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Is flexible labour good for innovation? Evidence from firm-level data

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Whether the use of flexible workers is damaging to innovation or not depends on the dominant innovation regime in a sector. In sectors with a 'routinised' innovation regime, high shares of low-paid temporary workers have a negative impact on the probability that firms invest in R&D. In sectors that tend towards a 'garage business' regime, however, flexibility has no impact. The two innovation regimes differ in the nature of their knowledge base: reliance on generally available knowledge or dependence on a firm's historically accumulated knowledge base. Innovation in the latter regime benefits from longer job durations. Our results are consistent with findings in macro-level studies that coordinated market economies with rigid labour markets have higher labour productivity gains than liberalised market economies.

Key words: Determinants of R&D, Entrepreneurship, Routinised innovation, Schumpeterian innovation models, Varieties of capitalism
JEL classifications: J53, M51, M54, O31, O32, O33

1. Introduction

The mainstream argues that unemployment is due to labour market rigidities. Examples of labour market rigidities are strong trade unions, generous social benefits, high minimum wages, powerful insiders or firing restrictions. The standard remedy consists of 'structural reforms', which essentially come down to lifting firing restrictions, reducing minimum wages or cutting back on social benefits.

The plea for 'structural reforms' has been supported by evidence that countries with deregulated labour markets tend to have lower unemployment. There are doubts, however, whether this holds true. For example, Vergeer and Kleinknecht (2012) demonstrated that the empirical model in a highly cited article by Nickell *et al.* (2005) is far from robust. Others have demonstrated that evidence provided by 'rigidities cause unemployment' studies can change if observation periods are extended or if new countries are added to a sample (Baker *et al.*, 2005; Baccaro and Rei, 2007; Howell *et al.*, 2007).

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The plea for deregulation of labour markets has also been supported by evidence that the USA experienced higher GDP growth compared with 'Old Europe', at least during the 1990s up to 2007. Meanwhile, we realise that higher growth was driven by an impressive growth of debt related to bubbles in asset markets (Maki and Palumbo, 2001; Palley, 2009). In the long run there is little difference in GDP growth rates between countries that have more rigid or more flexible labour markets, while there is evidence at the macro level that a mix of downwardly flexible wages and wage cost-saving deregulation of labour markets brings down labour productivity growth rates (Vergeer and Kleinknecht, 2011). A series of studies gives theoretical arguments and/or empirical support to the hypothesis that the rigid corporatist labour markets of 'Old Europe' may actually *favour* innovation and labour productivity growth.[1] Some studies, however, argue that the opposite should hold[2] and a single study reports insignificant results (Arvanitis, 2005).

In this paper we argue that some of the divergence in the findings may be explained once we control for the dominant innovation model in a firm's sector of principal activity. We distinguish an 'entrepreneurial' (or garage business) model and a 'routinised' model of innovation. The latter are sometimes called Schumpeter mark I (Schumpeter, 1912) and Schumpeter mark II models (Schumpeter, 1943). Table 1 gives a stylised sketch of the two Schumpeter models. The essential difference between the models relates to the properties of the knowledge base required for innovation. The garage business model

Table 1. *Stylised sketch of the two innovation models by Schumpeter (1912, 1943)*

Schumpeter mark I model: 'garage business innovation'	Schumpeter mark II model: 'routinised innovation'
Starters in high tech; niche players	Mature firms with professional R&D laboratories
Turbulent competition; creative destruction	Monopolistic competition, oligopolies
Frequent market entry and exit	Stable hierarchy of (dominant) innovators
Properties of the knowledge base	
General and generally available knowledge → low entry barriers	Dependence on historically accumulated, often firm specific and idiosyncratic knowledge from experience ('tacit knowledge') → high entry barriers
Properties of the related labour market institutions	
Hiring through external labour markets	Strong reliance on internal labour markets with well-protected insiders

Note: This table is also inspired by Breschi *et al.* (2000).

[1] See, e.g., Acharya *et al.* (2010), Agell (1999), Lucidi & Kleinknecht (2010); Appelbaum *et al.* (2000), Auer *et al.* (2005), Boeri and Garibaldi (2007), Huselid (1995), Kleinknecht *et al.* (2006), Michie and Sheehan (2001, 2003), Buchele and Christiansen (1999), Lorenz (1999), Pieroni and Pompei (2008) or Storm and Naastepad (2012).

