry vertically is particularly positive when competition is previously increased in an efficient way in the sector.

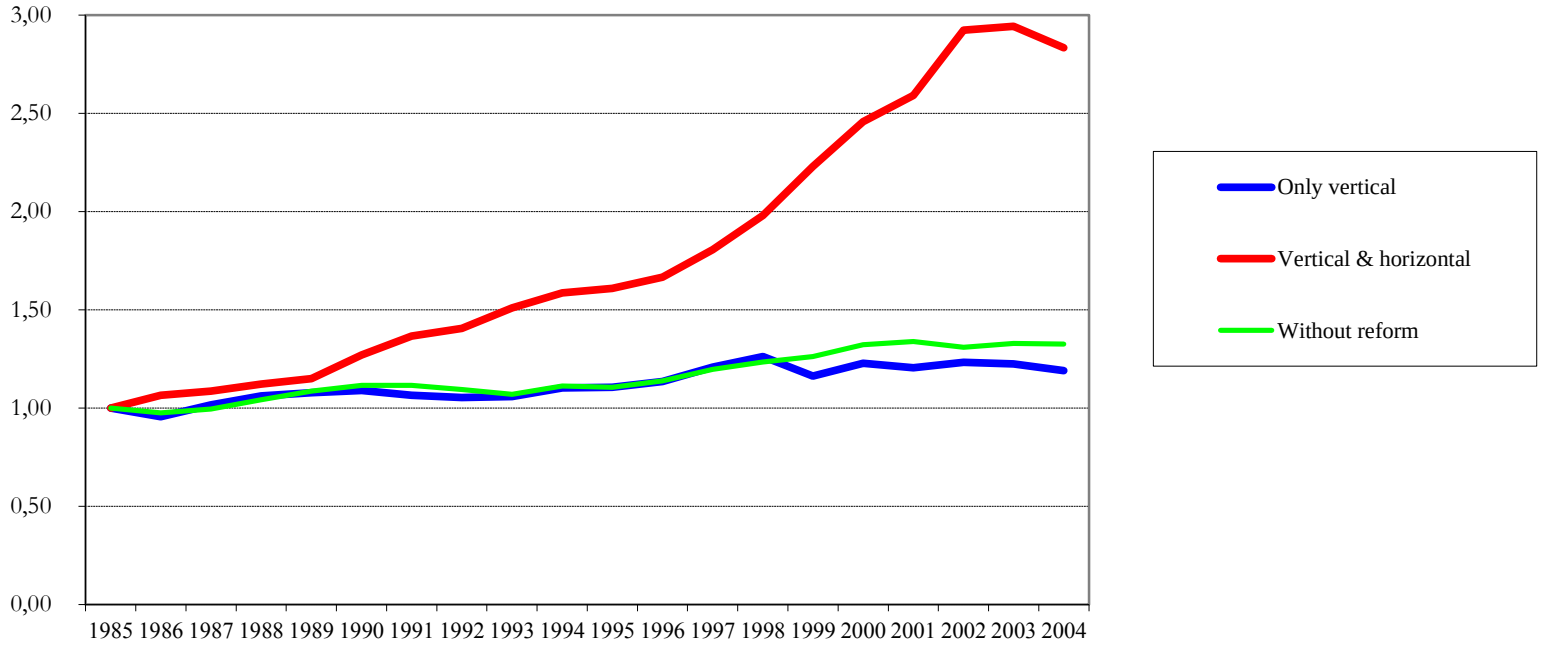
Recent reestructuring and deregulating measures: does VS + HR improve competition?



Source: Cantos et al, 2010

Recent reestructuring and deregulating measures: does VS + HR improve competition?

Figure 2: Productivity change (1985-2005) for EU15



Source: Cantos et al, 2010

Methodology

- Model 1: DEA to estimate efficiency allowing both CRS and VRS. Two-steps.
- Model 2: SFA with 2 steps using a translog function.
- Model 3: BC 1 step (Battese-Coelli one-step approach) to estimate efficiency and its determinants at the same time.

