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**EMPLOYMENT PROTECTION VERSUS  
FLEXICURITY: ON TECHNOLOGY  
ADOPTION IN UNIONISED FIRMS**

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## ABSTRACT

### Employment protection versus flexicurity: on technology adoption in unionised firms\*

We analyse how different labour market institutions--employment protection versus 'flexicurity'--affect technology adoption in unionised firms. We consider trade unions' incentives to oppose or endorse labour-saving technology and firms' incentives to invest in such technology. Increased flexicurity--interpreted as less employment protection and a higher reservation wage for workers--unambiguously increases firms' incentives for technology adoption. If unions have some direct influence on technology, a higher reservation wage also makes unions more willing to accept technological change. Less employment protection has the opposite effect, since this increases the downside (job losses) of labour-saving technology.

JEL Classification: J38, J51 and O33

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## I. Introduction

The rich countries of the world are similar in so many respects, but labour market relations differ quite significantly. A dividing line is often drawn between the flexible labour market of the US and the more regulated ones in Europe. The lack of European labour market flexibility has often been denoted as ‘eurosclerosis’ (see, e.g., Bentolila and Bertola, 1990) and given as a reason for why Europe lags behind the US in a time of rapid technological change and globalisation.

However, labour markets can be less than flexible in many ways, and the economic performance of European countries vary considerably. Many countries offer employment protection in various forms. This makes it costly to lay off workers, which is beneficial (at least in the shorter term) for workers who are already hired. But very strong employment protection can reduce the willingness of firms to hire people in the first place, and the work force can get stuck in old ways of production, with very little restructuring and technological and organisational change. In the longer perspective, this could also hurt the protected workforce.

‘Flexicurity’ is sometimes seen as an alternative to employment protection. Flexicurity purportedly exists in Scandinavia and the Netherlands, and the key elements are little employment protection, good unemployment insurance (and other means of income support for people outside the labour market), and an emphasis on labour market training and skill development to ease (re)entry into paid work.<sup>1</sup> Indeed, flexicurity has recently become somewhat of a buzzword among policy makers. For example, the 2005 Employment Outlook (OECD, 2005) recommends that countries such as Germany and France adopt a labour market model inspired by Denmark. Emerging economics literature also discusses flexicurity and employment protection within formal models, something we shall return to. Also, the present paper is an attempt to employ formal economic modelling to get to grips with the flexicurity debate.

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<sup>1</sup>OECD (2004) develops indices for employment protection and discusses how these have developed over time for some countries. Ochel (2008) gives an overview of the details of labour market reforms for several European countries.

‘Flexibility’ in the labour market is a rather vague concept that can be given many interpretations. One could perhaps delineate between ‘external flexibility’, which would refer to allocation and reallocation of workers among firms and sectors, and ‘internal flexibility’, which would concern the willingness to accept new technology, skill upgrading and the like within existing workplaces. Much of the literature on flexicurity, employment protection and unemployment insurance has focused on the effects of policy on structural change. In the present paper, what we think of as flexibility is the adoption of new labour-saving technologies in firms, which in this usage of language would be an example of ‘internal flexibility’. Not that we question whether labour market institutions have important effects on structural change, but we want to complement this type of analysis by studying labour-saving technology adoption. If, for example, a given policy package had beneficial effects on external flexibility (structural change), but at the same time had detrimental effects on internal flexibility (technological change), that policy package would indeed be something of a doubled-edged sword.<sup>2</sup>

Another salient feature of our analysis is that we assume that workers are unionised. Countries where authorities try to regulate the income security of workers, by employment protection, high unemployment insurance benefits, or the like, are typically those with other deviations from free, competitive labour markets, with trade unionism as a prime example. Trade unions are still important in most West-European economies. Membership rates may have fallen in some countries, but the coverage, i.e. the number of workers covered by a union wage agreement, has fallen much less.<sup>3</sup> The UK is perhaps a prime example of a country where unions markedly have been losing influence over the last couple of decades, but even for this country it can be asked if unions ‘have turned the corner’?<sup>4</sup> Notice also that trade unionism remains strong in countries that are first and foremost associated with flexicurity, such as the Scandinavian countries. We therefore think it is

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<sup>2</sup>The model in this paper is a partial equilibrium one. Labour-saving innovations will mean that less workers are employed in the industry under scrutiny. Under a longer-term perspective, this could imply that more labour is made available for other industries that want to expand. The concepts ‘internal’ and ‘external’ flexibility then becomes intertwined.

<sup>3</sup>For documentation, see OECD (1997) and EEAG (2004).

<sup>4</sup>Blanden, Machin and Van Reenen (2006).

interesting to ask how regulations as employment protection and unemployment benefits interact with unionised wage setting. This becomes particularly important when we define flexibility as technological change, because while it is plausible that trade unions might have the possibility to oppose changes that occur within the firm, it is harder to envisage that unions have any power to stand against changes that occur across firms.

