Cycle, productivity and efficiency in the European Regions

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Keywords

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The Cycle and the Long Run

(Change in) Total Factor Productivity

(Change in) Technical Efficiency

Technical Progress

Malmquist Index

Outline of the presentation

Motivation

The Literature

The Empirical Strategy

The Data

Main Results

Concluding Remarks

What do we look for? *(Our story)*

- Most economists believe that cyclical factors do not impact on (long-run) total factor productivity
- Some economists believe that there is a significant positive impact (Kaldorian view?). Some economists believe that there is a significant positive impact (Schumpeterian view)
- To the best of our knowledge **nobody has tried to disentagle the impact on (change of) technical efficiency («catching-up») from the impact on technical progress (shift of production possibility frontier). Plus, is there any sectoral or regional pattern?**

A key feature of this work

- In order to disentangle changes in technical efficiency from technical progress we compute for 268 NUTS2 regions a **Malquist index of total factor productivity**.
- We compute this index for the **aggregate regional economy**, as well as for industry excluding construction (**industry** henceforward).

A useful taxonomy

Cycles	Time range	Shocks	Scope
Kitchin	*3-5 years*	*Variations in psychological factors and crop yields*	*Fluctuations in inventories*
Juglar	***5-11 years***	***Waves of innovation***	***Fluctuations in investment***
Kondratieff	*45-60 years*	*Fundamental innovations*	*Fluctuations in stocks of basic capital goods*

The Literature (I)

- Schumpeterian view, “Cleansing effect” - it occurs in recessions. Less efficient firms exit the market. Also, the costs of adopting new technologies are reduced and obsolete technologies that become less profitable are abandoned and substituted.
- Kaldorian view, Learning by doing - firms implement new ideas especially in booms. Related mechanisms: reorganization and acquisition of new skills, higher R&D expenditure.

The Literature (II - S)

- **Technical progress depends on the reallocation of factors of production** (Hulten, 1992; Baily et al., 1992).
- Evidence for the **domination of reallocation effects** during recessions over pro-cyclical learning-by-doing effect (Bean, 1990; Gali and Hammour, 1992).
- **Exit from the market of less efficient firms** during recessions (Aghion and Howitt, 1992; Caballero and Hammour, 1994)
- **Lower opportunity cost of undertaking investment** activities during recessions (Hall, 1991; Saint-Paul, 1993).

The Literature (III - K)

- **Endogenous technical progress** (Stadler, 1990)
- **Research and Development spending** higher in booms (Stiglitz, 1993)
- **Introduction of new ideas** in booms (Barley, 2007)
- **Innovation** higher in booms (Research and Development; commercialization; implementation: François and Lloyd- Ellis, 2009)

The Literature (IV)

- Lee (2003): employment turnover has large positive effects on local productivity growth (S)
- Aghion et al. (2005, 2010): booms help overcoming credit constraints (K)
- Bachmann and Sims (2012): government spending shocks in a recession foster investment, which in turn stimulates productivity, … (K)
- Borio et al. (2015): credit booms misallocate labour (S)
- Kılınc (2016): no cleansing effect of recessions (K)

The Literature (V)

Notwithstanding the relative lack of interest, this seems to be an important issue. Both theoretically and policy-wise.

This issue matters also for EU regional economies

The Literature (VI)

Affuso - Capello - Fratesi (2011): productivity gains require industrial reconversion at the expense of employment growth.

Furceri - Mazzola - Pizzuto (2022): expansionary fiscal policy as well as higher share of EU cohesion funds facilitate the response of lagging regions to negative nation-wide shocks, contributing to stimulate reduction in regional disparities [positive impact on productivity?]