[2] See, e.g., Scarpetta and Tressel (2004), Bassanini *et al.* (2009) or Bartelsman *et al.* (2012).

relies more on *generally available* knowledge while the routinised innovation model relies more on *firm-specific and historically accumulated* knowledge, which creates path dependencies: what a firm is 'good' at depends on the knowledge it accumulated in the past. The accumulation of firm-specific (often 'tacit') knowledge creates barriers to entry, thus assuring monopoly profits that give incentives to innovation.

Using firm-level OSA-SCP data, we provide a simple empirical test of two hypotheses:

(i) In firms that operate in sectors that tend towards a routinised Schumpeter II regime, innovation will benefit from more rigid labour relations that imply long-lasting commitments between employers and employees.
(ii) In firms that operate in sectors that tend towards a Schumpeter I garage business model, flexible labour may benefit innovation.

The remainder of this paper is organised as follows. Section 2 discusses opposite arguments found in the literature and in popular discourse about whether flexible labour would enhance or damage innovation. Section 3 introduces our database and indicators. Section 4 provides an empirical test and Section 5 rounds up with discussions and conclusions.

2. Why and how could flexible labour impact on innovation?

2.1 Arguments why flexible labour could favour innovation and productivity growth

First, strong firing protection will slow down the reallocation of labour from old and declining sectors to new and dynamic ones (see, e.g., Nickell and Layard, 1999).

Second, the difficult or expensive firing of redundant personnel can frustrate labour-saving innovations at the firm level (Bassanini and Ernst, 2002; Scarpetta and Tressel, 2004).

Third, well-protected and powerful personnel could appropriate rents from innovation through higher wage claims, thus reducing incentives for taking innovative risks (Malcomson, 1997).

Fourth, firms will more easily engage in risky new ventures if they are sure they can easily dispense with their personnel in the case of failure (Bartelsman *et al.*, 2012).

Fifth, easier firing will increase rates of job turnover, allowing for more 'job matches'. This increases the chance that people will find the jobs in which they are most productive. When scrutinising the economic impact of party programmes for the 1912 national elections in the Netherlands, the Central Planning Office (CPB, The Hague) used this argument, attributing in its models positive productivity effects to proposals towards easier firing.

Sixth, higher labour turnover enhances the inflow of 'fresh blood': people with new ideas and new networks may foster innovation. Moreover, there is less chance that employees will be entrenched in safe jobs, gradually losing their creativity; further, the (latent) threat of easy firing may prevent 'shirking'.

Against such arguments, several objections are possible. As to the first argument, emerging new industries are likely to offer better career opportunities and higher pay than declining industries. Why should we not rely that such incentives will make people move voluntarily into new industries? As to the second argument, rates of job turnover have been estimated as being around 9–12%, thus offering some potential for downsizing without forced leave.[3] Moreover, if firing is difficult, firms have incentives to invest in

[3] Kleinknecht *et al.* (2006) report that, on average, 9–12% of a firm's personnel in the Netherlands leave voluntarily each year, the exact percentage depending on the state of the business cycle. Nickell and Layard (1999, p. 363) report that this figure amounts to more than 10%.

functional flexibility by means of training, which will allow labour to be shifted from old to new activities in internal labour markets. In other words, a lack of *numerical* flexibility will enhance *functional* flexibility.[4] The third argument may indeed be relevant in decentralised wage-bargaining settings typical of Anglo-Saxon labour markets. 'Rhineland'-type labour markets rely more on industry-level bargaining in which wage bargains are often imposed by government on *everyone* in a sector. Moreover, such labour market rigidity may actually enhance innovation, as technological laggards may be forced to make productivity-increasing investments in response to a rise in wages. The fourth argument may be relevant as it allows part of the entrepreneurial risks to be shifted to employees. This may notably encourage garage business innovation in young and fragile firms. The same holds for the 'fresh blood' argument: if firms rely on readily available *general* knowledge in a garage business model, a higher job turnover may be helpful for innovation. It may, however, be counterproductive in a 'routinised' Schumpeter II model when continuous accumulation of (often tacit) knowledge is crucial.