Within a unified framework, we take two different approaches to studying incentives for technology adoption in unionised firms. First, we consider the incentives for trade unions to oppose the implementation of (exogenously arriving) labour-saving innovations. Our starting point is the reasonable assumption that trade unions have some influence on the use of technology, and we then exaggerate this by assuming that the union can veto the adoption of any technology that is not in the best interest of the union membership. As in Dowrick and Spencer (1994) and Lommerud, Meland and Straume (2006), this is a stylised way to capture that unions – being concerned about job losses among their members – can use their collective power to significantly delay, if not permanently block, and make more costly the adoption of labour-saving technology. This is typically done by, for example, refusing to concede to the changes in manning rules, remuneration systems and the like that new technology requires.<sup>5</sup>

In the second part of the analysis, we use the assumption that technology is endogenous: the firm can install labour-saving technology at a cost, but takes into account the wage response of the trade union. The influence of the union is here as little as it can be and only indirect: it has no means to influence technology choices directly, but its influence over wage setting will possibly change technology adoption indirectly.

A key question in the paper is whether each of the two legs of a flexicurity policy, income protection for the unemployed and employment protection, is good or bad for technology adoption. We investigate how two parameters, an employment protection variable (the cost of laying people off) and a reservation wage variable (the utility of unionised workers outside the firm in question), affect technology adoption. We interpret

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<sup>5</sup>See, e.g., Dowrick and Spencer (1994) and Lommerud et al. (2006) for comprehensive analyses and discussions – including many empirical and anecdotal examples – of such ‘rational Luddism’ by trade unions.

‘flexicurity’ as an increase in the reservation wage and a decrease in employment protection. As forewarned, we are mainly interested in how flexicurity influences the adoption of labour-saving technological advances.

Our results suggest that flexicurity is unambiguously good for technology adoption if we only consider firm incentives, that is, the case where union influence is indirect and works through the wage setting process. Both the increase in reservation wage and the decrease in employment protection contribute to making the firm more willing to invest in new labour-saving technology.<sup>6</sup> However, the same unambiguous conclusion cannot be reached if we directly focus on union incentives to block technology adoption. While better outside options will make unions more technology-friendly, reduced employment protection – the other leg of the flexicurity system – has the opposite effect. The reason is that employment protection softens the downside of labour-saving technology, namely job losses, and therefore makes unions more willing to accept technological change. Thus, whether flexicurity is good for technological change depends on which party is more important for technology adoption in unionised economies: firms or trade unions, or put differently, to what extent can unions block or postpone the adoption of technology directly. In the policy debate on employment protection and unemployment insurance, we sometimes get the impression that less employment protection is the agent for change, while more unemployment insurance is something we need to give workers once employment protection is built down. Our results do not completely tally with this, since both legs of the flexicurity policy can independently bring about more technological change, and it can even be that more income insurance is the safer instrument to use in order to have more ‘flexibility’.

The flexicurity debate is often presented as a comparison between two European models. Less often is flexicurity compared with a non-interference type labour market as the US one. If one takes the existence of at least some union power as a starting point, our results suggest that non-interference is not a solution that best stimulates technol-

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<sup>6</sup>The positive effect of less employment protection on firm incentives for technology investment depends on the assumption that firing costs are predominantly red-tape costs. As shown in Section 5, results might change if a sufficiently large share of firing costs are redundancy payments that positively affect workers’ reservation wages.

ogy adoption. On the contrary, introducing minimum wages or social insurance that lifts the reservation wage of workers that lose their jobs – from the non-interference level – encourages technology adoption.

Pre-existing academic economics literature on the flexicurity, employment protection and unemployment insurance debate is relatively small, and less focussed on technology choices, but more focussed on issues we have dubbed ‘external flexibility’, such as structural change. Nevertheless, we would like to mention some related work. We start by first mentioning some papers that explicitly deal with flexicurity, seeing employment protection and unemployment insurance in conjunction.

Andersen and Svarer (2007) discuss the pros and cons of flexicurity with reference to actual Danish labour market reforms. Some observers think that the term ‘flexicurity’ should be reserved for the Danish case, as Denmark has built down employment protection more than some of the other candidate countries. Blanchard and Tirole (2008) study the optimal design both of unemployment insurance and employment protection, seen as two competing instruments to provide income security. In a first-best version of the model, they find that unemployment insurance should always be accompanied by employment protection – and go on to discuss various deviations from this first-best model. One of these deviations is wage bargaining. Structural change is not explicitly modelled, and there is no mention of technological change. The present paper does not study the joint optimality of unemployment insurance and employment protection, but instead focuses on the positive question of how more unemployment insurance and less employment protection influences the adoption of new technology. A few authors have also studied flexicurity in a political economy framework. These papers suggest that more unemployment insurance reduces the demand for employment protection (Boeri, Conde-Ruiz and Galasso, 2006, and Algan and Cahuc, 2009). The latter postulate, interestingly, that the tendency to cheat on unemployment insurance programmes is larger in some countries than in others. This can make flexicurity the optimal choice for some Northern European countries, while it is not necessarily optimal to copy this policy in countries closer to the Mediterranean.