Capello - Cerisola (2022): there are heterogeneous patterns of association between reindustrialization and industry productivity growth

The Empirical Strategy (I)

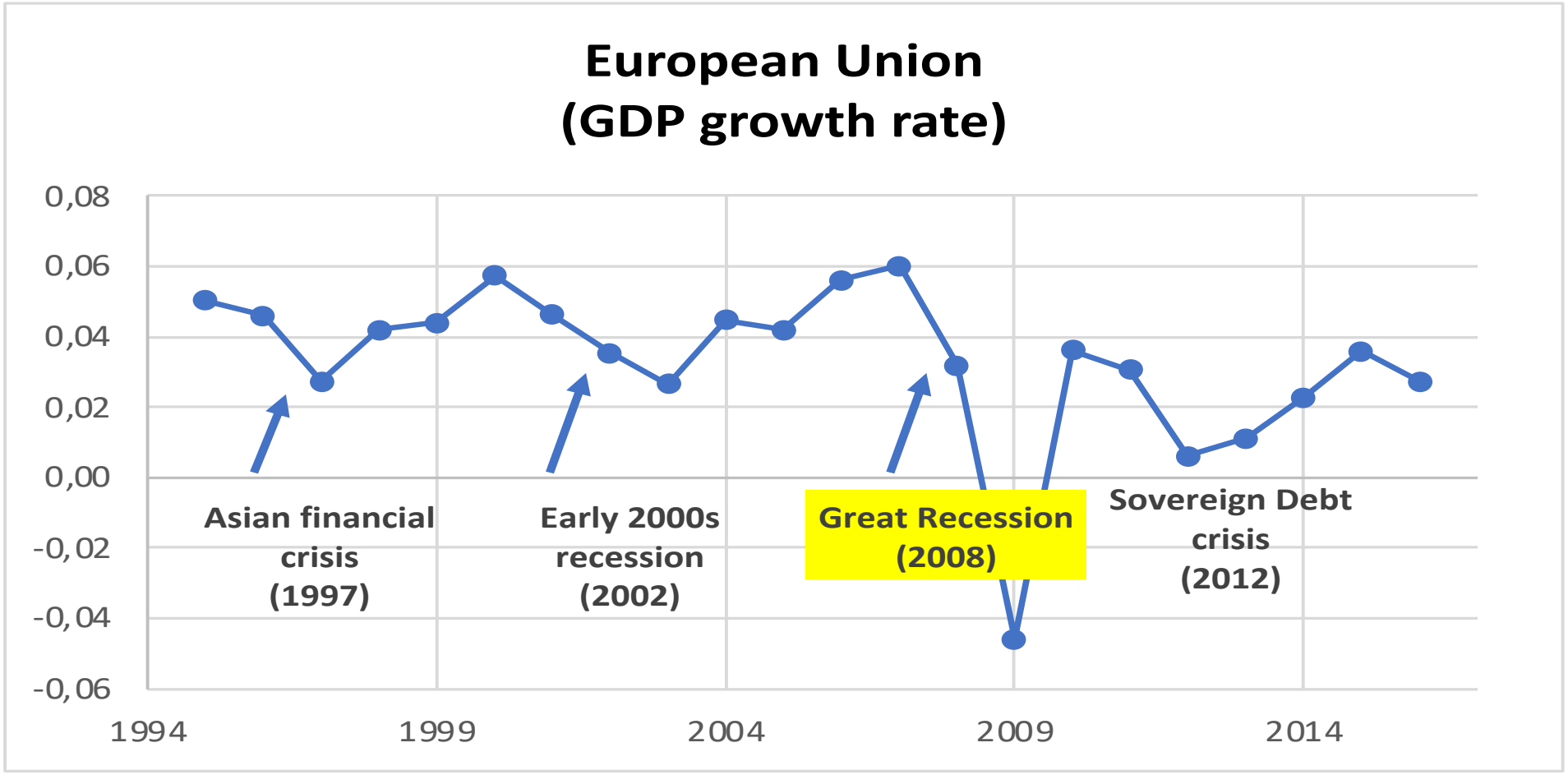
There is a lack of consistent empirical results.

However, what are the dominating features of TFP growth over the cycle across the EU NUTS2 regions?

