Is Modern Technology Responsible for Jobless Recoveries?*

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Abstract

Since the early 1990s, recoveries from recessions in the US have been plagued by weak employment growth. One possible explanation for these "jobless" recoveries is rooted in technological change: middle-skill jobs, often involving routine tasks, are lost during recessions, and the displaced workers take time to transition into other jobs (Jaimovich and Siu, 2014). But technological replacement of middle-skill workers is not unique to the US—it also takes place in other developed countries (Goos, Manning, and Salomons, 2014). So if jobless recoveries in the US are due to technology, we might expect to also see them elsewhere in the developed world. We test this possibility using data on recoveries from 71 recessions in 28 industries and 17 countries from 1970-2011. We find that after 1985, GDP recovered more slowly after recessions, but employment did not. Industries that used routine tasks more intensively experienced deeper recessions even before 1985, and this pattern did not worsen since. Finally, middle-skill jobs did not recover particularly slowly after recessions in industries that were more affected by technological change. Taken together, this evidence suggests that technology is not causing jobless recoveries in developed countries outside the US.

KEYWORDS: Job polarization, jobless recoveries, routine-biased technological change

JEL CLASSIFICATION: E32, J23, O33

1 Introduction

Since the early 1990s, recoveries from recessions in the US have been plagued by weak employment growth. Employment growth during the two years after each recession's trough was a little over five percent before 1990, and just under one percent since then (Gali, Smets, and Wouters, 2012). One possible explanation for the slower recovery of jobs is related to technological change. Middle-skill jobs, often involving routine tasks that are particularly susceptible to replacement by new technologies, might be destroyed permanently during recessions. The displaced workers are then forced into time-consuming

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transitions to different occupations and sectors, resulting in slow job growth during the recovery. This explanation has been proposed, along with empirical evidence, by Jaimovich and Siu (2014), and we confirm that it fits the employment patterns in the US. But we also examine whether this mechanism is at work in the rest of the developed world: labor market polarization (or "hollowing out" of middle-skill jobs) has been documented in the US as much as in other countries, and there is evidence that technology is one of the drivers of this change (Goos, Manning, and Salomons, 2014; Michaels, Natraj, and Van Reenen, 2014). Our main research question is therefore: could modern technology also be contributing to jobless recoveries across developed economies?

In order to examine technology's role in employment recoveries from recessions, we use data on 71 recessions, which took place in 17 developed countries from 1970-2011. We use both aggregate data and harmonized data on 28 industries within each of these countries.[1] We investigate how recoveries changed since the late 1980s, and whether these changes are likely attributable to technological change.

First, we examine whether recoveries from recessions after 1985 produced slower employment growth than earlier recoveries. Second, we test whether industries that make more intensive use of routine jobs, and are therefore more susceptible to technological change, have had particularly slow employment growth in recoveries. Finally, we investigate whether routine-intensive industries have seen more replacement of middle-skill jobs during recessions and recoveries.

We find that in contrast to the US, recoveries in other developed countries as a whole have not become significantly more jobless since the late 1980s, even though GDP did recover more slowly. Routine-intensive industries did experience deeper recessions and slower recoveries than other industries, but this pattern did not change significantly after 1985. Finally, we find that middle-skill employment grew similarly in routine-intensive industries and other industries during recent recoveries. Taken together, this evidence suggests that technology is not causing jobless recoveries in developed countries outside the US.

Our paper is related to the literature documenting slow or jobless recoveries (e.g. Gali, Smets, and Wouters, 2012). We show that this phenomenon, which has prevailed in the US since the late 1980s, is not characteristic of labor markets in other developed economies. Our findings are therefore consistent with explanations of jobless recoveries that are more related to US-specific conditions, including institutional and policy based explanations. For example, Mitman and Rabinovich (2014) show that unemployment benefit extensions, which increase workers' reservation wages, may slow down employment growth during recoveries. And in related work, Berger (2015) proposes that the substitution of workers during recessions and recoveries may have become more pronounced in recent decades because of the decline of unions.

Our paper is also related to the literature on the role of recessions in replacing existing production technologies, and thereby facilitating longer term growth. Caballero and Hammour (1994) argue that a reduction in adoption of new technologies may insulate employment from demand falls during recessions, although they conclude that recessions nonetheless increase job destruction, a conclusion that has been echoed in other recent research (e.g. Solon, Michaels, and Elsby, 2009, and Davis and Wachter, 2011).[2] Our study contributes to this literature, which has often focused on US recessions, by looking at

[1] Our main data sources include the EUKLEMS data set (O'Mahony and Timmer, 2009) and the World Input-Output Database (Timmer, Dietzenbacher, Los, Stehrer, and Vries, 2015).

[2] A recent addition to the literature on technology upgrading during recessions is Hershbein and Kahn (2016), who find that

a broad set of countries, and by focusing on recoveries from recessions.

Another literature to which our paper relates studies the effects of technological change, and specifically technologies that replace routine jobs.[3] Like other recent papers,[4] we examine evidence from a range of developed countries, but unlike most previous studies we focus on the business cycle, rather than on longer run trends.

2 Data

We obtain industry-level real value added, total hours worked, and hours worked by skill group, as well as country-level hours worked, from the EUKLEMS data set (O'Mahony and Timmer, 2009) and the World Input-Output Database (Timmer, Dietzenbacher, Los, Stehrer, and Vries, 2015, WIOD).[5] EUKLEMS covers the period 1970-2007 (for the US, 1977-2007) and also includes information on the share of ICT services in total capital services. WIOD covers 1995-2011.[6] We use the more recent WIOD data during years of overlap with EUKLEMS.

Our source for country-level GDP data, at both quarterly and annual frequency, is the OECD (2016). We obtain business-cycle peak and trough dates from the Economic Cycle Research Institute (ECRI).[7] For countries not covered by ECRI, we assign peak and trough dates using quarterly GDP data from the OECD, defining a recession as two or more consecutive quarters of negative GDP growth.[8]

Since our industry-level data are only available at annual frequency, we need a rule to classify each country-year as an expansion, recession, or recovery year, based on quarterly peak and trough indicators. The rule we use is to classify years during which GDP contracts for the majority of the time as recession years. We classify the two years immediately following a recession year as recovery years. All other years are expansion years.[9] Appendix Figure A1 displays all recession years for the countries in our sample from 1970-2015. Our final sample contains 71 recessions for which we observe at least the first year of recovery. We choose 1985 as the last year of our pre-period, consistent with Jaimovich and Siu (2014), who consider the 1990 recession in the US to be the first to feature a jobless recovery.

One might be concerned that our use of annual data causes measurement error in the timing of business cycles. However, prior literature on jobless recoveries focusses on cumulative employment growth, say over four or eight quarters as in Gali, Smets, and Wouters (2012), after a trough. This suggests that annual data, though admittedly not ideal, can be used to study jobless recoveries. Because

skill requirements in vacancy postings increased more in local labor markets that were more affected by the Great Recession, and that these patterns persisted.

[3]See e.g. Autor, Levy, and Murnane (2003), Acemoglu and Autor (2011), and Autor and Dorn (2013).

[4]For instance, Goos, Manning, and Salomons (2014), Michaels, Natraj, and Van Reenen (2014), and Graetz and Michaels (2015).

[5]EUKLEMS and WIOD provide data on three different skill groups: high (college and above), middle (high school, some college) and low (less than high school).

[6]Real value added is missing for some countries in 2010 and 2011.