One important ingredient in the flexicurity debate is unemployment insurance. Acemoglu and Shimer (2000) point out that unemployment insurance can yield productivity gains. In particular, insurance can motivate workers to move to higher productivity jobs and also motivate firms to create those jobs. Hassler and Rodriguez Mora (2008) characterise optimal unemployment insurance when workers can move and/or retrain; they find that the classical result that benefits should fall within the unemployment duration no longer necessarily holds. Both these papers picture ‘flexibility’ to mean structural and geographical mobility in the labour market, in contrast to our emphasis on the installment of labour-saving technology. Marimon and Zilibotti (1999) and Boeri and Macis (2008) are also relevant in this context.

The other important ingredient in flexicurity is the reduction of employment protection. Early and well-known contributions are Bentolila and Bertola (1990) and Bertola (1990). Bertola (2004) gives an overview of the debate on labour market institutions in Europe, with an emphasis on the consequences of employment protection. The focus is on structural change, rather than technology adoption.<sup>7</sup> It should be noted that Autor, Kerr and Kugler (2007), who do empirical work on US data, open up the possibility that firms in response to employment protection can substitute capital for labour, which at least is an example of what we call ‘internal flexibility’.

We would also like to point to a debate in the Nordic trade union movement, spurred by the two Swedish trade union economists Gösta Rehn and Rudolf Meidner (see Turvey, 1952). They argued that it was important to keep wages up in traditional industry in order to increase the rate of structural change and modernisation. On the other hand, unemployment insurance and active labour market policies should be used to ease the situation for workers who lost their jobs and to speed up their re-entry into the labour market.<sup>8</sup>

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<sup>7</sup>Ichino and Riphahn (2005) discuss employment protection in the context of absenteeism. Dewit, Leahy and Montagna (2003) and Kessing (2006) discuss the possible strategic advantages of employment protection – building on the key insight that a firm that finds it costly to get rid of its workers, will fight harder to retain market shares.

<sup>8</sup>Agell and Lommerud (1993) and Moene and Wallerstein (1997) provide two different attempts at capturing these ideas in neoclassical economics models. Staiger (1988) provides a somewhat related model, where unions drive out the most labour-intensive production to other countries, something which enables the union to take out a higher union rent.

Even though the instrument to further change is to keep wages in sunset industries high, rather than to offer low employment protection, the purpose of this policy package was much the same as the purpose of suggested flexicurity reforms.

Finally, we would like to draw attention to the relatively large literature base on how trade unionism influences technology choices of a firm. See, for example, Tauman and Weiss (1987), Palokangas (1996), Ulph and Ulph (1998), Calabuig and Gonzalez-Maestre (2002) and Haucap and Wey (2004). There is no mention of flexicurity or related policies in these papers.

The rest of this paper is organised as follows. The basic model is presented in the next section. In Section 3, we analyse the labour market effects of installing new labour-saving technology. In Section 4, we analyse union incentives to oppose exogenous technological change, and, in Section 5, we endogenise the technological change by analysing firm incentives for technology investments. The paper is concluded in Section 6.

## II. Model

In order to focus on the strategic interaction between a firm and its trade union, we place the analysis in a simple dynamic framework. A unionised firm exists for two periods. In both periods, wages are set by a monopoly trade union, while employment is set by the firm. In the second period, a new labour-saving technology becomes available for the firm to adopt. However, the presence of employment protection legislation makes employment downsizing costly for the firm.

The firm is a monopolist in its product market, where demand is equal in both periods.<sup>9</sup> The inverse demand function is given by the linear form

$$p(q_i) = \alpha - \beta q_i, \tag{1}$$

where  $q_i$  is the quantity produced in period  $i$ . Labour is the only factor of production in a

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<sup>9</sup>Our main results generalise beyond the assumption of monopoly. See the Concluding Remarks for a short discussion of how our main results generalise to the case of a Cournot duopoly.

simple linear technology.<sup>10</sup> Denoting employment in period  $i$  by  $L_i$ , the output produced in the first period is given by

$$q_1 = L_1, \quad (2)$$

while the output in the second period is

$$q_2 = \begin{cases} L_2 & \text{without new technology} \\ \phi L_2 & \text{with new technology} \end{cases}, \quad (3)$$

where  $\phi > 1$ . Thus, the parameter  $\phi$  measures the potential technological progress between the two periods.