The empirical strategy (II):

- We compute Malmquist indexes of TFP (and carry out a technical efficiency vs. state of technology decomposition).
- As a robustness check, we also compute (customary) Tornqvist indexes of TFP.
- ***We assess the relationship between TFP indexes and measures of the aggregate business cycle (time effects in a panel regression).***
- ***Basic hypothesis: the Great Recession is a demand-side phenomenon.***

The empirical strategy (III):



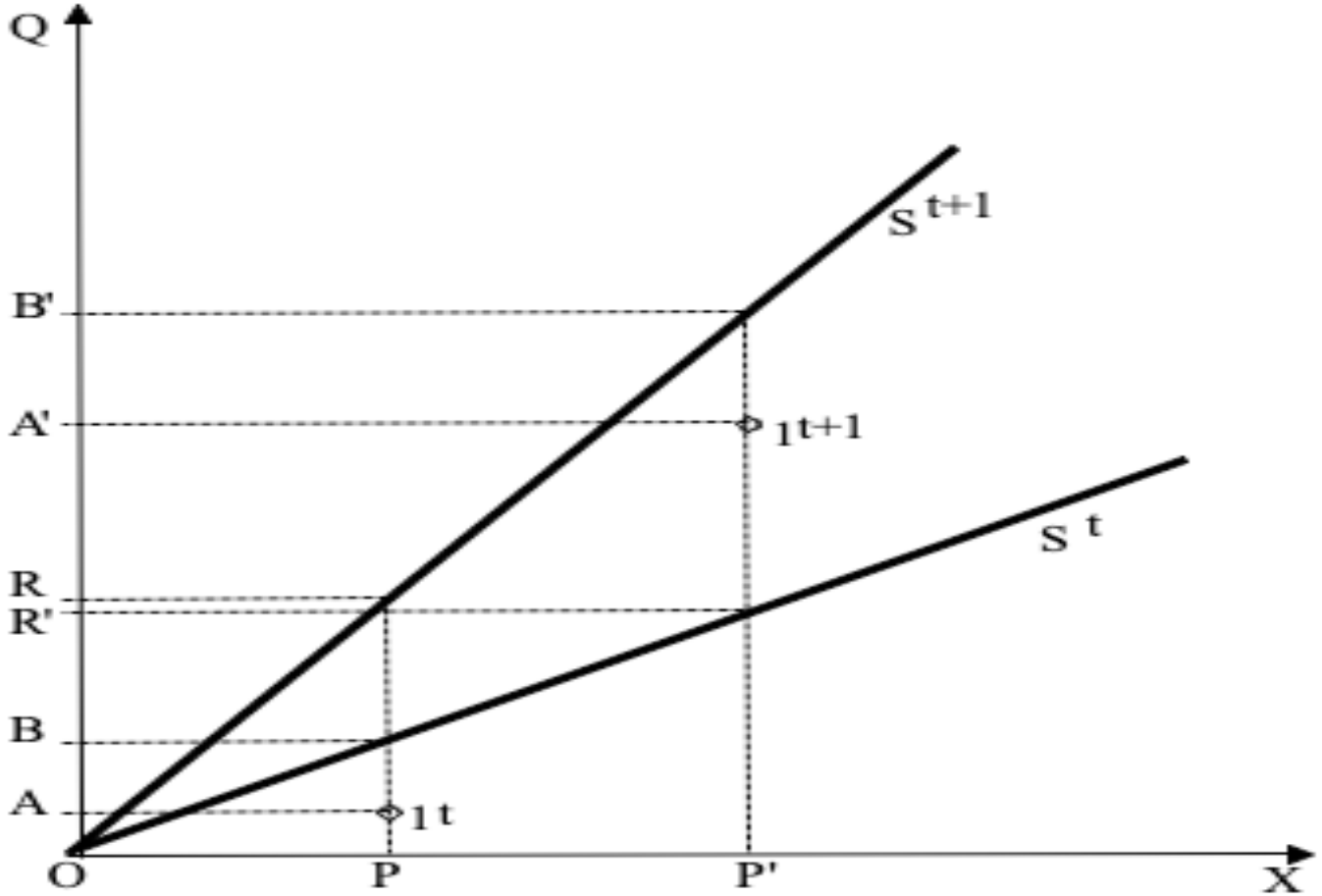
The empirical strategy (IV):