[7]See their table "Business Cycle Peak and Trough Dates, 21 Countries, 1948-2015", available at `https://www.businesscycle.com/download/report/3723` (accessed on Nov 1, 2016).

[8]The countries not covered by ECRI include Denmark, Finland, Ireland, and The Netherlands.

[9]When GDP both expands and contracts for two quarters in a given year, then we classify it as a recession year if the contraction falls in the third and fourth quarters, or in the second and third quarters, but not otherwise. To illustrate our rule, take the Great Recession in the US, with peak in 2007Q4 and trough in 2009Q2. The year 2007 counts as an expansion year. With all quarters of 2008 seeing negative growth, 2008 is a recession year. By our tie-breaking rule, 2009 is not a recession year.

the distinction of recession and recovery years may be noisy in some cases, we report coefficients on indicators for recession years, as well as recovery years, in all our results. Reassuringly, for the US we do detect patterns consistent with those documented by Jaimovich and Siu (2014) in our annual data. Furthermore, there are no significant differences in the frequency of recession years (about one in six) or the distribution of peak and trough quarters, between our pre-period (1970-1985) and post-period (1986-2011). It is therefore unlikely that measurement error due to using annual cycle indicators is driving our results.

We measure the extent to which industries are subject to technological change using routine intensity (RTI) as constructed in Autor and Dorn (2013).[10] We standardize RTI to have zero mean and unit variance. Consistent with prior literature, we find routine intensity to be positively related to the ICT share in total capital services in 1995: a one-standard-deviation increase in routine intensity is associated with a 0.2 increase in the share of ICT in total capital. This relationship does not vary between the US and other countries.[11] The most routine-intensive industries include financial intermediation, retail trade, and various manufacturing industries, while the least routine-intensive industries include agriculture, transportation, and education.

We also employ two alternative measures of exposure to technological change. The first is the ICT share in total capital in 1995—a measure of actual technology adoption at a point in time when the ICT revolution was well under way in all developed countries. The second is the share of labor hours replaceable by industrial robots. This industry-level replaceability measure, which we developed in an earlier paper, is based on differential replaceability of occupations, and differences in the hours share of occupations across industries, in the US in 1980; see Graetz and Michaels (2015) for more details.

3 Results

We begin by examining aggregate changes in recoveries from recessions. We do this by estimating regressions of the form

$$\Delta \log Y_{ct} = \mathbf{d}_{ct}'\beta_1 + \mathbf{x}_c'\beta_2 + \mathbb{1}\{t \geq 1986\} \times \mathbf{d}_{ct}'\beta_3 + \mathbb{1}\{t \geq 1986\} \times \mathbf{x}_c'\beta_4 + \varepsilon_{ct}, \tag{1}$$

using aggregate level data on annual changes in outcomes $Y_{ct} \in \{\text{GDP}_{ct}, \text{hours}_{ct}\}$ in country c and year t. The vector $\mathbf{d}_{ct}$ collects indicators for year t being a recession year, a year after a recession, or a year that comes two years after a recession. Formally,

$$\mathbf{d}_{ct}' \equiv (\mathbb{1}_{ct}\{\text{recession}\}, \mathbb{1}_{ct}\{\text{year after recession}\}, \mathbb{1}_{ct}\{\text{two years after recession}\}).$$

The matrix $\mathbf{x}_c$ contains country dummies. We cluster standard errors by country, using the small-group adjustment that Stata implements by default (Brewer, Crossley, and Joyce, 2013). To detect any changes

[10] The full procedure for constructing RTI is as follows. First, following Autor, Levy, and Murnane (2003) and Acemoglu and Autor (2011), we construct the variables routine, manual, and abstract using the Dictionary of Occupational Titles. Routine is the average of indicators for the requirements of "finger dexterity" and "precise attainment of set limits, tolerances, or standards." Manual is equal to the indicator for "eye-hand-foot coordination" and abstract equals the simple average of "GED math" and "responsibility for direction, control, or planning." We aggregate these occupation-level variables to the industry level using the 1980 US census. Finally, RTI is calculated as $\log(routine/(abstract \times manual))$, as in Autor and Dorn (2013).

[11] These results are available upon request.

in business cycles coinciding with the period of rapid technology adoption after 1985, we interact all variables with a dummy indicating this later period.

As columns (1) and (2) of Table 1 show, employment growth in the two years after the trough of a recession was slow across the 41 years of our study. After 1985, employment recoveries were not significantly slower than in the previous years, although the point estimates in this later period were a little lower. But to put these point estimates in context, the next two columns of Table 1 show that GDP recovery was also slower in the post-1985 period, especially in the first year of the recovery. Relative to GDP growth, there is little to suggest that employment growth in recent recoveries in the developed world has been particularly weak.

Next, we examine the differential behaviour of routine-intensive industries over the business cycle. We are motivated by a large literature documenting that routine-intensive jobs have been more exposed to technological change.[12] The focus on routine-intensive industries is also in the spirit of Jaimovich and Siu (2014).

To examine whether industries that are more intensive in routine tasks display a different pattern of recovery from recessions, we estimate regressions of the form

$$\begin{aligned} \Delta \log Y_{ict} &= \mathbf{d}'_{ct}\gamma_1 + \mathrm{RTI}_i \times \mathbf{d}'_{ct}\gamma_2 + \mathbf{x}'_{ic}\gamma_3 + \mathbb{1}\{t \geq 1986\} \times \mathbf{d}'_{ct}\gamma_4 \\ &\quad + \mathbb{1}\{t \geq 1986\} \times \mathrm{RTI}_i \times \mathbf{d}'_{ct}\gamma_5 + \mathbb{1}\{t \geq 1986\} \times \mathbf{x}'_{ic}\gamma_6 + \nu_{ict}, \end{aligned} \tag{2}$$

where the data are year-on-year changes at the country-industry level. RTI_i is routine intensity in industry i, standardized to have zero mean and unit variance. The matrix $\mathbf{x}_{ic}$ contains country and industry dummies. In some specifications, we omit industry dummies and include the non-interacted routine index instead. We continue to cluster standard errors at the country level. We weight all industry-level regressions by the within-country employment share of each country-industry, averaged over time. Weights sum up to one within countries, so that each country receives equal weight, as in our country-level regressions above.

The first column of Table 2 shows estimates similar to Table 1, but this time at the level of individual industries. Again, any slowdown in employment recoveries after 1985 appears small in magnitude, and is imprecisely estimated. Column (2) reports our main specification (2), replacing industry fixed effects with a measure of routine intensity and its interaction with an indicator for 1986 onwards. It shows that routine-intensive industries did not experience significantly slower employment growth over the period as a whole, although their employment contracted more during recessions. Employment growth during expansions in routine-intensive industries slowed down after 1985, but recoveries from recessions did not. Column (3) estimates specification 2 with industry fixed effects, and column (4) does the same but excluding observations that are missing data on industry value added. In both cases the picture remains similar, indicating that routine-intensive industries did not experience worse employment recoveries after 1985.

The final two columns of Table 2 report estimates of the same specifications as columns (3) and (4), but this time using changes in value added as the outcome. Again it seems that routine-intensive industries experienced deeper recessions and slower recoveries in terms of output, and their output recovery

[12] See e.g. Autor, Levy, and Murnane (2003), Acemoglu and Autor (2011), Autor and Dorn (2013), Goos and Manning (2007), Goos, Manning, and Salomons (2014), or Michaels, Natraj, and Van Reenen (2014).

after 1985 was slower in the first year after the recession. But as before, this pattern did not change appreciably after 1985.