With the above assumptions, profits in periods 1 and 2 are given by

$$\pi_1 = p(q_1)q_1 - w_1L_1, \quad (4)$$

$$\pi_2 = \begin{cases} p(q_2)q_2 - w_2L_2 - c(L_1 - L_2) & \text{if } L_2 < L_1 \\ p(q_2)q_2 - w_2L_2 & \text{if } L_2 \geq L_1 \end{cases}. \quad (5)$$

The degree of employment protection is given by the parameter  $c > 0$ , in the case of second-period downsizing of employment.<sup>11,12</sup>

Trade union objectives are given by the following Stone-Geary-type utility function for

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<sup>10</sup>Besides its analytical simplicity, a linear demand function is flexible enough to allow for labour-saving technological innovations, which is the focus of our study. In contrast, a constant-elasticity demand function, which is a natural alternative to the linear specification, requires that demand is elastic (i.e., the price elasticity of demand is higher than 1) for a profit-maximising solution to exist. With a linear technology, this in turn implies that labour demand must be elastic. However, this is a very restrictive assumption in the context of technological change, since it implies that labour-saving innovations are not possible. With elastic labour demand, an increase in labour productivity will always increase the demand for labour. See Dowrick and Spencer (1994) and Lommerud, Meland and Straume (2006) for more details.

<sup>11</sup>We focus on the red tape component of employment protection legislation. As noted by Boeri et al. (2006), both empirical evidence (Bertola et al, 2000) and economic theory (Lazear, 1990) suggest that it is mainly red tape and procedural costs that affect employment flow. Also OECD (2004), when constructing a measure for employment protection, puts ample weight on such bureaucratic costs. In Section 5, we also briefly consider the case where part of the downsizing costs are redundancy payments.

<sup>12</sup>Bentolila and Bertola (1990) argue that the effects of employment protection laws are best approximated by a fixed firing cost per worker, implying linear employment downsizing costs. We think this is a reasonable first approximation. Several recent authors, however, have emphasized that employment protection generally has a two-tier structure, where the core of the workforce is much better protected than some marginal, temporary workers (Ochel, 2008, and Bentolila, Dolado and Jimeno, 2008). We think it would be interesting to study the effect of two-tier employment protection on firm internal change, but leave this for future research.

period  $i$ :

$$U_i = (w_i - b)^\theta L_i, \tag{6}$$

where  $\theta > 0$  is a measure of the degree of wage orientation in union preferences<sup>13,14</sup>, while  $b > 0$  is the reservation (reference) wage level. It is reasonable, and standard, to assume that  $b$  reflects both opportunities outside the firm (e.g., the minimum wage level) and outside the labour market (e.g., unemployment benefits).

The union sets wages prior to the firm’s employment decision in each of the two periods and we solve the game by backwards induction, looking for a subgame perfect Nash equilibrium in pure strategies. In the next section, we start by deriving the equilibrium outcomes of the second-period subgames (for the cases with and without technological change). Subsequently, we provide two different approaches to analysing technological progress between the two periods. First, we assume that the arrival of the new technology is exogenous and we analyse the trade union’s incentive to oppose exogenous technological change. Second, we endogenise technological progress and analyse the firm’s incentive to invest in new labour-saving technologies, taking into account that technology choices influence the wage level set by the union.

### III. Labour market effects of technological change

In this section, we derive the equilibrium outcomes of the second-period subgames and analyse how new technology affects wages and employment. There are two subgames, one where the new labour-saving technology is installed and one where it is not.

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<sup>13</sup>The parameter  $\theta$  can be indirectly interpreted as the degree of ‘insider’ domination. A trade union that is more dominated by insiders will typically give more importance to wages (all else equal).

<sup>14</sup>As pointed out by a referee, it can be hard to distinguish empirically between  $\theta$  and the bargaining power of the trade union in a Nash bargaining model. Assuming that wages are decided in bargaining between the union and the firm, and denoting the relative bargaining power of the union by  $\mu$ , we can show that the bargained wage ( $w^*$ ) increases monotonically in both  $\theta$  and  $\mu$  and that  $\lim_{\theta \rightarrow 0} w^* = \lim_{\mu \rightarrow 0} w^* = b$ . This is not surprising, since the two parameters will enter the Nash maximand in a mathematically similar way – and we might, in some applications, even choose the alternative interpretation of  $\theta$  as reflecting the relative bargaining power of the trade union. However, in the particular context of our analysis, we must be careful with this interpretation. However, note that in some cases, the unions influence choices that are not included in the bargaining agenda, and then, a change in  $\theta$  will have a different implication than a change in  $\mu$ . This is the case in Section 4 when the union – apart from its participation in the wage determination process – can directly block technological change. See Footnote 17 in Section 4.1 for further details.