Methodology: DEA (VRS and CRS)

We assume that for each period *t* a set of *N* railway systems (*i* = 1,...,*N*) produces *M* outputs (*m* = 1,…,*M*) using *K* inputs (*k* = 1,…,*K*). The measurement of technical cost efficiency (input-oriented) under variable returns to scale using DEA is obtained by solving the following problem for each period and each railway system *j*:

$$
\begin{aligned}
Min \quad & \theta_j^{VRS} \\
s.t. \quad & \sum_i \lambda_i y_{im} \geq y_{jm} \quad \forall m \\
& \sum_i \lambda_i x_{ik} \leq \theta_j^{VRS} x_{jk} \quad \forall k \\
& \sum_i \lambda_i \, LT_i \leq LT_j \\
& \lambda_i \geq 0; \sum_i \lambda_i = 1; \quad i = 1,..., N
\end{aligned}
$$

If the restriction $\sum_i \lambda_i = 1$ is removed from the linear programming exercise we obtain the technical inefficiency under constant returns to scale (θ^{CRS}).

Methodology: Stochastic Frontier Approach (two steps)

In order to estimate the distance function we adopt an usual translog function form.

$$\ln D_{oi} = \alpha_0 + \sum_{m=1}^{M} \alpha_m \ln y_{mi} + \frac{1}{2} \sum_{n=1}^{M} \sum_{m=1}^{M} \alpha_{mn} \ln y_{mi} \ln y_{ni} +$$

$$+ \sum_{k=1}^{K} \beta_k \ln x_{ki} + \frac{1}{2} \sum_{k=1}^{K} \sum_{l=1}^{K} \beta_{kl} \ln x_{ki} \ln x_{li} + \frac{1}{2} \sum_{k=1}^{K} \sum_{m=1}^{M} \gamma_{km} \ln x_{ki} \ln y_{mi}$$

SFA estimates a "composed error term" ($\varepsilon_{it} = u_{it} + v_{it}$) that includes a standard error term v_{it}, accounting for measurement errors and other random factors, as well as a non-negative random error term u_{it}, representing technical inefficiency.

$$D_{0i} = E[exp(-u_{it})/\varepsilon_{it}]$$

Finally we estimate in a second equation the determinants of the inefficiency indexes.

$$\mu_{it} = \delta_0 + \sum_{j=1}^{J} \delta_j z_{jit}$$

Methodology: Stochastic Frontier Approach (one step)

Battese and Coelli (1995) suggest to estimate the distance function and the determinants of the inefficiency in an only step. This one-step approach can provide more reliable efficiency estimates.

We assume the following structure for the distance function:

$$D_{0i}=E[\exp(-u_{it}/\varepsilon_{it})]=\left\{\exp[-\mu_{it}+\frac{1}{2},\sigma_*^2]\right\}\left\{\Phi[\frac{\mu_{it}}{\sigma_*}-\sigma_*]/\Phi[\mu_{it}/\sigma_*]\right\}$$

where:

$$\mu_{it}=(1-\gamma)+[\delta_0+\sum_{j=1}^{J}\delta_j z_{jit}]-\gamma\varepsilon_{it},\quad \sigma_*^2=\gamma(1-\gamma)/\sigma^2,\quad \gamma=\frac{\sigma_u^2}{\sigma_v^2+\sigma_u^2}$$

We must note that one-step Battese-Coelli inefficiencies can be hardly compared with the obtained with the other techniques. The reason is that these inefficiencies are explained only by the set *z* of explanatory variables. If inefficiency is not sufficiently explained by these explanatory variables, the levels of inefficiency cannot be properly compared.

Data

- Source: Reports by “International Union of Railways (UIC)”
- 23 European railway national systems (adding all the data for each country) from 2001 to 2008.
- 2 outputs:
  - PKT: passengers-km transported
  - TKT: tonnes-km transported
- 3 inputs: number employees, number of rolling stock (coaches, railcars, locomotives and wagons), km of railway infrastructure.

Average values for the variables (2001-2008)

	Pass-km (millions)	Ton-km (millions)	EMP (thousands)	ROLL	LLT (kilom.)
Austria	8,761	18,176	46	22,082	5,786
Belgium	9,041	8,309	39	17,414	3,502
Bulgaria	2,538	5,041	35	15,391	4,215
Czech Rep,	6,749	16,313	69	42,967	9,492
Denmark	5,478	1,941	12	5,783	2,122
Finland	8,017	13,287	21	15,614	5,827
France	72,307	45,918	164	64,555	29,456
Germany	68,707	75,502	201	132,844	34,901
Greece	1,806	581	8	4,326	2,476
Hungary	7,000	8,127	48	20,314	7,951
Ireland	1,745	305	6	2,115	1,919
Italy	47,158	21,589	101	63,333	16,538
Luxembourg	297	461	3	3,476	275
Netherlands	14,176	3,848	26	7,353	2,809
Norway	2,406	2,723	9	3,086	4,111
Poland	17,818	45,115	134	93,835	19,738
Portugal	3,591	2,474	9	4,923	2,840
Romania	7,895	13,656	69	63,501	11,007
Slovak Rep,	2,352	9,809	38	19,897	3,647
Slovenia	778	3,239	8	5,100	1,229
Spain	19,888	11,820	23	19,780	12,853
Sweden	6,042	12,945	12	9,466	10,004
Switzerland	14,716	12,216	29	17,967	3,357
Total	**14,934**	**15,530**	**51**	**30,532**	**9,013**

