ROUTINE JOBS AND TECHNOLOGICAL INNOVATION IN GLOBAL VALUE CHAINS

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The role of GVCs and technology on employment

Background:

- Employment changes: Tech vs Trade (fragmentation).
- Production (and trade) according to tasks.
  - Routine tasks may be easier to offshore (e.g. Grossman & Rossi Hansberg, 2008).
  - Routine tasks may be more sensitive to substitution by tech (e.g. Acemoglu & Autor, 2011).
- But also:
  - Country-sectors have different content in routine tasks.
  - Not all innovations are labor-substituting.

This paper:

- **The question**: what drives demand of routine vs non-routine employment? GVCs vs technology
- Cross-country, cross-industry analysis over 2000-2011, but also aggregated microdata (PIAAC, Microdata Lab)
  - 27 EU countries + U.S., 27 industries.
  - Different modes of GVC participation.
  - Different ways of proxying technology
- **Contributions**:
  - New measure of routine intensity of sectors. Based on all occupations, and at a high level of disaggregation.
  - Assess several shifters of labour demand (trade & technology), + Do it in GVC context + beyond manufacturing.

(Ultra-quick) Literature

- **Routine & polarisation**: Autor et al., 2003; Goos et al., 2014; Autor 2015.
- **Determinants of changes in labour demand** :
  - Country-industry : Autor & Dorn, 2013; Goos et al., 2014
  - Firm level: Cortes & Salvatori, 2015; Pekkala Kerr, et al., 2015; Harrigan et al., 2017)
  - Individual level: Keller & Utar, 2016.
- **Determinants of labor demand by skill:** offshoring (e.g. Feenstra & Hanson, 1999; Blinder & Krueger, 2013; Autor et al., 2013) or ICT (e.g. Michaels et al., 2014)

The empirical specification

- Similar to Berman et al. (1994) and Feenstra & Hanson (1996), modify short-run labor demand equation with technology and GVC.

$$Ln(N_{q,i,k,t}) = \beta_0 + \beta_1 TECH_{i,k,t} + \beta_2 GVC_{i,k,t} + \beta_2 \boldsymbol{X}_{i,k,t} + \varphi_i + \gamma_k + \theta_t + \varepsilon_{q,i,k,t}$$

- $\boldsymbol{X}_{i,k,t}$= {VA, K, Hours, Wage, Wage & Hours by skill}
- Estimation with SUR (+ IV)
- No "usual" polarization here. Ln(W or L by skill) = f(Routine; offshorability).

Technology proxies

- Substitution vs complementarity with different types of labor.
- **ICT** :
  - Ideally: ICT GFCF (SNA). Coverage issue.
  - **Share of workers involved in ICT & engineering business functions** in the industry. Using EULFS occupation-sector matrix (Miroudot, 2016)

- Number of **patent families** in the industry (OECD Microdata Lab).
  - Van Looy et al. (2014): mostly manufacturing
  - Matching (Dernis et al. 2013): selected countries, both manufaucturing and services.

Trade in Value Added

- From Noguera and Johson (2012), Koopman, Wang and Wei (2014), Timmer, Los, Stehrer and de Vries (2013):
  - (narrow) offshoring: imported intermediate inputs (narrow) / total intermediate consumption
  - (narrow) offshoring of assembly: imports of VA in final goods only
  - (narrow) domestic outsourcing: same as offshoring, for domestic prod.
  - Service input outsourcing: intermediate consumption of service inputs over gross output

- Data from (**TiVA**): 62 Countries, 34 industries (16 manuf, 14 services). 1995-2011 available.

Measuring routine intensity (I)

- **Previous measures:** expert judgement (Blinder 2006, 2009), or Dictionary of Occupational Titles (DOT/O'NET) – Autor et al. 2003, 2013.
- Calculated for the USA in the 70s-90s. Or alternative national classifications (e.g. Spitz-Oener 2006)
- Ad-hoc classification of tasks in:
  - non-routine cognitive (analytical reasoning skills or interactive);
  - non-routine manual (tasks requiring eye-hand-foot coordination);
  - routine cognitive (tasks requiring the capability to comply with "limits, tolerances or standards");
  - routine manual ("finger dexterity")

Measuring routine intensity (II)

What is different here ?