*No new technology*

With the old technology, the firm has no incentive to downsize production in the second period. Maximising the second-period profit function with respect to  $L_2$ , and assuming that  $L_2 \geq L_1$ , second-period labour demand is given by

$$L_2(w_2) = \frac{\alpha - w_2}{2\beta}. \quad (7)$$

The trade union maximises its second-period utility by choosing a wage level that optimally balances the concerns for wages and employment. Inserting (7) into (6) and maximising with respect to  $w_2$  yields<sup>15</sup>

$$\hat{w}_2 = \frac{\theta\alpha + b}{1 + \theta}. \quad (8)$$

As expected, the wage increases in the wage orientation of the union ( $\theta$ ) and in the reservation wage level ( $b$ ). Substituting  $\hat{w}_2$  into (7) yields the equilibrium employment level

$$\hat{L}_2 = \frac{\alpha - b}{2\beta(\theta + 1)}. \quad (9)$$

*New technology*

We focus on the case of *labour-saving* innovations, implying that employment is downsized. Maximising the second-period profit function with respect to  $L_2$ , and assuming that  $L_2 < L_1$ , second period labour demand is given by

$$L_2(w_2) = \frac{\alpha\phi - w_2 + c}{2\beta\phi^2}. \quad (10)$$

Naturally, given the firm's incentives for employment downsizing, the presence of employment protection ( $c > 0$ ) makes second-period labour demand higher than it would have been in the absence of such legislation. In other words, employment protection makes second-period labour demand more inelastic, making the wage/employment trade-off more

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<sup>15</sup>We use 'hats' to denote equilibrium second-period values in the case of no technological progress.

favourable for the trade union. Inserting  $L_2(w_2)$  from (10) into (6) and maximising with respect to  $w_2$  yields

$$w_2^* = \frac{\theta(\phi\alpha + c) + b}{1 + \theta}. \quad (11)$$

As indicated above, stronger employment protection increases the wage level in a situation where the firm has incentives to downsize employment. Notice also that, since an increase in  $\phi$  makes labour demand less responsive to wage changes,<sup>16</sup> there is a negative relationship between labour productivity and labour demand elasticity. Consequently, technological progress is accompanied by higher wages. The corresponding employment level given by

$$L_2^* = \frac{\phi\alpha - b + c}{2\beta\phi^2(\theta + 1)}. \quad (12)$$

#### IV. Exogenous technological change

Assume that the new technology arrives in the second period with certainty. Both the firm and the trade union make their first-period choices by maximising the sum of first- and second-period payoffs. For simplicity, we abstract from discounting. For a given first-period wage, the firm chooses first-period employment by maximising  $(\pi_1 + \pi_2)$  with respect to  $L_1$ , taking into account that new technology will require costly employment downsizing in the second period. This yields the following first-period labour demand:

$$L_1(w_1) = \frac{\alpha - c - w_1}{2\beta}. \quad (13)$$

Notice the negative relationship between first-period labour demand and downsizing costs ( $c$ ). The more costly it is to downsize the labour stock, the lower is the first-period labour demand. This consequently increases the wage elasticity of labour demand in the first-period.

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<sup>16</sup>This is easily verified by observing, from (10), that the slope of the labour demand function is given by

$$\frac{\partial L_2(\cdot)}{\partial w_2} = -\frac{1}{2\beta\phi^2}.$$

Maximising union utility over the two periods, the trade union sets a first-period wage

$$w_1^* = \frac{\theta(\alpha - c) + b}{\theta + 1}. \quad (14)$$

The corresponding employment level is

$$L_1^* = \frac{\alpha - b - c}{2\beta(\theta + 1)}. \quad (15)$$

The effect of employment protection on wages and employment differs diametrically in the first and second periods. Stronger employment protection implies that it is more costly for the firm to operate with a large workforce in the first period, given the incentives for second-period downsizing. Thus, stronger employment protection yields lower labour demand in the first period. In other words, the positive effect on employment in the second period is counteracted by a negative first-period effect, with a corresponding wage effect. This illustrates – in a very simple framework – the standard concern about the dynamic employment effects of employment protection legislation: if the cost of laying off workers is increased, this will make firms less willing to hire workers in the first place.

The above results are derived under the assumption that  $L_2^* < L_1^*$  because of the arrival of new labour saving technology in the second period. We are yet to verify if this condition holds in equilibrium. Comparing (12) and (15), it can easily be shown that the condition holds if the technological progress is sufficiently large relative to downsizing costs.<sup>17</sup> Notice also that  $L_1^* < \widehat{L}_2$  as long as downsizing costs ( $c$ ) are positive. Thus, we consider the case where  $L_2^* < L_1^* < \widehat{L}_2$ .