Columns (1)-(3) of Table 3 show estimates of the same regressions as in columns (3), (4) and (6) of Table 2, but this time only for the US. These results show a picture that is broadly consistent with Jaimovich and Siu (2014): in the US, employment and value added growth were slower in recent recessions, and even more so in routine-intensive industries. In other words, the phenomenon of "jobless recoveries" as observed in the US could be related to technological change—but, as our previous tables show, the same conclusion does not apply outside the US.

In Appendix Table A1, we report a series of robustness checks, again using the specifications from columns (3), (4) and (6) of Table 2 as a benchmark. The three checks we report are: adding year fixed effects to the regressions (which are as usual in changes); estimating unweighted regressions; or using EUKLEMS instead of WIOD for the years when they overlap. In all cases the basic picture outlined above remains unchanged, and there is little evidence that routine-intensive industries experienced more-jobless recoveries after 1985.

While our main specifications follow the literature in using industries' routine intensity as a measure of exposure to technological change, we also consider alternative and more direct measures of technology adoption. In Appendix Table A2, we report estimates using the same specifications as in Table 2, but each time replacing industries' routine intensity with different technology measures. The first three columns report estimates using the share of ICT in total capital (measured in 1995) as the proxy for technology, showing a similar pattern as before, although here there is some evidence that in recent recessions employment in ICT-intensive industries grew more slowly during the first year of recovery (but not in the second year of recovery); in this case we do not see particularly slow recovery for value added in ICT-intensive industries after 1985. The next three columns repeat the exercise but this time using the fraction of hours worked in each industry that are subject to replacement by industrial robots (we exclude industries that do not employ industrial robots in any country as of 2011, see Graetz and Michaels, 2015). Industries that would eventually be more exposed to robotization, initially featured deeper recessions and slower recoveries, but if anything, this pattern slightly weakened after 1985. The final six columns repeat the estimates of the first six, but this time only for the US. Here, although only some of the estimates are significant at conventional levels, there appears to be more support for the view that in technology-intensive industries, employment grew less during recent recoveries. As before, however, this seems to be a US-specific phenomenon, rather than one that is shared by other developed countries.

To shed more light on the differences in our results between the US and other developed countries, we investigate whether the relationship between long-run employment growth and industries' routine intensity differs between countries. In Appendix Table A3, we report results from long-differenced regressions of log hours on routine intensity and its interaction with the post-1985 dummy. Panel *A* shows that until 1985, routine intensity was associated with faster employment growth across all countries. Afterwards, routine-intensive industries experienced slower employment growth in the US, but not in other countries. Replacing routine intensity by the share of ICT in total capital yields a somewhat similar pattern, as shown in panel *B*.[13] Given this, we investigate whether countries in which routine-intensive

[13] We lack industry-level data for the US prior to 1978. Using 1978 as the start year for all other countries yields qualitatively

industries saw more pronounced slowdowns in long-run employment growth, also experienced increasingly sluggish recoveries from recessions in routine-intensive industries. We estimate the interaction term of routine intensity and the post-1985 dummy separately for each country, both for long-run employment growth—as in Appendix Table A3—and for recoveries from recession—as in Table 2. We then plot the "short-run" coefficient against the "long-run" coefficient. If technology were behind jobless recoveries, we would expect a positive relationship: countries experiencing a larger degree of routine-biased technological change should feature larger long-run employment declines associated with routine intensity after 1985; and they should also feature increasingly slow recoveries in routine-intensive industries after 1985. However, Appendix Figure A2 shows no such relationship between "short-run" and "long-run" coefficients, with the US being somewhat of an outlier.[14]

Lastly, we examine whether recoveries from recessions have become particularly bad for the employment of middle-skill workers, whose jobs are more intensive in routine tasks than those of other skill groups (see e.g. Acemoglu and Autor, 2011 and Michaels, Natraj, and Van Reenen, 2014). In Appendix Table A4, we examine the changes in employment by skill groups during recessions and recoveries. Specifically, we report estimates from specification (1)—as in column (2) of Table 1—but this time separately for high-skill, middle-skill, and low-skill workers.[15] Here we find some suggestive evidence that after 1985 recessions became worse for middle-skill workers. But there is no evidence that employment changes during recoveries increasingly work against middle-skill workers in particular. While the aggregate results do not indicate that recent recoveries were biased against middle-skill workers, we also consider the possibility that in routine-intensive industries recoveries worked against middle-skill workers. In Appendix Table A5, we test this possibility estimating specification (2)—as in columns (1) and (2) of Table 2—but this time using each group's employment change as outcomes. Again the results show no evidence of a worsening in the employment prospects of middle-skill workers in routine-intensive industries in more recent recessions.[16]

4 Discussion

The main conclusion of our paper is that in developed countries outside the US, modern technologies are unlikely to be causing jobless recoveries. This conclusion stems from our findings that in most developed countries, recent recoveries are not particularly jobless; that recent recoveries have not become more jobless in routine-intensive industries, which are more prone to technological change; and that middle-skilled workers are not being differentially hurt during recent recoveries—both in general and specifically in routine-intensive industries.

Our results do, however, pose a puzzle as to the nature of recent jobless recoveries in the US. There are two (and perhaps more) possible explanations. The first builds on our finding that across industries in the US, technological change is associated with the recent joblessness of recoveries, consistent with

identical results to those in Appendix Table A3.

[14]Appendix Figure A3 shows results from alternative specifications. At most there is a very weak positive relationship in some cases.

[15]The breakdown of hours worked by skill group is unfortunately not available for some countries during the 1970s and 1980s.

[16]Even when we examine these results separately for the US there is still no evidence that middle-skill employment suffers disproportionately in routine-intensive industries in recent recessions.

Jaimovich and Siu (2014).[17] Although secular changes in occupational employment, likely driven by technology, have been very similar across the US and other developed countries, there are aspects of technology adoption that differ—see for instance Bloom, Sadun, and Van Reenen (2012). Perhaps such differences could explain the absence of jobless recoveries outside the US. The second possible explanation appeals to US-specific policy and institutional changes. For instance, Mitman and Rabinovich (2014) show that unemployment benefit extensions, which increase workers' reservation wages, may slow down employment growth during recoveries. Berger (2015) proposes that the substitution of workers during recessions and recoveries may have become more pronounced in recent decades because of the decline of unions. Establishing the relative merits of the technology- and policy-based explanations, which of course need not be mutually exclusive, is a task for future research.

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[17] This is also consistent with Hershbein and Kahn (2016), who document that skill requirements in vacancy postings increased more in local labor markets that were more affected by the Great Recession, and that these patterns persisted.