- Country specific, for several countries.
  - Technology doesn't diffuse & get adopted equally across country.
  - Factor prices differ (endowment, institutions, …).
- More on-the-point questions.
  - Abstract reasoning: Non-routine (abstract) tasks?
  - Finger dexterity: Routine (manual) tasks?
- Not ad-hoc association, asking workers directly.

- In the future: time variant in a straight-forward way
- Individual level : not here

Measuring routine intensity (III)

- **Routine intensity:** the extent to which tasks are carried out in a codifiable and repetitive way
- 4 PIAAC questions on individuals' own assessment of:
  1. Their degree of freedom in establishing the sequence of their tasks (sequentiability)
  2. Their degree of freedom in deciding the type of tasks to be performed on the job (flexibility)
  3. The frequency with which they plan their own activities (plan_own)
  4. The frequency with which they organise their own time (organise_own)

Further data: OECD PIAAC Survey

- Approx. 2-5,000 adults aged 16-65 in each country;
- 22 countries, **2011-2012**.
- Detailed employee information, including occupations (ISCO08, 3-dig) and sectors (ISIC Rev4, 4-dig)
- Individuals report frequency of *Sequentiability, Flexibility, Plan_own, Organise_own* in their jobs, from 1 (Every day) to 5 (Never)

The Routine Intensity Index

- For each individual *k*, $RII_{k,i,o} =$

$$w_{seq}Sequentiability_{k,i,o} + w_{flex}Flexibility_{k,i,o} + w_{planown}Plan\_own_{k,i,o} + w_{orgown}Organise\_own_{k,i,o}$$

- Increasing in latent "routine intensity".
- N possible weights and combinations with variables. Highly correlated (>80%). Choose one (PCA).
- Rank occupations by median value **in each country**.

Classification of 3-digit occupations in Quartiles

Routine-intensity of occupations: some examples

- ***Low routine-intensive occupations (Q1)***

Legislators and senior officials; Managing directors and chief executives; Sales and purchasing agents and brokers; Authors, journalists and linguists.

- ***Medium-low routine-intensive occupations (Q2)***

Secondary education teachers; Hotel and restaurant managers; Administrative and specialised secretaries; Hairdressers, beauticians and related workers.

- ***Medium-high routine-intensive occupations (Q3)***

Machinery mechanics and repairers; Shop salespersons; Medical and pharmaceutical technicians; Other clerical support workers.

- ***High routine-intensive occupations (Q4)***

Assemblers; Food preparation assistants; Tellers, money collectors and related clerks; Metal processing and finishing plant operators.

Comparison with Goos et al. (2014)

- Re-calculate at 2-digit level (exclude some occupations, define quartiles) across country.
- Spearman, by country: 45%