#### *Union resistance to technological change*

Will the new labour-saving technology be adopted in the second-period? Giving the trade union the power to veto any adoption of new technology, this question is answered by a comparison of second-period union utility with and without new technology. Denoting

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<sup>17</sup>More specifically,  $L_2^* < L_1^*$  if  $\phi > \frac{\alpha + \sqrt{\alpha^2 - 4(b-c)(\alpha - b - c)}}{2(\alpha - b - c)}$ , or, equivalently, if  $c < \frac{(\phi - 1)(\phi(\alpha - b) - b)}{\phi^2 + 1}$ .

the utility gain of new technology by  $\Delta U = U_2 - \widehat{U}_2$ , this is given by

$$\Delta U = \frac{\theta^\theta \Psi}{2\beta\phi^2(\theta+1)^{1+\theta}}, \quad (16)$$

where

$$\Psi = (\alpha\phi - b + c)^{\theta+1} - \phi^2(\alpha - b)^{\theta+1}.$$

**Proposition 1** *Given that the adoption of new technology leads to employment downsizing, there exists a critical value  $\theta^*$ , such that  $\Delta U > (<) 0$  if  $\theta > (<) \theta^*$ .*

**Proof.** It should be noted that  $\text{sign}(\Delta U) = \text{sign}(\Psi)$ . If  $\theta = 0$ ,  $\Psi < 0$  if  $L_2^* < L_1^* < \widehat{L}_2$  (the employment downsizing regime). Furthermore, since  $\alpha\phi - b + c > \alpha - b$ ,  $\Psi$  is monotonically increasing in  $\theta$ . Finally, since  $\theta$  is not bounded from above,  $\Psi > 0$  for sufficiently high values of  $\theta$ , implying that there exists a unique value  $\theta^*$  above (below) which  $\Delta U > (<) 0$ . ■

Labour-saving innovations present the union with the following trade-off: fewer union members are employed by the firm, but the remaining workers can enjoy higher wages. How this trade-off is assessed depends on the union preferences for wages relative to employment. In the extreme case where the union only cares about employment ( $\theta = 0$ ), a labour-saving innovation is always detrimental to the union, since it does not care about the wage increase that accompanies the job losses. In the other extreme case, where the union only cares about wages ( $\theta \rightarrow \infty$ ), a labour-saving innovation is always beneficial to the union, since it does not care about the job losses that accompany the wage increase. In general, the union will benefit from labour-saving innovations if it is sufficiently wage oriented. The implication for union resistance to technological change follows directly<sup>18</sup>:

**Corollary 1** *Sufficiently employment oriented trade unions will oppose labour-saving technological change.*

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<sup>18</sup>Notice here that we cannot use the alternative interpretation of  $\theta$  as reflecting union bargaining power in an equivalent model with Nash bargaining over wages, since union attitudes towards technological change depends critically on how much the union values wages relative to employment, regardless of the bargaining strength. See Footnote 18 and Section 6.3 of Lommerud, Meland and Straume (2006) for further details.



*Flexicurity versus employment protection*

Our main objective is to analyse how different labour market institutions affect incentives for technology adoption. When analysing union incentives, we refer to  $\theta^*$  as a measure of union resistance to technological change by applying the following argument: if there are many union-firm pairs in the economy and union preferences are distributed over a wide range of  $\theta$ , some unions will resist new technology while others will endorse it. An increase (reduction) in  $\theta^*$  then implies that more (fewer) unions will resist technological progress, implying an overall increase in technology resistance by trade unions.

Our key labour market parameters here are  $c$  and  $b$ . The degree of employment protection is directly given by the size of  $c$ , while we interpret increased flexicurity as a combination of lower  $c$  and higher  $b$ . Comparative statics on the utility gain of technological change, (16), give us the following result.

**Proposition 2** *Union resistance to technological change will decrease due to (i) more employment protection, and/or (ii) a higher reservation wage level.*

**Proof.** (i) From (16) we derive  $\frac{\partial(\Delta U)}{\partial c} = \frac{\theta^\theta(\alpha\phi - b + c)^\theta}{2\beta\phi^2(\theta+1)^\theta} > 0$ , implying that  $\frac{\partial\theta^*}{\partial c} < 0$ . (ii) From (16) we also have  $\frac{\partial(\Delta U)}{\partial b} = \frac{\theta^\theta[\phi^2(\alpha - b)^\theta - (\alpha\phi - b + c)^\theta]}{2\beta\phi^2(\theta+1)^\theta}$ . Notice that, since  $\alpha\phi - b + c > \alpha - b$ ,  $\Psi = 0$  implies that  $\phi^2(\alpha - b)^\theta > (\alpha\phi - b + c)^\theta$ . Thus,  $\phi^2(\alpha - b)^\theta > (\alpha\phi - b + c)^\theta$ , implying  $\frac{\partial(\Delta U)}{\partial b} > 0$ , at  $\theta = \theta^*$ . Consequently,  $\frac{\partial\theta^*}{\partial b} < 0$ . ■

With respect to the effects of different labour market institutions on union opposition to technological change, we see that the picture is somewhat mixed. Increased employment protection unambiguously reduces union Luddism.<sup>19</sup> The reason is that this type of labour market regulation reduces the downside of technological change for unionised workers, namely, job losses. A policy that reduces the downside of labour-saving innovations while preserving the upside will generally make unions more technology-friendly.