2.2 Arguments why flexible labour could damage innovation and productivity

First, Vergeer and Kleinknecht (2011) demonstrated that, during 1960–2004, the 'rigid' labour markets of 'Old Europe' showed substantially higher real-wage increases compared with 'flexible' Anglo-Saxon type labour markets in which easy firing restricts the power of labour. From this it can be derived that higher labour productivity gains in 'Old Europe' may have been caused by stronger substitution of capital for labour and by vintage effects: old vintages of capital need to be replaced more quickly as they become less profitable with rising wages. Lower wage increases can thus result in a growing age of capital stock, which has been shown to be one of the reasons behind the productivity crisis in the Netherlands after 1984 when trade unions voluntarily sacrificed wages against the promise of more jobs (see Naastepad and Kleinknecht, 2004).

Second, from a Schumpeterian perspective, it can be argued that due to their monopoly rents from innovation, innovators are better able than technological laggards to live with wage increases (or with high adjustment costs due to stricter regulation). Therefore, high real-wage growth and labour market rigidities may enhance the Schumpeterian process of *creative destruction* in which innovators compete away technological laggards (Kleinknecht, 1998). This makes innovation more rewarding. Actually, Vergeer and Kleinknecht (2011) report that, in a sample of 19 OECD countries (1960–2004), a 1% lower wage increase will result in a lower growth of labour productivity by 0.33–0.39%.

Third, easier firing and higher labour turnover shorten the payback period of a firm's investment in manpower training. In addition, workers will be more interested in acquiring *general* skills that increase their employability on the external job market, but may be reluctant to acquire firm-specific skills if there is no long-term commitment to their employers (Belot *et al.*, 2002). A similar conclusion emerges from the hypothesis that highly flexible labour reduces the compression of the wage structure (both within and between firms); note that Acemoglu and Pischke (1999) and Agell (1999) argue that wage compression is a reason for the provision of training by firms.

[4] Acemoglou and Pischke (1999) emphasise that wage compression in rigid German labour markets enhances training for highly educated *and* for low-educated workers, while in the liberalised US system mainly highly educated workers receive training.

Fourth, work by Huselid (1995), Buchele and Christiansen (1999), Lorenz (1999), Michie and Sheehan (2001, 2003) and Naastepad and Storm (2006) shows favourable productivity effects of 'high trust' or 'high road' human resource management practices. Long-lasting working relations and strong protection against dismissal can be interpreted as an investment in trust (see also Svensson, 2011), loyalty and commitment, which favours productivity growth in four ways: (i) it reduces costs of monitoring and control—e.g. Naastepad and Storm (2006, pp. 170–91) demonstrated that firms in low-trust 'Anglo-Saxon' countries typically have much thicker management bureaucracies for monitoring and control compared with 'Rhineland' countries; (ii) the greater loyalty of personnel reduces positive externalities, i.e. the leakage of trade secrets to competitors; (iii) more continuity of personnel favours long-run historical accumulation of (tacit) knowledge in a 'routinised' innovation model (see Table 1); and (iv) better protection against firing will favour critical feedback for bosses from the shop floor. Powerful managers have a tendency to surround themselves by people who hardly contradict them. If this is enhanced by a change of power relations due to easier firing, it can favour conformist attitudes and autocratic management practices.

Fifth, an argument closely related to the previous one comes from Acharya *et al.* (2010), who study patents and patent citations as a proxy for innovation. They argue that stringent labour laws provide firms with a 'commitment device' to not punish short-run failures and this would encourage employees pursuing risky and value-enhancing innovative activities. Exploiting time-series variation in changes of dismissal laws, they find that 'innovation and growth are fostered by stringent laws governing dismissal of employees, especially in the more innovation-intensive sectors. Firm-level tests within the United States that exploit a discontinuity generated by the passage of the federal Worker Adjustment and Retraining Notification Act confirm the cross-country evidence' (Acharya *et al.*, 2010, p. 1).

Finally, Lorenz (1999) has argued that protection against dismissal may enhance productivity performance, as secure workers will be more willing to cooperate with management in developing labour-saving processes and in disclosing their (tacit) knowledge to the firm. More generally, workers who are easy to fire have incentives to hide information about how their work can be done more efficiently. This implies that a flexible firing system is likely to make poor use of (tacit) knowledge on the job floor.