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Table 1: Growth in aggregate hours worked and GDP

	Hours		GDP	
	(1)	(2)	(3)	(4)
$\mathbb{1}\{\text{recession year}\}$	-2.07	-1.78	-3.63	-3.46
	(0.35)	(0.33)	(0.48)	(0.41)
$\mathbb{1}\{\text{one year after recession}\}$	-2.16	-1.95	-2.24	-1.74
	(0.24)	(0.35)	(0.21)	(0.34)
$\mathbb{1}\{\text{two years after recession}\}$	-0.78	-0.49	-0.49	-0.46
	(0.22)	(0.21)	(0.30)	(0.36)
$\mathbb{1}\{\text{recession year}\} \times \mathbb{1}\{t \geq 1986\}$		-0.50		-0.43
		(0.48)		(0.51)
$\mathbb{1}\{\text{one year after recession}\} \times \mathbb{1}\{t \geq 1986\}$		-0.29		-1.09
		(0.57)		(0.43)
$\mathbb{1}\{\text{two years after recession}\} \times \mathbb{1}\{t \geq 1986\}$		-0.47		-0.24
		(0.43)		(0.35)
Observations	690	690	690	690

Notes: Dependent variables are annual changes in the log of hours and GDP, respectively, multiplied by 100 so that coefficients are scaled in log points. Standard errors, clustered by country, in parentheses. All regressions include a full set of country dummies. In specifications that interact cycle indicators with the dummy for the post-1985 period, country dummies are also interacted with that dummy.

Table 2: Growth in industry-level hours and VA over the business cycle, by period and routine intensity

	Hours				VA	
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}\{$recession year$\}$	-1.75	-1.74	-1.74	-1.73	-3.38	-3.38
	(0.28)	(0.28)	(0.28)	(0.28)	(0.46)	(0.46)
$\mathbb{1}\{$year after recession$\}$	-2.01	-2.00	-2.00	-2.00	-1.59	-1.59
	(0.37)	(0.38)	(0.38)	(0.38)	(0.35)	(0.35)
$\mathbb{1}\{$two years after recession$\}$	-0.58	-0.58	-0.58	-0.58	-0.77	-0.77
	(0.25)	(0.25)	(0.25)	(0.25)	(0.34)	(0.34)
RTI		1.25			1.18	
		(0.22)			(0.36)	
RTI$\times\mathbb{1}\{$recession year$\}$		-0.83	-0.72	-0.73	-0.97	-0.97
		(0.14)	(0.13)	(0.13)	(0.22)	(0.22)
RTI$\times\mathbb{1}\{$year after recession$\}$		-0.67	-0.57	-0.57	-1.43	-1.43
		(0.16)	(0.15)	(0.15)	(0.54)	(0.54)
RTI$\times\mathbb{1}\{$two years after recession$\}$		-0.22	-0.10	-0.11	-0.38	-0.38
		(0.21)	(0.20)	(0.20)	(0.46)	(0.45)
$\mathbb{1}\{$recession year$\}\times\mathbb{1}\{t \geq 1986\}$	-0.63	-0.65	-0.65	-0.85	-0.23	-0.23
	(0.47)	(0.46)	(0.47)	(0.46)	(0.56)	(0.56)
$\mathbb{1}\{$year after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.44	-0.44	-0.44	-0.55	-1.44	-1.44
	(0.59)	(0.58)	(0.58)	(0.57)	(0.43)	(0.44)
$\mathbb{1}\{$two years after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.24	-0.24	-0.24	-0.63	-0.22	-0.22
	(0.53)	(0.53)	(0.53)	(0.29)	(0.38)	(0.38)
RTI$\times\mathbb{1}\{t \geq 1986\}$		-0.48			-0.20	
		(0.16)			(0.30)	
RTI$\times\mathbb{1}\{$recession year$\}\times\mathbb{1}\{t \geq 1986\}$		0.31	0.20	0.17	-0.39	-0.39
		(0.21)	(0.22)	(0.22)	(0.33)	(0.33)
RTI$\times\mathbb{1}\{$year after recession$\}\times\mathbb{1}\{t \geq 1986\}$		-0.19	-0.27	-0.28	0.26	0.25
		(0.31)	(0.30)	(0.31)	(0.55)	(0.54)
RTI$\times\mathbb{1}\{$two years after recession$\}\times\mathbb{1}\{t \geq 1986\}$		0.28	0.19	-0.05	0.13	0.12
		(0.32)	(0.31)	(0.24)	(0.63)	(0.63)
Industry dummies	✓		✓	✓		✓
Excluding observations with missing industry VA				✓	✓	✓
Observations	19,320	19,320	19,320	18,284	18,284	18,284

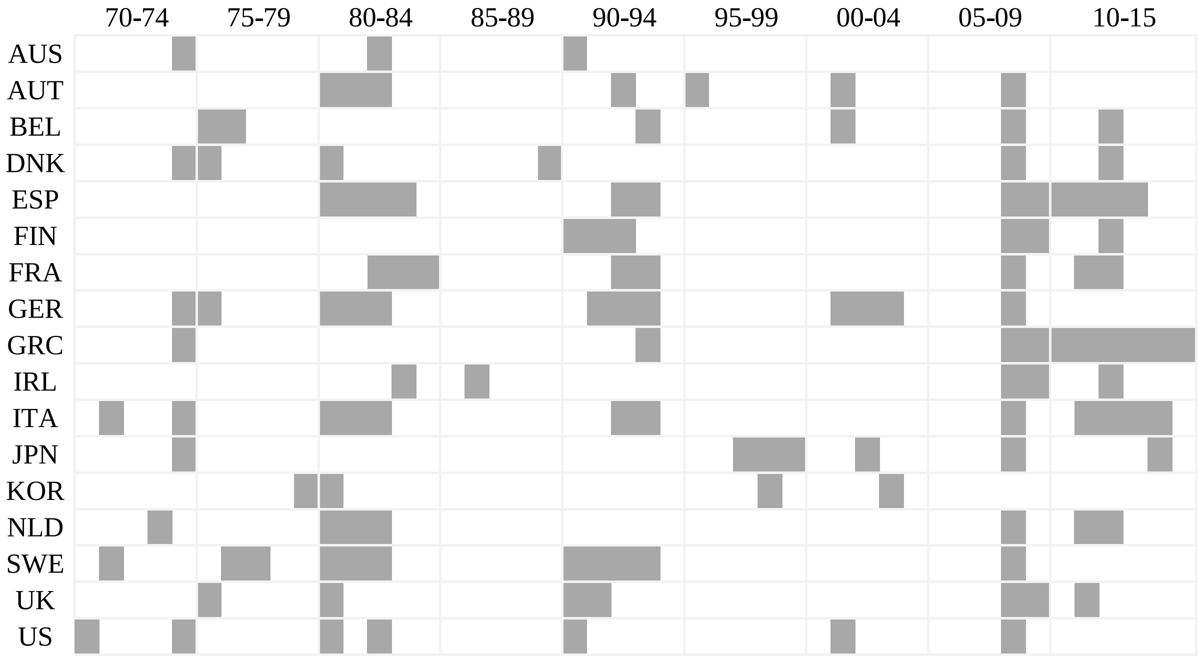
Notes: The dependent variables are annual changes in the log of hours worked and the log of value added, respectively, multiplied by 100 so that coefficients are scaled in log points. RTI refers to the routine index, which is standardized to have zero mean and unit variance. Standard errors, clustered by country, in parentheses. Regressions are weighted by within-country employment shares, averaged across the entire sample period. All regressions include a full set of country dummies, and a full set of industry dummies where indicated. In specifications that interact cycle indicators with the dummy for the post-1985 period, country (and industry) dummies are also interacted with that dummy.