However, the effect of increased flexicurity is, a priori, ambiguous. One leg of this policy – less employment protection – makes unions less inclined to accept new technology, while

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<sup>19</sup>Luddism has come to refer to all sorts of opposition against new technology, but, historically, the term refers to the machine-breaking riots in Britain in 1811-12, which purportedly were led by a ‘General’ Ludd.

the other leg – better outside options – has the opposite effect. The positive effect of a higher reservation wage is due to two different mechanisms – one direct and the other indirect – that both work in the same direction. A higher reservation wage leads to an increase in the union wage rate, but the difference  $(w - b)$  becomes lower, reducing the utility gain of employment.<sup>20</sup> Consequently, a higher reservation wage reduces the utility loss of (technology-induced) layoffs, making the union more willing (all else equal) to accept labour-saving innovations. This direct effect is reinforced by an indirect effect that works through the union’s wage setting policy: A higher reservation wage pushes up the union wage level, implying that the firm will operate (all else equal) with a smaller labour stock. This makes the labour demand response to better technology more positive (or less negative), indirectly reducing the downside of labour-saving innovations for unions.<sup>21</sup>

## V. Endogenous technological change

In the previous section, we may have exaggerated the influence of the union by assuming that it could block adoption of labour-saving technology as it sees fit. Here, we contrast this by presenting a model where the union has no direct influence over technology. Instead, the union has an indirect influence as the technology installed by the employer will in turn influence the wage demands of the union. We assume that the firm can make an investment in the first period to improve the technology in the second period. We then ask how the characteristics of the labour market institutions – given by the parameters  $c$  and  $b$  – affect the firm’s incentives to invest in better technology.

Assume that the firm can make an investment in the first period that yields a productivity  $\phi > 1$  in the second period. We assume that the technology remains constant over the two periods if no investment is made. In this case, wages, employment and profits are equal in both periods:  $\hat{w}_1 = \hat{w}_2$  and  $\hat{L}_1 = \hat{L}_2$ , given by (8) and (9), respectively. Thus,

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<sup>20</sup>  $\frac{\partial w_2^*}{\partial b} = \frac{1}{\theta+1} \in (0, 1)$ .

<sup>21</sup> There are two counteracting effects of improved labour productivity on labour demand. On the one hand, the *effective wage* rate ( $w_2/\phi$ ) drops, which tends to increase labour demand. On the other hand, fewer workers are needed to produce a given level of output, which tends to reduce labour demand. The higher the wage elasticity of labour demand, the stronger is the former effect compared to the latter. See Dowrick and Spencer (1994) or Lommerud, Meland and Straume (2006) for a more extensive discussion.

without investment, total profits over the two periods are given by

$$\Pi_{NI} = \hat{\pi}_1 + \hat{\pi}_2 = \frac{(\alpha - b)^2}{2\beta(\theta + 1)^2}. \quad (17)$$

On the other hand, if the firm invests, wages and employment in the two periods are given by (14)-(15) and (11)-(12), and the corresponding total profits are

$$\Pi_I = \pi_1^* + \pi_2^* = \frac{\phi \left( 2\alpha(\phi(\alpha - b - c) - (b - c)) + \phi(b + c)^2 \right) + (b - c)^2}{4(\theta + 1)^2 \beta \phi^2}. \quad (18)$$

Thus, the profit gain of the investment is given by

$$\Delta\Pi = \Pi_I - \Pi_{NI} = \frac{(b - c) \left( (\phi - 1) 2\phi\alpha - \phi^2(b + c) \right) + 2bc\phi^2 + (b - c)^2}{4(\theta + 1)^2 \beta \phi^2}. \quad (19)$$

The investment will be undertaken if the payoff, given by (19), is sufficiently large to cover the investment costs. Naturally, the firm's incentives to invest will increase with the magnitude of  $\Delta\Pi$ .