The opposite arguments in favour and against the hypothesis that flexible labour may damage (or enhance) innovation call for empirical tests to be done, as described in the remainder of this paper.

3. Data and indicators

As opposed to all earlier empirical studies, this paper will explicitly control for innovation models. As a proxy for the extent to which an industry is Schumpeter I or II, we use the degree of concentration of R&D budgets in an industry, using the well-known Herfindahl–Hirschman index. In other words, every industry receives a value on a continuous scale between 0 (perfect dispersion of R&D) and 1 (perfect concentration of R&D). Values closer to zero indicate a Schumpeter I garage business model; values closer to 1 indicate a Schumpeter II model in which dominant innovators have erected strong entry barriers thanks to their historical accumulation of (tacit) knowledge. The Herfindahl–Hirschman measure of concentration is calculated from Community

Innovation Survey data available from Statistics Netherlands, taking averages over the years 1998–2008 in 26 manufacturing and commercial service sectors (see the illustration in Table A3; Appendix).

From our database we have chosen two variables that can indicate whether a firm tends more towards 'low road' Human Resources Management (HRM) practices in an Anglo-Saxon style or whether it tends more towards 'high road' practices in a corporatist Rhineland style: the percentage of personnel on temporary contracts (without a perspective of tenure) and the percentage of hours worked in a firm by manpower agency workers. In our estimates, both measures will be interacted with the Herfindahl–Hirschman concentration index in a firm's sector of principal activity, this being our crucial variable of interest. Our firm-level data are from the enterprise survey of OSA-SCP over the years 1987–88.[5]

The OSA-SCP database covers two types of innovation indicators:[6]

(i) A firm has some R&D activities ('yes'/'no' answers).
(ii) A firm describes its R&D activities as occasional or as permanent activities.

As both indicators are given as dummy variables, we estimate logit models. We use firm size and firm age, and dummies for whether a firm underwent a major reorganisation or a merger or an acquisition as control variables. We also introduce a measure of the thickness of management layers, which may be somewhat ambiguous. From what was discussed above, thick management layers may reflect a lack of trust and loyalty and a need for tougher control, which might be frustrating for creative people. On the other hand, innovative projects might be enhanced by extra management efforts.

The firm age variable was insignificant in all preliminary estimates and is omitted from the final versions. As our dependent is a dummy variable, we expect the coefficients for firm size to be highly significantly positive. This does not allow drawing conclusions about the innovativeness of smaller versus larger firms. A positive coefficient simply indicates that larger trees catch more wind and there is an obvious need to correct for this.

4. Results

Before going into detail, it should be mentioned that in all versions of our estimates, the coefficients of manpower agency workers were always close to zero and far from significant. So we can safely conclude that manpower agency work has no relationship with innovation. On the other hand, the temporary workers variable does show a number of significant outcomes. What could explain these different outcomes? The difference is likely to relate to different motives behind the choice between temporary contracts and manpower agency workers. Estimates of firm-level wage equations in the Netherlands show that firms with high percentages of temporary workers pay significantly lower average hourly wages (after controls for age, sex, education, etc.). Independently, person-level wage equations in the Netherlands show that temporary

[5] Available through the web site www.dans.knaw.nl.

[6] A third indicator relates to 'new product' introductions during the past two years. This indicator, however, is dominated by products 'new to the firm' (rather than 'first in the market') and therefore tends to measure imitation rather than innovation. In our data exploration we discovered that many firms reporting such imitative new products do not report R&D activities, suggesting that this indicator covers lots of trivial product improvements. Preliminary estimates suggested that there are no robust relationships between flexible labour and imitative new products, which is consistent with similar findings by Zhou *et al.* (2011). This indicator is therefore omitted from our analysis.

workers earn up to 20% lower wages compared with tenured workers with similar properties (see Kleinknecht *et al.*, 2006). The same does *not* hold, however, for manpower agency workers. The latter may earn less than tenured people, but the firm also has to pay the manpower agency's margin. Ultimately, the wage costs paid by the firm for manpower agency workers do not differ significantly from those of tenured workers. From this we conclude that temporary contracts are primarily used by firms that intend to economise on wage costs, while manpower agency workers fulfil a true need for flexibility (e.g. replacements for maternity leave, etc.). We therefore confine our tables to the former. In other words, percentages of temporary workers reflect a firm's need for wage cost-saving labour flexibility. It can therefore indicate whether a firm's HRM strategy tends towards 'low road' or 'high road' practices.