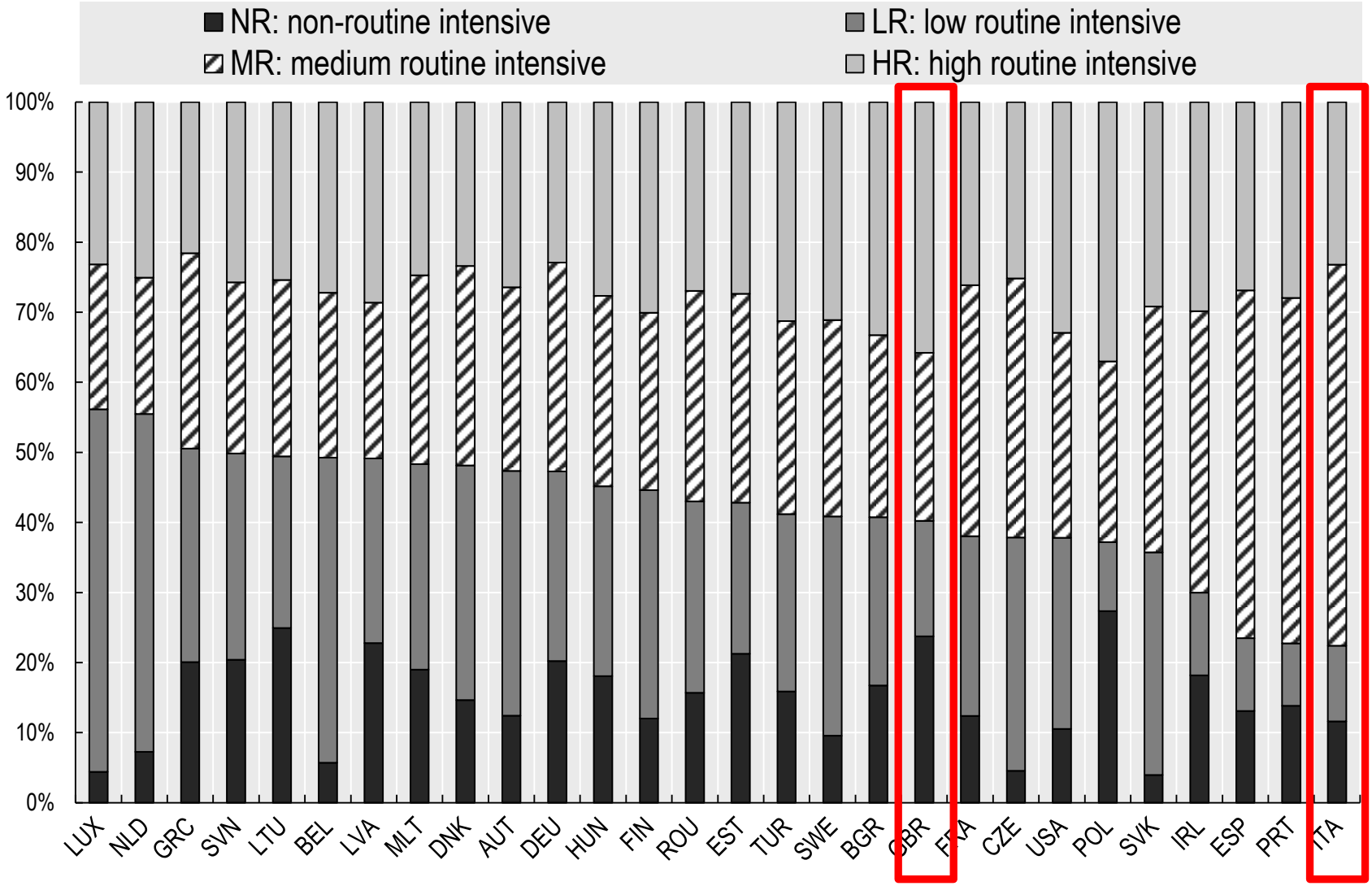
Goos et al. (2014)	OECD	ISCO88	
NonR	HighR	83	Drivers and mobile plant operators
HighR	LowR	73	Precision, handicraft, craft printing and related trade workers
HighR	LowR	41	Office clerks

From individuals to occupations and sectors

- Assume 2011 classification applies to all years.
  - ⇒ Changes in routine content driven by occupational structure of industries and countries.
  - ⇒ Attenuation bias: lower changes in routine and non-routine employment than "true".
- Apply to (3dig occupation)*(2dig sector) employment data
  - EULFS + CPS Census. Data hurdle.