Table 3: Growth in industry-level hours and VA over the business cycle, by period and routine intensity—US only

	Hours		VA
	(1)	(2)	(3)
$\mathbb{1}\{$recession year$\}$	-4.07	-4.07	-6.80
	(0.96)	(0.97)	(1.85)
$\mathbb{1}\{$year after recession$\}$	-2.80	-2.80	-2.01
	(0.51)	(0.51)	(0.97)
$\mathbb{1}\{$two years after recession$\}$	-0.17	-0.17	0.62
	(0.45)	(0.45)	(0.97)
RTI$\times\mathbb{1}\{$recession year$\}$	-0.50	-0.50	-0.32
	(1.00)	(1.01)	(1.96)
RTI$\times\mathbb{1}\{$year after recession$\}$	0.66	0.66	1.65
	(0.43)	(0.43)	(1.24)
RTI$\times\mathbb{1}\{$two years after recession$\}$	0.47	0.47	-0.84
	(0.43)	(0.43)	(1.09)
$\mathbb{1}\{$recession year$\}\times\mathbb{1}\{t \geq 1986\}$	2.02	1.94	4.74
	(0.55)	(0.55)	(1.30)
$\mathbb{1}\{$year after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-1.41	-1.49	-1.74
	(0.86)	(0.85)	(1.14)
$\mathbb{1}\{$two years after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-2.21	-1.94	-0.85
	(0.98)	(0.85)	(0.95)
RTI$\times\mathbb{1}\{$recession year$\}\times\mathbb{1}\{t \geq 1986\}$	-0.93	-0.89	-1.16
	(0.65)	(0.65)	(1.56)
RTI$\times\mathbb{1}\{$year after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-2.01	-1.98	-3.15
	(0.77)	(0.76)	(1.96)
RTI$\times\mathbb{1}\{$two years after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.66	-0.81	-0.59
	(0.92)	(0.82)	(0.72)
Excluding observations with missing industry VA		✓	✓
Observations	952	896	896

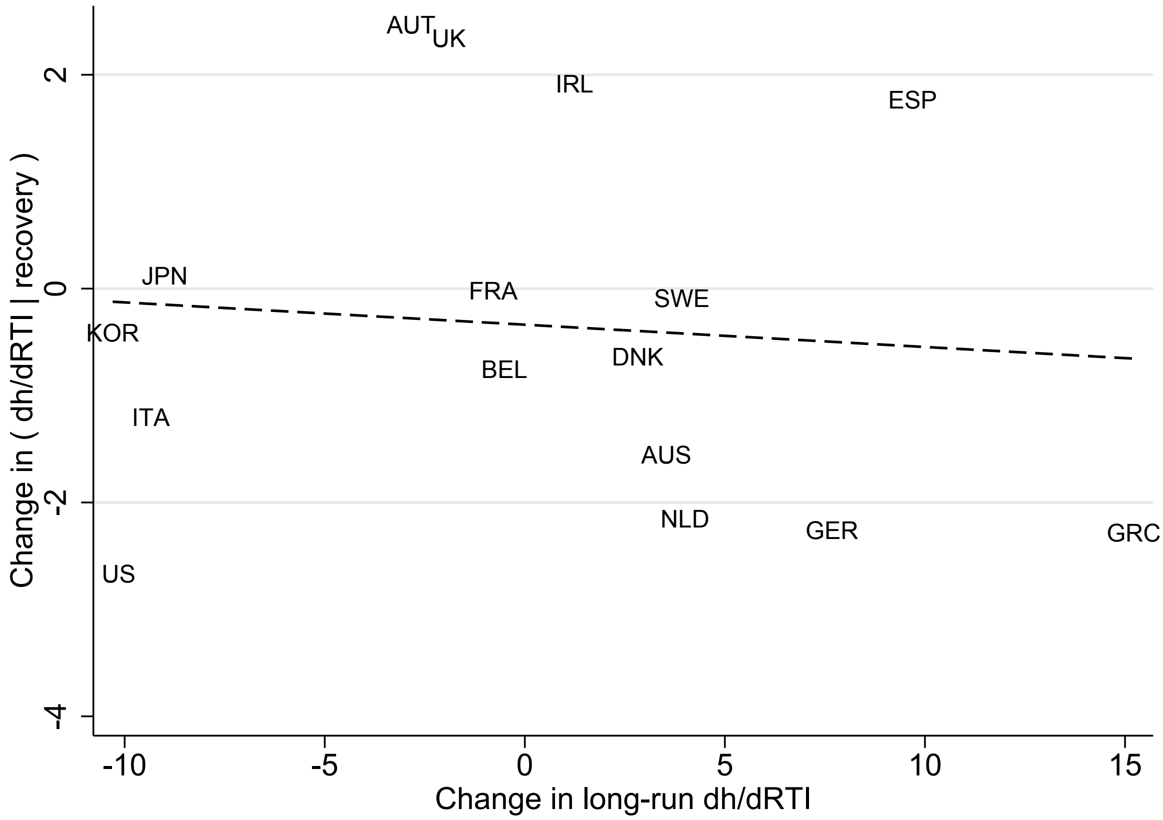
Notes: The dependent variables are annual changes in the log of hours worked and the log of value added, respectively, multiplied by 100 so that coefficients are scaled in log points. RTI refers to the routine index, which is standardized to have zero mean and unit variance. Standard errors, clustered by industry, in parentheses. Regressions are weighted by employment shares, averaged across the entire sample period. All regressions include a full set of industry dummies interacted with the post-1985 dummy.

Appendix Figures and Tables



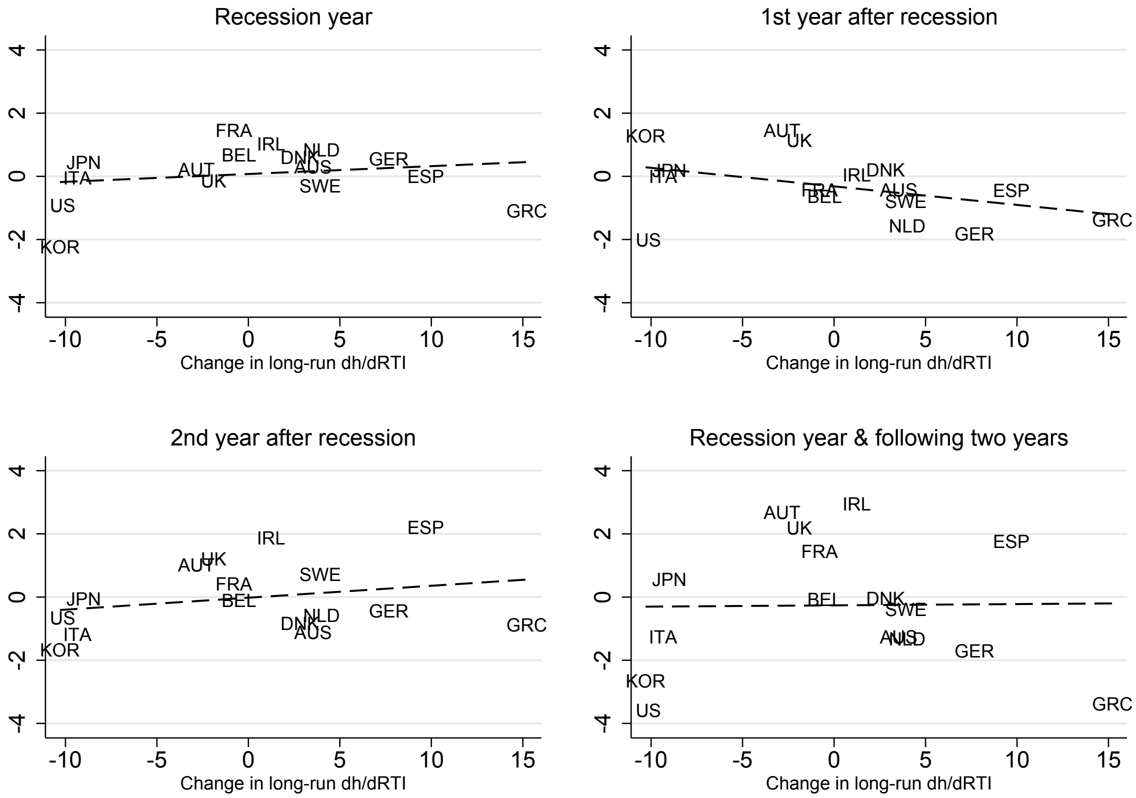
Notes: Recession years are marked by grey boxes. See Section 2 for data sources and definitions.