- Why do we do this? Because assessing the relationship between TFP growth and cycle by **regressing TFP measures over measures of cyclical output involves delicate problems of reverse causality and identification**.
- **Better to rely on a very rough (but perhaps convincing) identification hypothesis:**
- **Slumps in the EU, and especially the Great Recession, come from exogenous demand shocks.**
- Then, we see what are the changes in TFP growth and its components at those times.

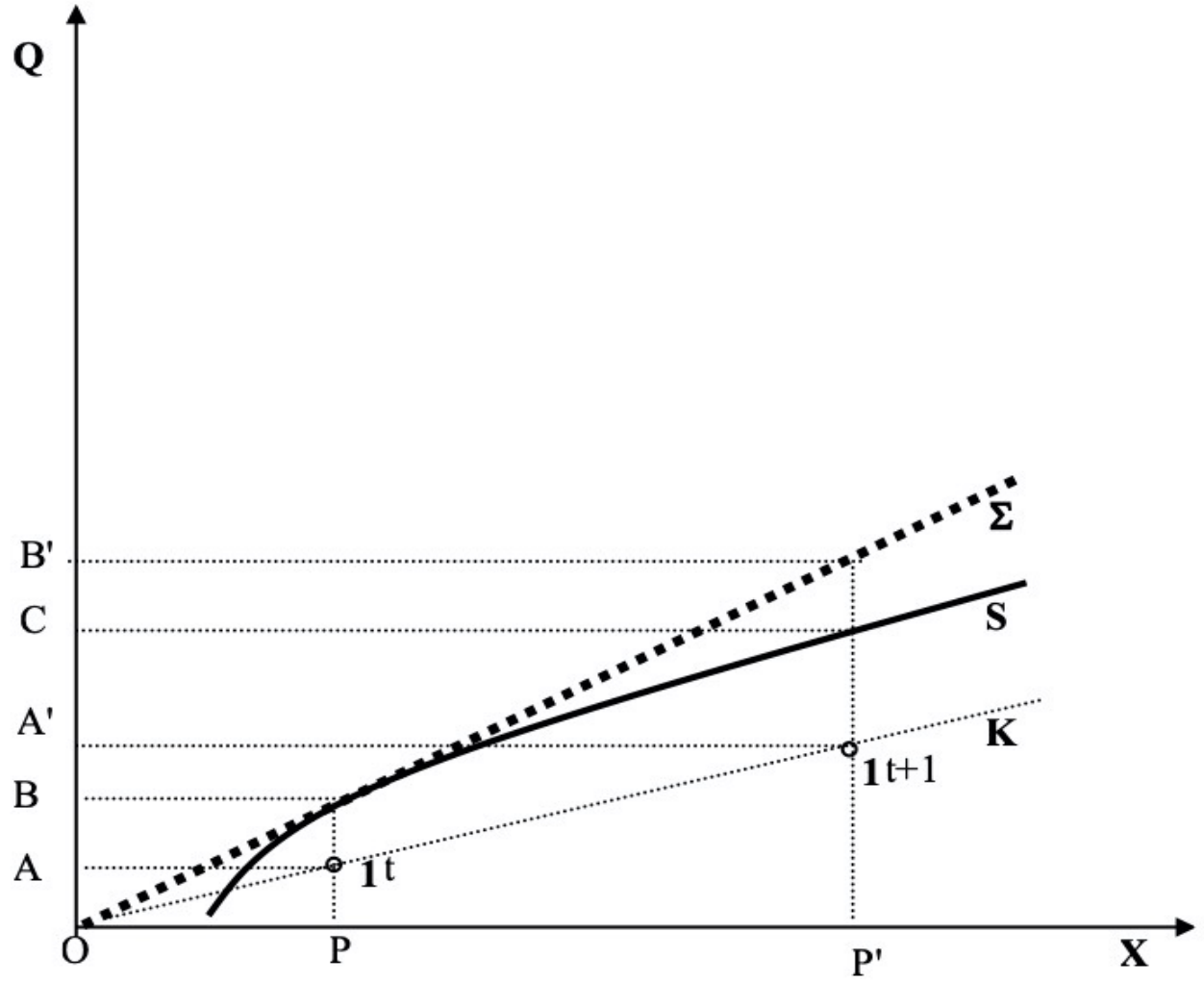
The empirical strategy (V):