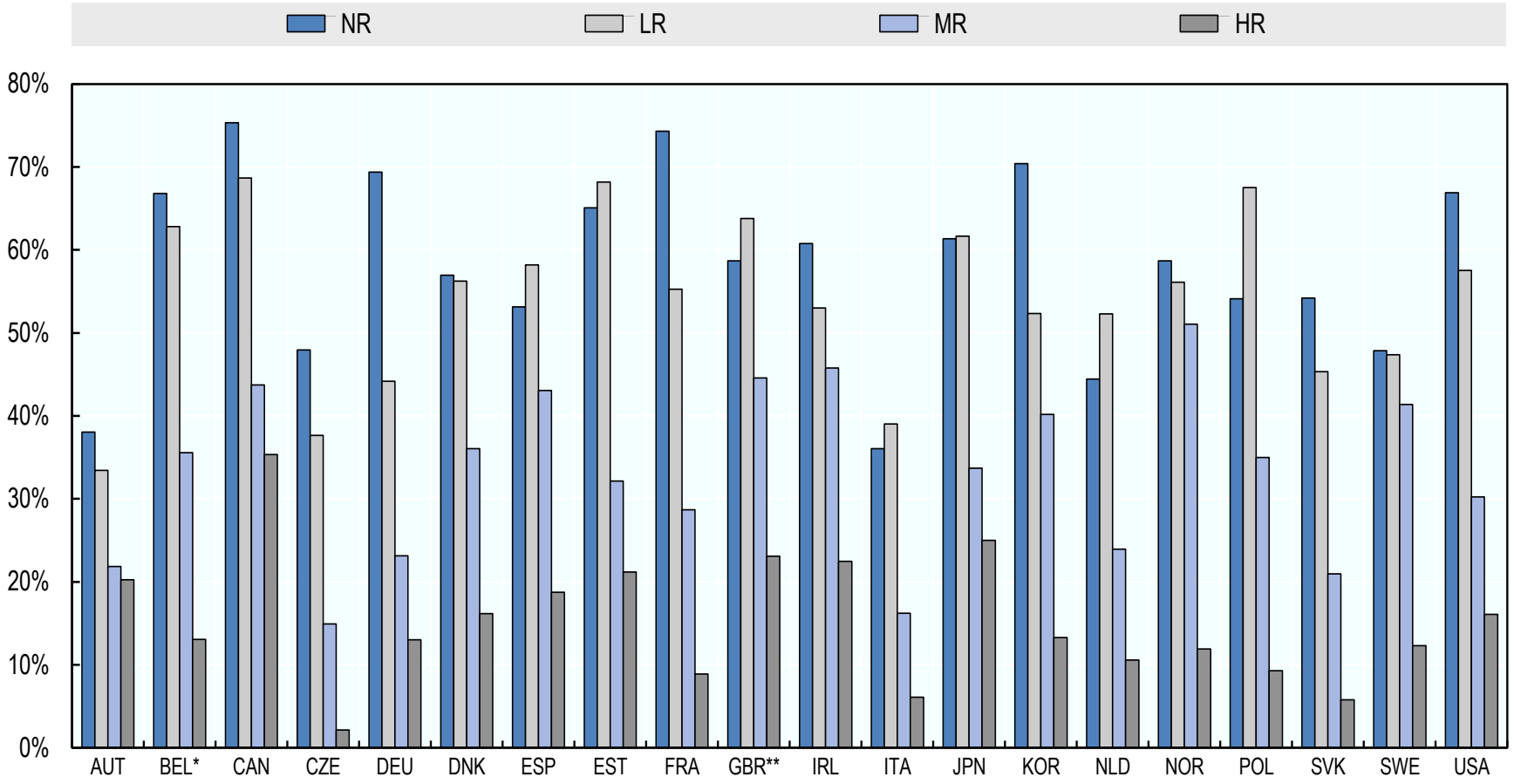
Intensity of 2-digit SECTORS in routine quartiles

Percentage of employment by quartile of routine intensity, (average 2000-2011)



Skills vs Routine intensity (2011)

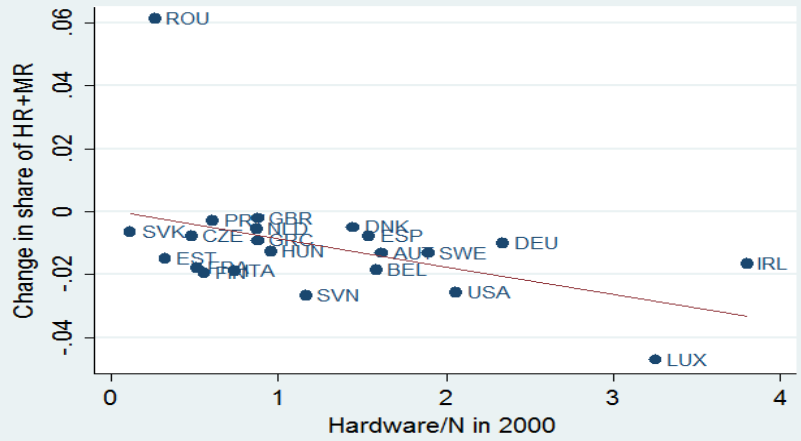
Share of tertiary educated in employment of a given quartile