Results

There are differences between the efficiency levels from each method, quite significant for some countries

	DEA		
	CRS	VRS	SFA (2 steps)
Austria	0,960	0,975	0,468
Belgium	0,709	0,742	0,439
Bulgaria	0,384	0,442	0,183
Czech Rep.	0,532	0,553	0,241
Denmark	0,811	0,953	0,797
Finland	0,986	0,988	0,532
France	0,952	0,996	0,398
Germany	0,834	0,997	0,350
Greece	0,360	0,668	0,280
Hungary	0,456	0,484	0,256
Ireland	0,631	1,000	0,365
Italy	0,845	0,969	0,370
Luxembourg	0,477	1,000	0,426
Netherlands	1,000	1,000	0,785
Norway	0,782	0,920	0,358
Poland	0,724	0,923	0,288
Portugal	0,672	0,889	0,569
Romania	0,435	0,457	0,208
Slovak Rep.	0,559	0,605	0,229
Slovenia	0,845	0,969	0,300
Spain	1,000	1,000	0,606
Sweden	1,000	1,000	0,486
Switzerland	1,000	1,000	0,953

Results

- On efficiency levels:
  - There are differences between the results from each method, quite significant for some countries
- But Spearman's rank correlation show a positive and sizeable correlation between those results

Sperman Correlation Coefficients

	CRS	VRS	SFA (2 steps)
CRS	1		
VRS	0.724	1	
SFA (2 steps)	0.726	0.718	1

Results

- On determinants of efficiency:
- Using the information in the previous table we distinguish 3 types of reforms:
  - VERT: takes 1 for vertical separation
  - FREEOPEN: takes 1 for competition in freight market
  - PASSTEND: takes 1 for competition in passenger services
- Other control variables (length of railtrack, population density,…)

Results

- On determinants of efficiency (Tobit regression):

Table 4. Determinants of inefficiency

	CRS		VRS		BC (2 steps)		BC (1 step)	
	Coeffic.	t-stud	Coeffic.	t-stud	Coeffic.	t-stud	Coeffic.	t-stud
LLT	-.51e-05	-1.04	-.17e-05	-2.61	.112e-05	3.11	-.91e-05	-1.09
DENS	-.0009	-1.65	-.0006	-0.98	-.001	-2.74	-.006	-4.17
VERT	**-.123**	**-1.37**	**-.041**	**-0.90**	**-.029**	**-0.44**	**-.075**	**-1.16**
PASSTEND	**-.365**	**-2.37**	**-.721**	**-3.61**	**-.302**	**-2.73**	**-.954**	**-3.78**
FREEOPEN	**-.209**	**-1.96**	**-.031**	**-0.25**	**-.084**	**-1.07**	**-.121**	**-1.70**
CONST	.923	9.10	.382	3.13	1.099	14.80	.904	4.35
Log-lik	-13.35		-13.53		-79.63			
Pseudo R^2	0.118		0.120		0.149			
N. observ	129							

- A negative sign means a positive effect on efficiency

Results

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- Vertical separation (VERT) is not statistical significant
- Franchising in passenger services (PASSTEND) improves efficiency with all techniques
- New operators in freight (FREOPEN) have significant positive effects depending on the technique (but always with negative sign)

Conclusions

- Reforms of the European railway systems seem to have improved their efficiency.
- Vertical separation is not statistically significant (by itself seems not to be enough): it coincides with most of previous papers.
- Horizontal reforms seem to be more important:
  - Franchising in passenger services improves efficiency with all techniques
  - Entry of new operators in freight sector seems to promote efficiency but to a lesser extent
- The estimated magnitude for these effects seems to depend to some extent on the technique

Extensions for future research

- Complete this type of analysis:
  - With national studies in specific countries.
  - With comparison with other international experiences (USA, Canada or some south-american countries)

- Other factors can influence on efficiency:
  - Existence of an independent regulator
    - ✓ Is there a non-discriminatory access system available for every new operator?
  - Level of government support for railways and infrastructure investments

Thank you very much for your attention