- Decomposing TFP growth into technical change (shift of the production possibility frontier) and change in technical efficiency (catching up).
- **We do this through computation of a Malmquist index.**
- Alternatives are, to the best of our knowledge, not readily available.

The Malmquist Index (I)



The Malmquist Index (II)



The Malmquist Index (III)

- We compute the MI using Data Envelopment Analysis, more precisely through an output-oriented DEA-VRS procedure.
- This is a deterministic procedure, but there are no outliers in the production set, **once data inconsistencies are carefully culled**.
- To repeat, we provide the aggregate MI (percentage change), the percentage change in technical efficiency, and technical progress in percentage terms.
- Besides, we calculate a Tornqvist TFP index (percentage change), using conventional input weights (2/3 for labour, 1/3 for capital).

TFP changes over the cycle

- Problem: due to changing capacity utilisation and labour hoarding, TFP changes are spuriously related to cycle.
- Solution: we smooth these changes using 3-year MA's, 5-year MA's and 7-year MA's.
- Raw and adjusted TFP changes are included in a two-way fixed effect panel regression. **Then we focus on the time pattern of year effects.**

The Regional Dataset (I)

- *Gross domestic product (GDP), 2010 constant prices*
- *Gross value added (industry), 2010 constant prices*

- *Hours of work (total economy)*
- *Hours of work (industry)*

Source: ARDECO Database

The Regional Dataset (II)

- *Gross Fixed Capital Stock (total economy), 2010 constant prices*
- *Gross Fixed Capital Stock (industry), 2010 constant prices*

Source: data courtesy of **Ben Gardiner, Cambridge Econometrics**

Due to data problems, we end up with

268 NUT2 regions (EU27 + UK) for total economy, and

228 NUT2 regions (EU27) for industry.

Descriptive statistics (total)

Variable	Obs	Mean	Std. Dev.	Min	Max
Trnqv	5,628	.008022	.0307085	-.20972	.35580
Mlmq	5,628	.012791	.0346054	-.17382	.42775
Δ eff.	5,628	.002834	.0361722	-.17639	.36482
TC	5,607	.010717	.0245796	-.06117	.07930

Descriptive statistics (industry)

Variable	Obs	Mean	Std. Dev.	Min	Max
Trnqv	4,788	.022793	.0644034	-.40906	.48496
Mlmq	4,788	.028473	.0704772	-.33334	.62271
Δ eff.	4,788	.000682	.0967234	-.38179	.54585
TC	4,769	.030608	.0818310	-.19725	.26680

What do we find? *(A preview)*

- Negative impact of the cycle on changes in technical efficiency
- Positive impact of the cycle on technical change
- As a result, weak positive impact of the cycle on changes in total factor productivity.
- Effects are stronger in industry than in the aggregate economy