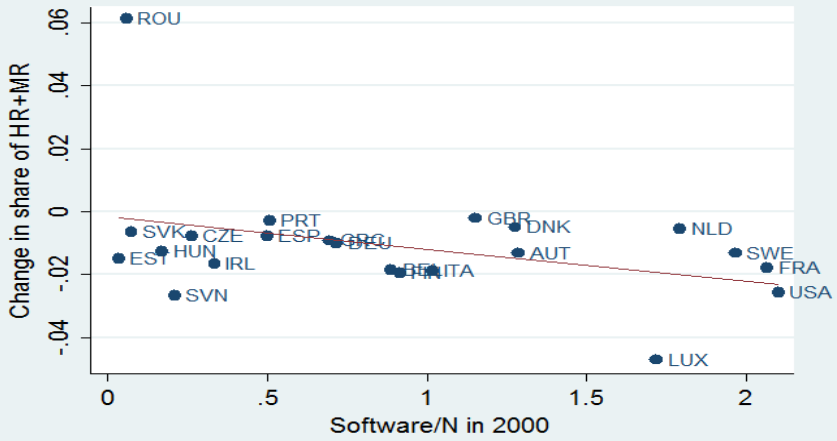


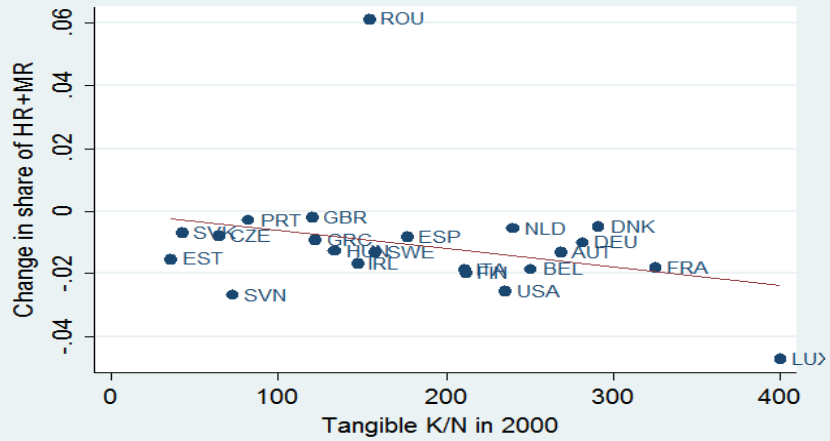
Further tests in [Marcolin et al. (2016)]

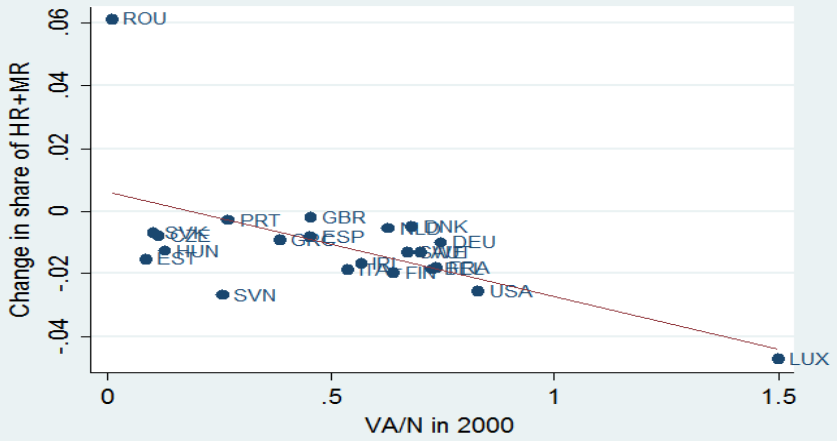
Basic associations

Change (2000-2010) vs level (2000).