Figure A1: Recession years 1970-2015



Notes: The horizontal axis shows the change in the association of routine intensity and long-run employment growth between the pre-period (a single long difference from 1970-1985) and the post period (a single long difference from 1985-2005) in each country. For the US, this value is displayed in Appendix Table A3, namely the coefficient on RTI$\times\mathbb{1}\{$1985-2005$\}$ in column (4). The vertical axis shows the change in the association of routine intensity and employment growth during the two years following a recession (summing over coefficients) between the pre- and post-period in each country. For the US, this value can be obtained from Table 3, namely the sum of the coefficients on RTI$\times\mathbb{1}\{$year after recession$\} \times \mathbb{1}\{t \geq 1986\}$ and RTI$\times\mathbb{1}\{$two years after recession$\} \times \mathbb{1}\{t \geq 1986\}$ in column (1).

Figure A2: Routine intensity, employment recovery, and long-run employment growth



Notes: See the notes to Appendix Figure A2 for a description of the horizontal axis. The vertical axis shows coefficients from the same regressions as in Appendix Figure A2. In particular: the coefficients for the interaction of routine intensity, the post dummy, and recession year; one year after recession; two years after recession; and the sum of (interacted) coefficients over recession year and two years after, are shown.

Figure A3: Routine intensity, employment growth during recessions and recoveries, and long-run employment growth

Table A1: Growth in industry-level hours and value added—robustness checks

	Baseline			Year FEs			Unweighted			EUKLEMS		
	(1) H	(2) H	(3) VA	(4) H	(5) H	(6) VA	(7) H	(8) H	(9) VA	(10) H	(11) H	(12) VA
$\mathbb{1}\{$recession year$\}$	-1.74	-1.73	-3.38	-1.82	-1.82	-2.49	-2.06	-2.06	-4.03	-2.06	-2.06	-4.03
	(0.28)	(0.28)	(0.46)	(0.43)	(0.43)	(0.47)	(0.37)	(0.37)	(0.48)	(0.37)	(0.37)	(0.48)
$\mathbb{1}\{$year after recession$\}$	-2.00	-2.00	-1.59	-2.04	-2.05	-0.82	-2.38	-2.38	-1.97	-2.38	-2.38	-1.97
	(0.38)	(0.38)	(0.35)	(0.48)	(0.48)	(0.46)	(0.43)	(0.43)	(0.44)	(0.43)	(0.43)	(0.44)
$\mathbb{1}\{$two years after recession$\}$	-0.58	-0.58	-0.77	-0.76	-0.76	-0.62	-0.56	-0.56	-0.15	-0.56	-0.56	-0.15
	(0.25)	(0.25)	(0.34)	(0.24)	(0.24)	(0.37)	(0.26)	(0.26)	(0.49)	(0.26)	(0.26)	(0.49)
RTI$\times\mathbb{1}\{$recession year$\}$	-0.72	-0.73	-0.97	-0.73	-0.73	-0.95	-0.98	-0.98	-1.04	-0.98	-0.98	-1.04
	(0.13)	(0.13)	(0.22)	(0.14)	(0.14)	(0.22)	(0.25)	(0.25)	(0.33)	(0.25)	(0.25)	(0.33)
RTI$\times\mathbb{1}\{$year after recession$\}$	-0.57	-0.57	-1.43	-0.57	-0.57	-1.45	-0.60	-0.60	-1.15	-0.60	-0.60	-1.15
	(0.15)	(0.15)	(0.54)	(0.15)	(0.16)	(0.55)	(0.17)	(0.17)	(0.44)	(0.17)	(0.17)	(0.44)
RTI$\times\mathbb{1}\{$two years after recession$\}$	-0.10	-0.11	-0.38	-0.10	-0.10	-0.36	-0.30	-0.29	-0.77	-0.30	-0.29	-0.77
	(0.20)	(0.20)	(0.45)	(0.20)	(0.20)	(0.47)	(0.24)	(0.24)	(0.44)	(0.24)	(0.24)	(0.44)
$\mathbb{1}\{$recession year$\}\times\mathbb{1}\{t \geq 1986\}$	-0.65	-0.85	-0.23	-0.44	-0.65	-0.12	-0.55	-0.81	-0.18	-0.40	-0.64	0.14
	(0.47)	(0.46)	(0.56)	(0.61)	(0.67)	(0.40)	(0.44)	(0.47)	(0.64)	(0.46)	(0.50)	(0.63)
$\mathbb{1}\{$year after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.44	-0.55	-1.44	0.59	0.63	-0.36	-0.18	-0.25	-1.67	-0.19	-0.26	-1.70
	(0.58)	(0.57)	(0.44)	(0.63)	(0.71)	(0.59)	(0.80)	(0.78)	(0.56)	(0.80)	(0.79)	(0.55)
$\mathbb{1}\{$two years after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.24	-0.63	-0.22	0.08	-0.23	-0.12	0.04	-0.45	-0.76	0.06	-0.43	-0.65
	(0.53)	(0.29)	(0.38)	(0.60)	(0.48)	(0.47)	(0.54)	(0.34)	(0.51)	(0.53)	(0.35)	(0.47)
RTI$\times\mathbb{1}\{$recession year$\}\times\mathbb{1}\{t \geq 1986\}$	0.20	0.17	-0.39	0.19	0.15	-0.44	0.36	0.36	-0.30	0.53	0.55	-0.04
	(0.22)	(0.22)	(0.33)	(0.22)	(0.22)	(0.33)	(0.25)	(0.25)	(0.25)	(0.21)	(0.22)	(0.39)
RTI$\times\mathbb{1}\{$year after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.27	-0.28	0.25	-0.23	-0.24	0.34	-0.42	-0.34	0.21	-0.37	-0.30	0.10
	(0.30)	(0.31)	(0.54)	(0.29)	(0.30)	(0.54)	(0.28)	(0.32)	(0.51)	(0.27)	(0.31)	(0.56)
RTI$\times\mathbb{1}\{$two years after recession$\}\times\mathbb{1}\{t \geq 1986\}$	0.19	-0.05	0.12	0.20	-0.03	0.16	0.31	0.20	0.60	0.35	0.26	0.56
	(0.31)	(0.24)	(0.63)	(0.32)	(0.25)	(0.64)	(0.28)	(0.29)	(0.49)	(0.27)	(0.28)	(0.48)
Excluding observations with missing industry VA		✓	✓		✓	✓		✓	✓		✓	✓
Observations	19,320	18,284	18,284	19,320	18,284	18,284	19,320	18,284	18,284	19,320	18,284	18,284

Notes: The dependent variables are the annual change in the log of hours worked (indicated by H) and the change in the log of value added (indicated by VA), multiplied by 100 so that coefficients are scaled in log points. The specifications under the heading "EUKLEMS" use EUKLEMS data up until and including 2007, and WIOD data thereafter (all other specifications in this paper use WIOD data from 1995). RTI refers to the routine index, which is standardized to have zero mean and unit variance. Standard errors, clustered by country, in parentheses. Regressions are weighted by within-country employment shares, averaged across the entire sample period (except specifications under the "Unweighted" heading). All regressions include a full set of country and industry dummies, interacted with the dummy for the post-1985 period.