Tornqvist Index (I = industry; T = total), full sample

Sect./ meas.	I raw	T raw	I 3-MA	T 3-MA	I 5-MA	T 5-MA	I 7-MA	T 7-MA
2008	-0.0214	-0.0225	-0.0216	-0.0239	-0.0160	-0.0177	-0.0130	-0.0130
	-9.63	-10.63	-10.92	-12.71	-9.01	-10.34	-8.46	-8.86
2009	-0.0460	-0.0536	-0.0259	-0.0299	-0.0210	-0.0238	-0.0174	-0.0186
	-19.31	-22.22	-14.42	-16.92	-13.54	-15.53	-13.18	-14.44
2010	0.0020	0.0024	-0.0100	-0.0114	-0.0112	-0.0126	-0.0108	-0.0110
	0.93	1.05	-5.89	-6.61	-7.61	-8.50	-8.43	-8.62
2011	-0.0057	-0.0046	-0.0050	-0.0055	-0.0091	-0.0102	-0.0104	-0.0104
	-2.62	-2.10	-2.74	-2.98	-6.04	-6.74	-8.16	-8.25
2012	-0.0183	-0.0228	-0.0118	-0.0143	-0.0094	-0.0112	-0.0105	-0.0111
	-10.49	-12.74	-6.87	-8.55	-6.57	-7.83	-8.74	-9.43
2013	-0.0127	-0.0146	-0.0115	-0.0137	-0.0096	-0.0111	-0.0087	-0.0086
	-7.55	-8.59	-7.06	-8.49	-6.57	-7.70	-7.06	-7.12

Malmquist Index (I = industry; T = total), full sample

Sect./ meas.	I raw	T raw	I 3-MA	T 3-MA	I 5-MA	T 5-MA	I 7-MA	T 7-MA
2008	-0.0173	-0.0156	-0.0180	-0.0147	-0.0128	-0.0105	-0.0100	-0.0101
	-7.64	-6.25	-8.66	-6.66	-7.01	-5.44	-6.36	-6.00
2009	-0.0436	-0.0325	-0.0222	-0.0165	-0.0176	-0.0137	-0.0147	-0.0132
	-16.22	-11.72	-11.40	-8.26	-10.62	-8.09	-10.58	-9.06
2010	0.0083	0.0076	-0.0051	-0.0032	-0.0075	-0.0055	-0.0078	-0.0077
	3.46	3.22	-2.78	-1.74	-4.83	-3.53	-5.85	-5.62
2011	-0.0010	-0.0026	-0.0015	-0.0009	-0.0064	-0.0049	-0.0083	-0.0085
	-0.42	-1.11	-0.79	-0.48	-4.15	-3.16	-6.31	-6.23
2012	-0.0199	-0.0131	-0.0114	-0.0078	-0.0091	-0.0066	-0.0101	-0.0094
	-10.05	-6.45	-6.48	-4.22	-6.26	-4.46	-8.20	-7.29
2013	-0.0123	-0.0094	-0.0123	-0.0091	-0.0103	-0.0081	-0.0088	-0.0091
	-6.51	-4.85	-7.19	-5.25	-6.90	-5.39	-7.00	-7.03

Change in technical efficiency (I = industry; T = total), full sample

Sect./ meas.	I raw	T raw	I 3-MA	T 3-MA	I 5-MA	T 5-MA	I 7-MA	T 7-MA
2008	0.0070	0.0014	0.0125	0.0103	0.0139	0.0082	0.0087	0.0057
	2.72	0.51	5.83	4.69	7.34	4.24	5.38	3.48
2009	-0.0053	0.0022	0.0197	0.0082	0.0166	0.0093	0.0098	0.0057
	-1.98	0.81	10.06	4.16	9.86	5.54	7.02	4.01
2010	-0.0281	-0.0093	0.0078	0.0085	0.0134	0.0066	0.0067	0.0034
	-11.81	-4.03	4.27	4.69	8.79	4.38	5.12	2.59
2011	-0.0179	0.0140	0.0041	0.0095	0.0087	0.0081	0.0067	0.0059
	-7.91	4.70	2.22	4.59	5.62	5.18	5.13	4.52
2012	-0.0302	-0.0173	-0.0009	0.0013	0.0028	0.0026	0.0012	0.0011
	-15.18	-7.39	-0.50	0.68	1.88	1.81	0.94	0.94
2013	-0.0360	-0.0106	-0.0059	0.0024	-0.0003	0.0039	-0.0030	0.0016
	-18.86	-5.54	-3.46	1.39	-0.20	2.60	-2.43	1.27