The empirical estimation

Reminder:

$$Ln(N_{q,i,k,t}) = \beta_0 + \beta_1 TECH_{i,k,t} + \beta_2 GVC_{i,k,t} + \beta_2 \boldsymbol{X}_{i,k,t} + \varphi_i + \gamma_k + \theta_t + \varepsilon_{q,i,k,t}$$

Manufacturing

The role of technology

The impact of offshoring and GVCs

	NR	LR	MR	HR
Log(VA)	0.117***	0.147***	0.184***	0.145***
	(0.018)	(0.017)	(0.018)	(0.017)
Log(Capital)	0.060***	0.080***	0.078***	0.091***
	(0.012)	(0.011)	(0.012)	(0.011)
ICT Intensity	0.940***	0.479***	0.124	-0.925***
	(0.123)	(0.115)	(0.125)	(0.114)
Log(Number Patents)	0.063***	0.075***	0.023*	0.036***
	(0.012)	(0.011)	(0.012)	(0.011)
Input Offshoring	-0.067	0.094	0.162	0.486***
	(0.144)	(0.134)	(0.146)	(0.133)
Domestic Outsourcing	0.222	0.136	0.544***	0.366**
	(0.201)	(0.187)	(0.204)	(0.185)
Assembly Offshoring	-0.576***	-0.175	0.265	-0.180
	(0.221)	(0.207)	(0.225)	(0.204)
Services Inputs in Manuf	-0.129	-0.020	0.018	-0.212*
	(0.131)	(0.122)	(0.133)	(0.121)
Log(Avg Wage)	-0.190***	-0.198***	-0.264***	-0.225***
	(0.029)	(0.027)	(0.029)	(0.027)
Wage Diff	0.006***	0.003***	0.005***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Log(Total Hours Worked)	0.388***	0.461***	0.481***	0.577***
	(0.020)	(0.018)	(0.020)	(0.018)
HighSkill/Total Hours	0.020***	0.016***	0.013***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	1,818	1,818	1,818	1,818

Services

The role of technology

The impact of offshoring and GVCs

	NR	LR	MR	HR
Log(VA)	0.061	0.244***	0.113***	0.349***
	(0.046)	(0.048)	(0.043)	(0.043)
Log(Capital)	0.038	0.041	0.130***	0.115***
	(0.024)	(0.025)	(0.023)	(0.022)
ICT Intensity	-0.273	0.953**	1.140***	-0.726**
	(0.375)	(0.386)	(0.351)	(0.347)
Input Offshoring	-0.592*	0.728**	-1.162***	0.259
	(0.331)	(0.342)	(0.310)	(0.307)
Domestic Outsourcing	-0.248	-1.056***	0.032	0.828***
	(0.234)	(0.242)	(0.219)	(0.217)
Log(Wage)	-0.448***	-0.289***	-0.310***	-0.626***
	(0.103)	(0.107)	(0.097)	(0.096)
Wage Diff	0.058***	0.011	0.014	0.052**
	(0.022)	(0.023)	(0.021)	(0.020)
Log(Total Hours Worked)	0.669***	0.437***	0.489***	0.415***
	(0.046)	(0.048)	(0.043)	(0.043)
HighSkill/Total Hours	0.005	0.001	-0.001	0.000
	(0.003)	(0.003)	(0.003)	(0.003)
Observations	839	839	839	839

Instrumenting (preliminary)

- Manufacturing
- Lags (Anderson & Hsiao, 1981)