Table A2: Growth in industry-level hours and value added, alternative measures of technology

	ICT			Robots			ICT, US only			Robots, US only		
	(1) H	(2) H	(3) VA	(4) H	(5) H	(6) VA	(7) H	(8) H	(9) VA	(10) H	(11) H	(12) VA
$\mathbb{1}\{$recession year$\}$	-1.71	-1.70	-3.04	-1.83	-1.82	-3.32	-4.26	-4.26	-7.03	-5.30	-5.30	-10.28
	(0.25)	(0.25)	(0.29)	(0.41)	(0.41)	(0.65)	(0.93)	(0.93)	(1.74)	(2.53)	(2.53)	(4.41)
$\mathbb{1}\{$year after recession$\}$	-1.93	-1.93	-1.71	-2.20	-2.19	-0.62	-2.66	-2.66	-1.54	-3.79	-3.79	-6.00
	(0.33)	(0.33)	(0.36)	(0.46)	(0.46)	(0.69)	(0.53)	(0.53)	(0.95)	(1.75)	(1.75)	(2.50)
$\mathbb{1}\{$two years after recession$\}$	-0.63	-0.63	-0.76	-0.71	-0.70	-0.32	-0.06	-0.06	0.74	-0.11	-0.11	2.89
	(0.26)	(0.26)	(0.35)	(0.34)	(0.35)	(0.41)	(0.47)	(0.47)	(0.84)	(0.26)	(0.26)	(2.33)
Technology	0.13	0.13	0.20				8.06	8.06	3.39			
	(0.13)	(0.14)	(0.15)				(0.33)	(0.33)	(0.51)			
Technology$\times\mathbb{1}\{$recession year$\}$	-0.11	-0.11	-0.37	-1.27	-1.28	-1.63	0.83	0.83	1.69	-2.38	-2.38	-1.61
	(0.21)	(0.22)	(0.25)	(0.31)	(0.32)	(0.30)	(0.77)	(0.77)	(1.69)	(1.31)	(1.32)	(2.32)
Technology$\times\mathbb{1}\{$year after recession$\}$	0.15	0.15	-0.58	-1.08	-1.09	-1.77	-0.02	-0.02	-1.10	0.60	0.60	3.20
	(0.25)	(0.25)	(0.32)	(0.33)	(0.34)	(0.61)	(0.62)	(0.62)	(1.32)	(0.94)	(0.94)	(1.66)
Technology$\times\mathbb{1}\{$two years after recession$\}$	-0.32	-0.32	-0.37	-0.39	-0.40	-0.21	-0.09	-0.09	-3.11	0.50	0.50	-0.18
	(0.24)	(0.25)	(0.37)	(0.21)	(0.21)	(0.64)	(0.43)	(0.43)	(1.21)	(0.22)	(0.22)	(1.89)
$\mathbb{1}\{$recession year$\}\times\mathbb{1}\{t \geq 1986\}$	-0.88	-1.04	-0.46	-0.71	-0.90	0.34	1.99	1.92	4.63	3.09	2.99	7.60
	(0.49)	(0.48)	(0.57)	(0.71)	(0.70)	(0.71)	(0.53)	(0.53)	(1.22)	(1.24)	(1.19)	(3.75)
$\mathbb{1}\{$year after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.92	-1.15	-1.71	0.09	-0.22	-1.77	-1.71	-1.78	-2.44	-1.94	-2.05	1.08
	(0.43)	(0.35)	(0.34)	(0.64)	(0.70)	(0.57)	(0.93)	(0.92)	(1.41)	(0.81)	(0.87)	(2.70)
$\mathbb{1}\{$two years after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.41	-0.55	-0.22	-0.53	-0.63	-0.76	-2.28	-1.99	-1.14	-3.59	-2.92	-2.93
	(0.56)	(0.29)	(0.39)	(0.86)	(0.33)	(0.84)	(0.91)	(0.80)	(0.94)	(0.75)	(0.51)	(1.31)
Technology$\times\mathbb{1}\{t \geq 1986\}$	0.09	0.09	-0.05				-1.71	-1.39	3.03			
	(0.13)	(0.11)	(0.08)				(0.37)	(0.37)	(0.51)			
Technology$\times\mathbb{1}\{$recession year$\}\times\mathbb{1}\{t \geq 1986\}$	-0.06	-0.10	-0.24	0.64	0.50	-0.13	-1.83	-1.88	-1.53	0.83	0.92	-0.66
	(0.21)	(0.24)	(0.28)	(0.27)	(0.31)	(0.35)	(0.76)	(0.75)	(1.65)	(0.77)	(0.76)	(2.15)
Technology$\times\mathbb{1}\{$year after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.52	-0.90	0.32	0.30	0.30	0.28	-1.51	-1.55	0.07	-2.15	-2.05	-4.51
	(0.31)	(0.27)	(0.32)	(0.63)	(0.64)	(0.77)	(1.06)	(1.05)	(1.81)	(0.53)	(0.55)	(1.72)
Technology$\times\mathbb{1}\{$two years after recession$\}\times\mathbb{1}\{t \geq 1986\}$	-0.05	-0.25	-0.20	1.04	0.74	0.68	-0.78	-1.33	1.63	-0.51	-0.80	-0.72
	(0.25)	(0.23)	(0.35)	(0.41)	(0.42)	(0.84)	(0.81)	(0.74)	(1.30)	(0.40)	(0.31)	(1.60)
Excluding observations with missing industry VA		✓	✓		✓	✓		✓	✓		✓	✓
Observations	17,024	16,100	16,100	11,040	10,448	10,448	952	896	896	544	512	512

Notes: The dependent variables are the annual change in the log of hours worked and value added, multiplied by 100 so that coefficients are scaled in log points. In columns (1)-(3) and (7)-(9), the measure of technology is the ratio of ICT capital to total capital in 1995. In columns (4)-(6) and (10)-(12), the measure of technology is the fraction of hours that is replaceable by industrial robots—results reported in these columns are from samples excluding industries that do not use any robots as of 2011. Both measures are standardized to have zero mean and unit variance. Standard errors, clustered by industry (in the "US only" specifications) or country (all other), in parentheses. Regressions are weighted by within-country employment shares, averaged across the entire sample period. All regressions include a full set of country and industry dummies, interacted with the dummy for the post-1985 period.