Technical change (I = industry; T = total), full sample

Sect./ meas.	I raw	T raw	I 3-MA	T 3-MA	I 5-MA	T 5-MA	I 7-MA	T 7-MA
2008	-0.0227	-0.0164	-0.0294	-0.0251	-0.0260	-0.0189	-0.0180	-0.0157
	-22.03	-13.01	-42.33	-44.25	-36.12	-31.67	-26.25	-34.42
2009	-0.0387	-0.0372	-0.0422	-0.0261	-0.0343	-0.0240	-0.0244	-0.0193
	-129.93	-58.94	-107.48	-56.92	-67.87	-55.01	-49.84	-59.87
2010	0.0355	0.0163	-0.0139	-0.0128	-0.0217	-0.0129	-0.0149	-0.0115
	82.67	24.41	-58.89	-39.95	-56.39	-44.50	-35.57	-41.98
2011	0.0163	-0.0166	-0.0067	-0.0109	-0.0161	-0.0138	-0.0156	-0.0147
	29.19	-10.09	-23.13	-12.99	-37.99	-33.02	-34.32	-48.90
2012	0.0095	0.0032	-0.0115	-0.0098	-0.0129	-0.0099	-0.0119	-0.0109
	23.45	2.07	-30.58	-12.71	-28.38	-26.59	-29.40	-40.49
2013	0.0231	0.0006	-0.0073	-0.0120	-0.0108	-0.0125	-0.0064	-0.0108
	88.38	0.86	-34.51	-36.16	-29.88	-41.35	-17.84	-42.35

What do we find? *(A preview)*

- The negative impact of the cycle on changes in technical efficiency is stronger in new EU entrants.
- As a result, the positive impact of the cycle on changes in total factor productivity is stronger in mature economies.

Tornqvist Index (I = industry; T = total), sample of new entrants

Sect./ meas.	I raw	T raw	I 3-MA	T 3-MA	I 5-MA	T 5-MA	I 7-MA	T 7-MA
2008	-0.0230	-0.0224	-0.0038	-0.0054	-0.0004	-0.0018	-0.0011	-0.0018
	-3.50	-3.66	-0.62	-0.89	-0.08	-0.32	-0.21	-0.36
2009	-0.0645	-0.0715	-0.0154	-0.0180	-0.0106	-0.0129	-0.0099	-0.0118
	-9.57	-10.80	-2.84	-3.31	-2.25	-2.70	-2.40	-2.91
2010	-0.0103	-0.0076	0.0012	0.0009	-0.0012	-0.0021	-0.0037	-0.0045
	-1.81	-1.36	0.25	0.20	-0.27	-0.48	-0.91	-1.11
2011	-0.0108	-0.0105	0.0094	0.0087	0.0021	0.0004	-0.0029	-0.0041
	-2.26	-2.16	2.03	1.85	0.50	0.10	-0.75	-1.08
2012	-0.0313	-0.0378	0.0012	-0.0025	0.0012	-0.0017	-0.0037	-0.0061
	-6.62	-7.42	0.25	-0.50	0.26	-0.38	-0.98	-1.63
2013	-0.0224	-0.0250	0.0009	-0.0018	0.0020	-0.0008	-0.0007	-0.0024
	-4.48	-5.22	0.16	-0.34	0.42	-0.16	-0.16	-0.58