	NR	LR	MR	HR
Domestic Outsourcing	0.674	1.984***	2.144***	1.553***
	(0.507)	(0.445)	(0.463)	(0.455)
Input Offshoring(N)	-0.076	0.623	1.553***	0.909*
	(0.551)	(0.484)	(0.503)	(0.495)
Services Inputs in Mar	0.451	-0.057	0.275	-0.120
	(0.815)	(0.716)	(0.744)	(0.732)
Log(VA)	0.194***	0.172***	0.180***	0.258***
	(0.022)	(0.019)	(0.020)	(0.020)
Log(Capital)	0.021**	0.022***	0.032***	0.028***
	(0.009)	(0.008)	(0.008)	(0.008)
ICT Intensity	0.278***	0.275***	0.001	-0.494***
	(0.067)	(0.059)	(0.062)	(0.061)
Log(Number Patents)	0.021**	0.018**	0.015*	0.030***
	(0.010)	(0.009)	(0.009)	(0.009)
Log(Wage)	-0.231***	-0.218***	-0.220***	-0.293***
	(0.024)	(0.021)	(0.022)	(0.022)
Log(H)	0.162***	0.171***	0.172***	0.255***
	(0.018)	(0.016)	(0.017)	(0.016)
Hansen p-value	0.2605	0.6726	0.2509	0.0457

Extra results

- Skills by quartile: always positively correlated with employment, for all quartiles.
- ICT capital rather than ICT employment intensity.
- Innovation in services
- Splitting between transition and G7 countries
- Robust: Unconditional to VA
- Robust: Entire time series 2000-2011 (WIOD).
- Robust: Restricting to PIAAC countries only.

Preliminary conclusions

- Complex interactions between skills, technology and trade => no clear ‘losers’ and ‘winners’ in GVCs on the basis of the routine-intensity of occupations.
- Most important is the specialisation of countries through technology, vs no strong ground for GVC.
  - In line with literature (e.g. Michaels et al. 2015)
  - BUT may be missing general equilibrium role of GVCs (e.g. through incentives to innovation)
  - ICT can displace HR workers. Innovation as employment enhancer.

What's next?

- Interaction GVC & technology.
- Exploit timing (lags) in estimation.
- Further on RII:
  - Within-occupation dispersion. Different role of tech and trade (Pekkala Kerr et al., 2015)
  - Bundles of routine & non-routine tasks
  - LEED?

THANK YOU

BACKUP SLIDES

Measuring routine intensity (IV)

- Routine intensity vs. *Offshorability*
  - Complex tasks can be offshored.
  - Manual routine tasks may not be offshored.

- Routine intensity vs. *Automation*
  - Separability of different tasks
  - Even if codifiable, not yet replaceable (e.g. nurse)