Table A3: Long-run employment growth by technology intensity

	All		US only		excluding US	
	(1)	(2)	(3)	(4)	(5)	(6)
A. Routine intensity						
RTI	14.15		5.41		14.58	
	(2.94)		(3.23)		(3.05)	
RTI$\times\mathbb{1}\{1985\text{-}2005\}$	0.80	0.80	-10.15	-10.15	1.23	1.23
	(2.02)	(2.05)	(4.67)	(6.61)	(2.08)	(2.11)
Industry dummies		✓		✓		✓
Observations	952	952	56	56	896	896
B. ICT adoption						
ICT	10.81		13.97		10.72	
	(3.42)		(8.35)		(3.51)	
ICT$\times\mathbb{1}\{1985\text{-}2005\}$	4.24	4.08	-0.49	-0.49	4.37	4.33
	(3.30)	(2.84)	(4.74)	(6.70)	(3.39)	(2.93)
Industry dummies		✓		✓		✓
Observations	840	840	56	56	784	784

Notes: The sample includes the years 1970 (1978 for the US), 1985, and 2005. The dependent variable is the change in the log of hours worked, multiplied by 100 so that coefficients are scaled in log points. All regressions control for country and year dummies. Standard errors, clustered by industry (in the "US only" specifications) or country (all other), in parentheses.

Table A4: Growth in aggregate hours by skill group, by period

	All, skill sample (1)	High (2)	Middle (3)	Low (4)
$\mathbb{1}\{\text{recession year}\}$	-2.14	-3.11	-1.94	-2.08
	(0.62)	(1.84)	(0.68)	(1.05)
$\mathbb{1}\{\text{year after recession}\}$	-2.74	-3.57	-2.73	-2.20
	(0.49)	(1.43)	(0.62)	(0.50)
$\mathbb{1}\{\text{two years after recession}\}$	-0.77	-0.58	-1.40	-0.32
	(0.35)	(1.40)	(0.55)	(0.52)
$\mathbb{1}\{\text{recession year}\}\times\mathbb{1}\{t \geq 1986\}$	-0.47	1.45	-1.47	-0.89
	(0.77)	(1.93)	(0.89)	(0.98)
$\mathbb{1}\{\text{year after recession}\}\times\mathbb{1}\{t \geq 1986\}$	0.31	1.79	-0.14	-0.65
	(0.82)	(1.94)	(1.05)	(1.26)
$\mathbb{1}\{\text{two years after recession}\}\times\mathbb{1}\{t \geq 1986\}$	-0.31	-1.30	0.39	-0.99
	(0.31)	(1.47)	(0.62)	(0.75)
Observations	513	513	513	513

Notes: "All" refers to total hours worked, "High", "Middle", and "Low" refer to hours worked by different skill groups. The breakdown of hours by group is not available for several countries in the 1970s and 1980s. The dependent variables are the annual change in the log of hours worked by the indicated group, multiplied by 100 so that coefficients are scaled in log points. Standard errors, clustered by country, in parentheses. All regressions include a full set of country dummies, interacted with the dummy for the post-1985 period.

Table A5: Growth in industry-level hours by skill group, by period and routine intensity

	All, skill sample		High			Middle			Low		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$\mathbb{1}\{\text{recession year}\}$	-2.03	-1.99	-3.12	-3.10	-2.97	-1.96	-1.93	-3.19	-1.84	-1.79	-5.17
	(0.57)	(0.57)	(2.05)	(2.04)	(1.35)	(0.68)	(0.69)	(1.24)	(0.95)	(0.96)	(1.58)
$\mathbb{1}\{\text{year after recession}\}$	-2.75	-2.73	-4.57	-4.56	-3.89	-2.77	-2.74	-2.61	-2.26	-2.23	-2.22
	(0.54)	(0.55)	(1.71)	(1.70)	(1.08)	(0.67)	(0.67)	(0.94)	(0.55)	(0.56)	(1.39)
$\mathbb{1}\{\text{two years after recession}\}$	-0.70	-0.68	-1.76	-1.74	1.96	-1.21	-1.19	-2.04	-0.13	-0.10	-1.04
	(0.40)	(0.39)	(1.43)	(1.43)	(0.83)	(0.58)	(0.57)	(0.76)	(0.54)	(0.53)	(1.37)
RTI$\times\mathbb{1}\{\text{recession year}\}$		-1.02		-0.37	1.14		-1.13	-1.27		-1.41	-3.00
		(0.24)		(1.01)	(1.36)		(0.49)	(1.37)		(0.41)	(1.50)
RTI$\times\mathbb{1}\{\text{year after recession}\}$		-0.65		-0.36	2.86		-0.70	-0.18		-0.71	0.86
		(0.20)		(0.49)	(0.91)		(0.18)	(0.94)		(0.36)	(1.53)
RTI$\times\mathbb{1}\{\text{two years after recession}\}$		-0.38		-0.42	-0.41		-0.37	0.91		-0.39	1.91
		(0.26)		(0.76)	(1.28)		(0.32)	(1.04)		(0.31)	(1.09)
$\mathbb{1}\{\text{recession year}\}\times\mathbb{1}\{t \geq 1986\}$	-0.66	-0.70	0.49	0.47	1.57	-1.40	-1.44	1.28	-1.12	-1.17	3.28
	(0.78)	(0.78)	(2.19)	(2.18)	(1.49)	(0.89)	(0.89)	(0.72)	(0.89)	(0.88)	(0.70)
$\mathbb{1}\{\text{year after recession}\}\times\mathbb{1}\{t \geq 1986\}$	0.14	0.13	2.47	2.47	0.06	-0.18	-0.20	-1.78	-0.55	-0.56	1.84
	(0.85)	(0.84)	(2.32)	(2.30)	(1.22)	(1.12)	(1.12)	(0.76)	(1.31)	(1.31)	(3.04)
$\mathbb{1}\{\text{two years after recession}\}\times\mathbb{1}\{t \geq 1986\}$	-0.43	-0.46	-0.20	-0.22	-4.53	0.31	0.28	0.24	-1.25	-1.28	-0.89
	(0.37)	(0.36)	(1.57)	(1.56)	(2.83)	(0.68)	(0.67)	(1.04)	(0.78)	(0.76)	(2.96)
RTI$\times\mathbb{1}\{\text{recession year}\}\times\mathbb{1}\{t \geq 1986\}$		0.47		-0.23	-2.73		0.61	-0.15		1.39	0.12
		(0.28)		(1.14)	(1.37)		(0.61)	(1.12)		(0.53)	(0.57)
RTI$\times\mathbb{1}\{\text{year after recession}\}\times\mathbb{1}\{t \geq 1986\}$		-0.18		-0.47	-4.08		-0.13	-1.63		0.26	5.01
		(0.35)		(0.62)	(0.80)		(0.31)	(0.81)		(0.66)	(6.25)
RTI$\times\mathbb{1}\{\text{two years after recession}\}\times\mathbb{1}\{t \geq 1986\}$		0.26		0.49	-1.98		-0.13	-0.90		0.94	3.14
		(0.29)		(0.68)	(2.27)		(0.55)	(1.33)		(0.77)	(2.68)
US only					✓			✓			✓
Observations	14,364	14,364	14,364	14,364	896	14,364	14,364	896	14,364	14,364	896

Notes: "All" refers to total hours worked, "High", "Middle", and "Low" refer to hours worked by different skill groups. The breakdown of hours by group is not available for several countries in the 1970s and 1980s. The dependent variables are the annual change in the log of hours worked by the indicated group, multiplied by 100 so that coefficients are scaled in log points. RTI refers to the routine index, which is standardized to have zero mean and unit variance. Standard errors, clustered by industry (in the "US only" specifications) or country (all other), in parentheses. Regressions are weighted by within-country employment shares, averaged across the entire sample period. All regressions include a full set of country and industry dummies, interacted with the dummy for the post-1985 period.