Malmquist Index (I = industry; T = total), sample of new entrants

Sect./ meas.	I raw	T raw	I 3-MA	T 3-MA	I 5-MA	T 5-MA	I 7-MA	T 7-MA
2008	-0.0127	-0.0134	0.0008	0.0034	0.0006	0.0028	-0.0018	-0.0006
	-1.84	-1.70	0.12	0.47	0.09	0.42	-0.31	-0.10
2009	-0.0595	-0.0487	-0.0100	-0.0060	-0.0093	-0.0058	-0.0113	-0.0084
	-8.04	-5.98	-1.66	-0.97	-1.75	-1.08	-2.54	-1.83
2010	0.0039	-0.0001	0.0079	0.0083	0.0004	0.0019	-0.0047	-0.0036
	0.64	-0.01	1.45	1.48	0.09	0.40	-1.08	-0.80
2011	-0.0046	-0.0050	0.0114	0.0125	-0.0001	0.0024	-0.0067	-0.0049
	-0.79	-0.84	2.10	2.32	-0.03	0.51	-1.62	-1.17
2012	-0.0368	-0.0271	-0.0036	0.0019	-0.0059	-0.0017	-0.0113	-0.0078
	-6.41	-4.94	-0.66	0.34	-1.26	-0.37	-2.87	-1.95
2013	-0.0243	-0.0203	-0.0055	-0.0015	-0.0073	-0.0032	-0.0095	-0.0071
	-4.94	-3.85	-0.97	-0.26	-1.41	-0.61	-2.21	-1.62

Change in technical efficiency (I = industry; T = total), sample of new entrants

Sect./ meas.	I raw	T raw	I 3-MA	T 3-MA	I 5-MA	T 5-MA	I 7-MA	T 7-MA
2008	0.0124	0.0057	0.0330	0.0294	0.0295	0.0216	0.0189	0.0157
	1.60	0.67	4.71	4.14	4.70	3.34	3.43	2.71
2009	-0.0195	-0.0105	0.0346	0.0184	0.0276	0.0175	0.0158	0.0112
	-2.58	-1.33	5.67	3.02	5.27	3.37	3.62	2.49
2010	-0.0331	-0.0150	0.0223	0.0212	0.0239	0.0147	0.0123	0.0085
	-5.86	-2.47	4.10	3.87	4.99	3.16	2.87	1.95
2011	-0.0232	0.0216	0.0183	0.0275	0.0172	0.0184	0.0107	0.0115
	-3.98	3.63	3.40	5.09	3.62	3.93	2.59	2.77
2012	-0.0451	-0.0220	0.0089	0.0156	0.0085	0.0103	0.0025	0.0048
	-7.82	-4.32	1.59	2.84	1.82	2.26	0.63	1.22
2013	-0.0491	-0.0189	0.0019	0.0109	0.0044	0.0099	-0.0019	0.0043
	-9.72	-3.65	0.34	1.90	0.87	1.93	-0.44	0.99

Technical change (I = industry; T = total), sample of new entrants

Sect./ meas.	I raw	T raw	I 3-MA	T 3-MA	I 5-MA	T 5-MA	I 7-MA	T 7-MA
2008	-0.0230	-0.0179	-0.0300	-0.0255	-0.0260	-0.0176	-0.0178	-0.0147
	-15.53	-6.25	-25.23	-22.17	-20.59	-15.45	-14.07	-16.62
2009	-0.0401	-0.0401	-0.0440	-0.0255	-0.0350	-0.0231	-0.0248	-0.0188
	-72.32	-37.01	-99.34	-28.52	-39.86	-28.81	-26.86	-30.19
2010	0.0343	0.0134	-0.0153	-0.0144	-0.0227	-0.0129	-0.0155	-0.0114
	34.56	11.28	-65.47	-33.81	-34.73	-24.00	-19.53	-20.88
2011	0.0172	-0.0266	-0.0078	-0.0158	-0.0168	-0.0159	-0.0160	-0.0157
	18.55	-16.83	-12.48	-18.34	-18.47	-36.08	-16.93	-33.89
2012	0.0072	-0.0058	-0.0130	-0.0144	-0.0138	-0.0117	-0.0125	-0.0119
	8.40	-3.45	-15.31	-17.43	-13.85	-24.07	-14.31	-28.57
2013	0.0234	-0.0020	-0.0079	-0.0129	-0.0109	-0.0124	-0.0064	-0.0103
	54.06	-1.23	-18.59	-18.49	-14.52	-21.09	-8.58	-21.28

Concluding Remarks

- Spurious cyclicality: we considered hours worked for Labour. What about measuring capacity utilisation for Capital?
- Other ways to compute the MI (FDH, SFA)?
- More complex production sets including, perhaps, R&D?