Turning to the results (see Appendix for descriptive data), we can see that, as expected, in almost all versions of our model, the probability of giving a 'yes' answer rises with firm size. Moreover, management matters: if the percentage of managers in total personnel rises by 1%, the probability that a firm will invest in R&D increases by 3.5–7.5% in the various models in Table 2. Restructuring operations seem to have little impact on innovation, while mergers and acquisitions have, in most cases, a negative impact.

The most interesting outcome relates to the interaction term between a firm's flexible staff and the degree to which its sector of principal activity tends towards a Schumpeter I or rather to a Schumpeter II innovation model (see model B in Table 2). Earlier explorations of the data without using interaction terms revealed that temporary contracts always had a negative sign, which was almost always significant. Only in a single specification did we find weakly significant coefficients. This is consistent with the impression gained from the literature: most contributions report significantly negative coefficients (see footnote 1).

As expected, the interaction term 'Herfindahl*percentage of temporary workers' has a significantly negative sign in Table 2. This indicates that a mix of high concentration of R&D in a sector (as a proxy for a routinised Schumpeter II model) and high shares of wage cost-saving temporary contracts has a strongly negative impact on the probability that a firm would engage in (permanent) R&D. Consistent with our expectations, we see that the weaker form of innovation (i.e. *occasional* R&D activities) has weaker significance levels than the other two (i.e. R&D or permanent R&D). By studying the effects, we observe that the coefficients of the interaction term in Table 2 are not straightforward to interpret. Simulations (data not shown) show that the negative relationship between temporary workers and the probability of conducting (occasional or permanent) R&D is definitely stronger in Schumpeter II industries than in Schumpeter I industries.

As a robustness check and as a more intuitive illustration of the effects, we present in Table 3 an alternative specification. In this case we split the sample into two groups: 13 industries with higher versus 13 industries with lower values of the Herfindahl–Hirschman concentration index. Table 3 gives the separate estimates for the lower concentration ('garage business', or Schumpeter I) industries and for higher concentration ('Schumpeter II') industries.

Table 3 confirms the impression from the interaction term in Table 2: coefficients of temporary workers are *insignificant* in Schumpeter I industries, but highly significantly *negative* in Schumpeter II industries. In other words, in industries that tend towards a high concentration of R&D (i.e. a 'routinised' innovation model), a high share of temporary workers has a significantly negative impact on the probability that R&D takes place. According to Table 3, an increase in the percentage of temporary workers in a

Table 2. *The probability that a firm will invest in R&D (summary of logit estimates)*

	R&D: yes/no?		Occasional R&D (versus no R&D)		Permanent R&D (versus no R&D)	
	Model A	Model B	Model A	Model B	Model A	Model B
Firm size (reference group: 5–9 workers)	–	–	–	–	–	–
10–19 workers	0.620**	0.625**	0.103	0.109	1.083***	1.086***
20–49 workers	1.129***	1.160***	0.689*	0.724*	1.517***	1.547***
50–99 workers	1.502***	1.538***	0.617	0.655	2.206***	2.240***
100–499 workers	2.002***	2.019***	1.093***	1.111***	2.725***	2.740***
≥500 workers	2.330***	2.301***	0.811	0.783	3.281***	3.252***
Share of managers in personnel	0.060***	0.058***	0.036**	0.035**	0.075***	0.073***
Firm underwent restructuring	−0.281*	−0.317*	−0.305	−0.343	−0.271	−0.305
Firm had merger or acquisition	−0.415*	−0.429*	−0.313	−0.331	−0.473*	−0.486*
Herfindahl–Hirschman index in sector of principal activity	−0.226	1.021*	−0.268	1.040	−0.197	1.012
Constant term	−2.360***	−2.553***	−2.280***	−2.487***	−3.670***	−3.856***
Variables of interest:						
Interaction term 'Herfindahl index*percentage of temporary workers'	–	−0.075**	–	−0.077*	–	−0.074**
Percentage of temporary contracts	−0.020***	−0.008	−0.022***	−0.009	−0.019***	−0.007
Number of observations	1216	1216	1216	1216	1216	1216
R^2 (Nagelkerke)	0.17	0.17	0.17	0.18	0.17	0.18

Notes: *10% level of significance; **5% level of significance; ***1% level of significance.
Significance levels are determined using the Wald test.