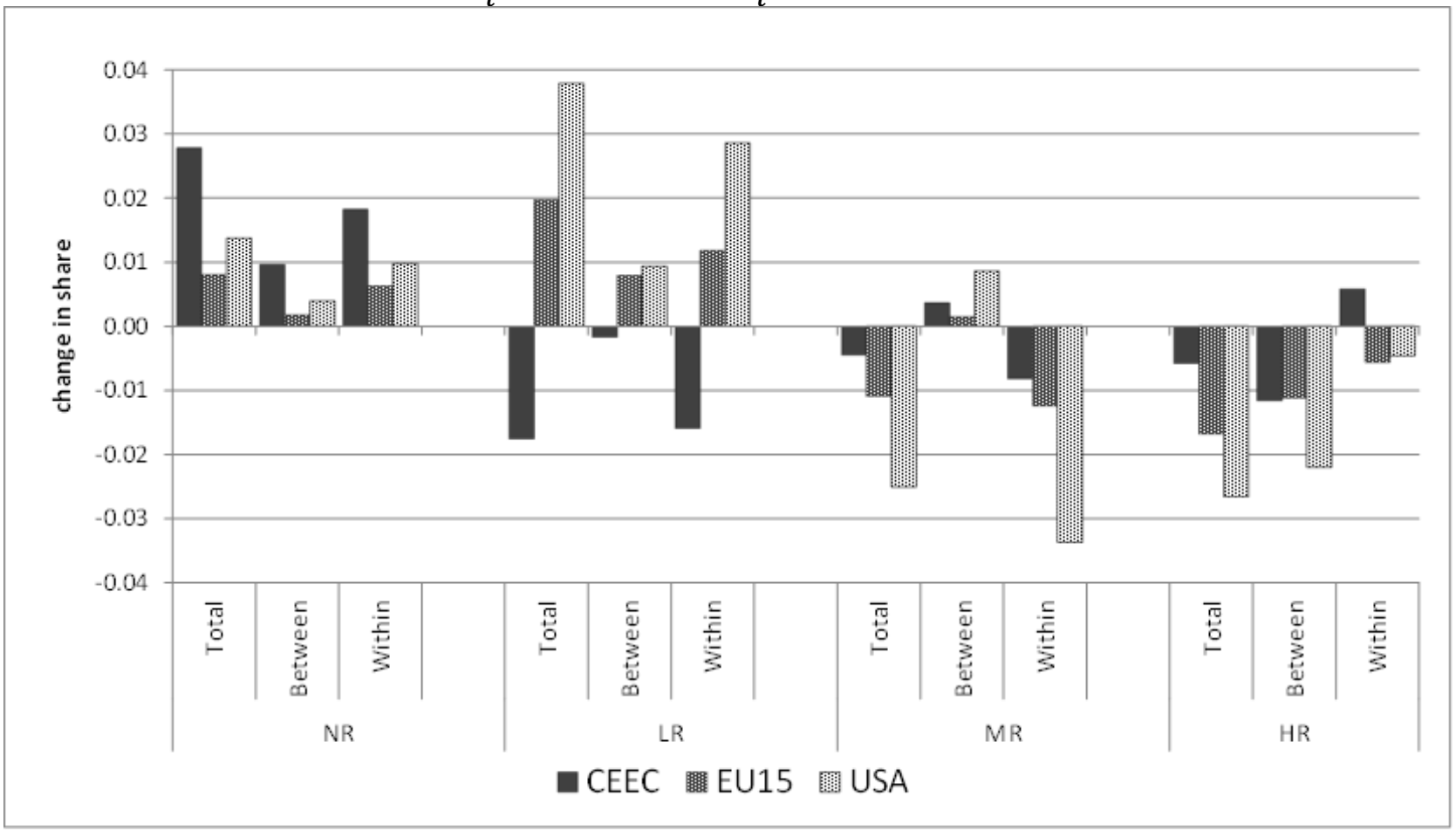
Industry breakdown

Shares of industry employment by quartile of routine intensity.
Simple averages over U.S.A. and selected European countries, 2010.

Manufacturing					Services				
	NR	LR	MR	HR		NR	LR	MR	HR
Food&Beverages	9%	16%	25%	50%	**Utilities**	14%	29%	34%	24%
Textiles	9%	18%	22%	51%	**Constructions**	11%	17%	44%	29%
Wood	8%	16%	31%	44%	**Trade**	16%	19%	41%	24%
Paper&Publishing	19%	31%	23%	26%	**Hotel&Restaurants**	14%	22%	27%	37%
Oil	14%	26%	31%	29%	**Transport**	8%	18%	19%	54%
Chemicals	16%	28%	25%	31%	**Post&TLC**	14%	31%	31%	24%
Rubber&Plastics	11%	21%	21%	46%	**Finance**	25%	39%	21%	15%
NonMetallicMinerals	11%	20%	29%	40%	**Business Services**	23%	36%	23%	17%
Metals	10%	20%	36%	35%	**Government**	19%	37%	26%	18%
Machinery	13%	25%	32%	29%	**Education**	16%	45%	28%	10%
ElectricMachines&PC	14%	27%	25%	33%	**Health**	13%	31%	35%	21%
TranspMachines	11%	23%	31%	34%	**OtherServices**	17%	31%	24%	28%
OtherManufacturing	10%	18%	29%	43%					
Cross-industry mean	12%	22%	28%	38%		16%	30%	30%	25%
Std Deviation	3%	5%	4%	8%		5%	9%	8%	12%

Changes in shares (of a given routine type)

$$\Delta S_{q,t} = \sum_i \Delta\theta_{i,t}\overline{s}_{i,q} + \sum_i \overline{\theta}_i \Delta s_{i,q,t}$$



Industry dimension

Shares in the macroindustry employment.