Table 3. *Separate logit estimates for Schumpeter I[a] and II[b] industries*

	R&D: yes/no?		Occasional R&D (versus no R&D)		Permanent R&D (versus no R&D)	
	Schumpeter I	Schumpeter II	Schumpeter I	Schumpeter II	Schumpeter I	Schumpeter II
Firm size (reference group: 5–9 workers)	–	–	–	–	–	–
10–19 workers	0.563	0.809	0.305	−0.265	0.745	2.687**
20–49 workers	1.078***	1.420**	0.772	0.662	1.292***	2.874**
50–99 workers	1.325***	2.145***	0.80	0.461	1.690***	4.524***
100–499 workers	1.927***	2.303***	1.391***	0.500	2.289***	4.781***
≥500 workers	2.274***	2.422***	0.615	0.529	2.969***	4.961***
Share of managers in personnel	0.063***	0.053**	0.050***	0.003	0.070***	0.101***
Firm underwent restructuring	−0.349*	−0.113	−0.375	−0.103	−0.336	−0.124
Firm had merger or acquisition	−0.456*	−0.545	−0.348	−0.551	−0.516*	−0.514
Constant term	−2.569***	−2.120***	−2.869**	−1.199	−3.491***	−5.320***
Variable of interest:						
Percentage of temporary contracts	−0.008	−0.045***	−0.012	−0.040***	−0.005	−0.048***
Number of observations	803	413	803	413	803	413
R^2 (Nagelkerke)	0.14	0.27	0.14	0.30	0.15	0.30

Notes: *10% level of significance; **5% level of significance; ***1% level of significance.
Significance levels are determined using the Wald test.
[a]'Schumpeter I', the 13 out of 26 industries with the lowest value of the Herfindahl–Hirschman index.
[b]'Schumpeter II', the 13 out of 26 industries with the highest value of the Herfindahl–Hirschman index.

firm's total personnel by 1% reduces the probability of investing in R&D by 4–5%. The apparent differences between Schumpeter I and Schumpeter II industries in Table 3 explain why outcomes of earlier studies were not clear-cut: by lack of control for innovation models, an important variable was missed.

5. Discussion and conclusions

Adherents of 'structural reforms' of European labour markets may be comfortable with our results: the Netherlands has high shares of flexible workers since 'insiders' are strongly protected. So a firm's need for flexibility will increase numbers of 'outsiders'. If structural reforms reduced the protection of insiders, numbers of outsiders might actually decline—and this would result in higher innovation probabilities in our model!

This argument neglects that a major motive behind structural reforms of labour markets is more 'dynamism' in the labour market, i.e. more frequent job matches, which increase the chance that people will find jobs in which they are the most productive. Moreover, lower protection of insiders allows firms to dispense with people more easily if risky innovation projects fail and this encourages risk-taking. Another motive is that people should not be entrenched in safe jobs and firms should have the ability to fire easily in the case of shirking.

The problem with such arguments is that they look at the labour market in isolation from the innovation process. Undoubtedly, from the perspective of Walrasian general equilibrium theory, labour markets can never be flexible enough. Flexible *hire and fire* guarantees (static) allocative efficiency! From a Schumpeterian innovation perspective, however, things look different. The field of innovation is full of market imperfections. For example, knowledge has strong public goods characteristics; hence property rights are hard to protect, resulting in underinvestment in R&D. Moreover, various sorts of information asymmetry can play, for example in the search for suitable collaboration partners. Moreover innovation is subject to strong uncertainty (high failure rates). All this, combined with the sunk-costs character of innovative investments, can leave innovative efforts far below the social optimum.

Recognising that market failures are the rule rather than rare exceptions, we arrive at a pattern of argument that tries to repair for one market imperfection by introducing another. For example, institutions such as trademarks, copyrights or the patent system give a degree of monopoly power to creative people. From a Walrasian general equilibrium perspective, monopoly power is undesirable as it prevents the efficient allocation of scarce resources. From a Schumpeterian perspective, however, a degree of monopoly power is a highly desirable incentive for investment in creative solutions. Or take another example: perfect competition is most efficient for the allocation of scarce resources from a static Walrasian perspective, but it is undesirable from an innovation viewpoint since easy entry would too quickly erode monopoly profits from innovation and hence take away incentives to carry innovative risks. Finally, according to the logic of Schumpeter's (1943) routinised innovation model, labour market rigidities are useful since longer job durations create loyalty and make the long-run accumulation of (tacit) knowledge easier.

Looking at policy implications, we conclude that more flexibility in labour relations appears to be without problems in Silicon Valley-type garage businesses. According to our estimates, flexible working has no impact on innovation among young and small firms. In industries that tend towards a routinised innovation model, however, such flexibility appears to be harmful. 'Structural reforms' aimed at easier firing would probably enhance job hopping, which disturbs knowledge accumulation and is a major channel

for positive externalities. To conclude, the above may shed some light on the observation that, in spite of a highly flexible labour market, the USA is doing quite well in industries that have high rates of new-firm foundations, such as IT. Our findings, however, might also explain why, since the Reagan era, many 'classical' industries in the USA (e.g. steel or automobiles) have found it hard to compete against Japanese and German suppliers.

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Appendix

Table A1. *Descriptive statistics*

	Min.	Max.	Mean	Std Dev.
Dependent variables				
R&D yes/no	0.00	1.00	0.330	0.470
Permanent R&D	0.00	2.00	0.533	0.810
Independent variables				
Firm size	1.00	6.00	3.170	1.663
Size of management	0.00	40.00	13.779	8.418
Numerical flexibility (Percentage of employees on temporary contracts)	0.00	100.00	17.457	16.456
Herfindahl–Hirschman index	0.03	1.00	0.150	0.185
Dummy 'reorganisation'	0.00	1.00	0.149	0.356
Dummy 'merger and acquisition'	0.00	1.00	0.069	0.253

Table A2. *Pearson correlations between variables*

	1	2	3	4	5	6	7
1 Firm size	1						
2 Percentage of managers	−0.57**	1					
3 Percentage of temporary workers	−0.33**	0.18**	1				
4 Herfindahl concentration	0.06	−0.09**	−0.14**	1			
5 Interaction Herfindahl/ temporary workers	−0.12**	−0.01	−0.56**	0.72**	1		
6 Dummy 'reorganisation'	0.30**	−0.19	0.11**	0.13**	0.07*	1	
7 Dummy 'merger and acquisition'	0.14**	−0.05*	−0.09**	−0.03	−0.06*	0.15**	1

Note: **Significant at 0.01 level; **significant at 0.05 level (two-tailed tests).

Table A3. *Herfindahl–Hirschman indices by sector*

	Sectors	Herfindahl
1	Mining and quarrying	0.11
2	Food and tobacco	0.03
3	Textile and leather	0.12
4	Wood and paper	0.06
5	Publishing and printing	0.19
6	Oil/chemicals	0.13
7	Rubber and plastics	0.05
8	Concrete, cement and plaster	0.15
9	Metal industry	0.03
10	Mechanical engineering	0.51
11	Computer/electrical/electronics	0.33
12	Medical equipment	0.56
13	Transport equipment	0.67
14	Furniture/other/recycling	0.18
15	Utilities and water	0.27
16	Construction and building industry	0.05
17	Trade, repair, retail, catering	0.26
18	Wholesale and retail trade	0.05
19	Transport services	0.06
20	Transport-related services	0.07
21	Post and telecom	1[a]
22	Financial services	0.07
23	Real estate, rental services	0.26
24	ICT services	0.04
25	R&D laboratories	0.34
26	Other business services	0.08
27	Environmental and other services	0.15
	Mean	0.13
	Standard deviation	0.19
	Minimum	0
	Maximum	1

[a]Omitted from regressions.