From (19) we derive

$$\frac{\partial(\Delta\Pi)}{\partial c} = - \left( \frac{(\phi - 1)(\phi\alpha - b(\phi + 1)) - c(\phi^2 + 1)}{2(\theta + 1)^2 \beta \phi^2} \right) < 0, \quad (20)$$

$$\frac{\partial(\Delta\Pi)}{\partial b} = \frac{(\alpha\phi - (b - c)(\phi + 1))(\phi - 1)}{2(\theta + 1)^2 \beta \phi^2} > 0, \quad (21)$$

$$\frac{\partial(\Delta\Pi)}{\partial \theta} = - \frac{2(\Delta\Pi)}{(\theta + 1)} < 0. \quad (22)$$

Notice that the unambiguous signs of (20) and (21) are established by imposing the equilibrium restriction  $L_2^* < L_1^*$ .

**Proposition 3** *The firm's incentives to invest in better technology decreases with the degree of employment protection and the union's wage orientation, and increases with the reservation wage level.*

When unions only have indirect influence over technology choice (through the way tech-

nology influences wage setting), we see from Proposition 3 that the relationship between labour market institutions and technology adoption is clear-cut. Both lower employment protection and better outside options for workers give the firm stronger incentives to invest in labour-saving technology. Thus, a labour market reform towards more flexicurity is unambiguously positive for technological change within this framework.

In order to understand the intuition behind these results, which are not straightforward, it is useful to decompose the impact of technology investment on the total profits into three separate effects:

$$\Delta\Pi = (\pi_1^* - \widehat{\pi}_1) + (\pi_2^* - \widehat{\pi}_2) - C^*, \quad (23)$$

where the first effect is the change in first-period operating profits, given by

$$\pi_1^* - \widehat{\pi}_1 = c \left( \frac{2\theta(\alpha - b - c) - c}{4\beta(\theta + 1)^2} \right), \quad (24)$$

the second effect is the change in second-period operating profits, given by

$$\pi_2^* - \widehat{\pi}_2 = \frac{b(\phi - 1)(2\alpha\phi - b(\phi + 1)) - c(c + 2\theta\alpha\phi) + 2c\theta(b - c)}{4\beta\phi^2(\theta + 1)^2}, \quad (25)$$

and the third effect is the second-period downsizing costs, given by

$$C^* := c(L_1^* - L_2^*) = c \left( \frac{\alpha\phi(\phi - 1) + (b - c) - \phi^2(b + c)}{2\beta\phi^2(\theta + 1)} \right). \quad (26)$$

Notice that the first and second effects, (24) and (25), are both ambiguously signed, although the sum of the two effects is always positive. Obviously, the last effect is always negative, since the adoption of labour-saving technology requires a costly downsizing of the labour stock.

Consider first an increase in the reservation wage level,  $b$ . It is fairly straightforward to show that this will reduce the first-period profit gain<sup>22</sup>, increase the second-period gain

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<sup>22</sup>From (24) we have  $\frac{\partial(\pi_1^* - \widehat{\pi}_1)}{\partial b} = -\frac{c\theta}{2\beta(\theta+1)^2} < 0$ .

in operating profits<sup>23</sup> and reduce total downsizing costs.<sup>24</sup> In other words, the stimulating effect of a higher reservation wage on the firm's incentive for technology investment is due to the impact of  $b$  on the second and third effects outlined above. The main intuition is the following. A higher reservation wage translates into a higher actual wage set by the trade union, which reduces profits in both periods regardless of technology. However, the more productive workers are, the smaller is the effect of an increase in the reservation wage on the effective wage rate.<sup>25</sup> Thus, a higher reservation wage increases the firm's incentive to operate with a smaller and more productive workforce. In other words, a higher  $b$  increases the second-period gain in operating profits from having better technology. In addition, a higher reservation wage – and thereby a higher actual wage – implies that the firm operates on a more elastic part of the labour demand function.<sup>26</sup> All else equal, this reduces the negative labour demand response to better technology and the firm's downsizing costs are correspondingly reduced. Notice that both of these effects rely on a positive relationship between outside ( $b$ ) and inside ( $w$ ) options for workers. The stronger this relationship is, the stronger is the positive effect of workers' outside options on the firm's incentives for technology investments. In our model, where the relationship between  $b$  and  $w$  is determined by a monopoly trade union, this implies that the positive effect of  $b$  on technology investments become stronger the more *employment oriented* unions become. The reason is simply that the relationship between  $b$  and  $w$  is stronger when  $\theta$  is lower.<sup>27</sup> Thus, if we interpret the special case of  $\theta = 0$  as a competitive labour market with no trade union, the presence of union power will actually dampen the positive technology investment effect of better outside options for workers.<sup>28</sup>

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<sup>23</sup>From (25) we have  $\frac{\partial(\pi_2^* - \hat{\pi}_2)}{\partial b} = \frac{(\phi-1)(\alpha\phi - b(1+\phi)) + c\theta}{2\beta\phi^2(\theta+1)^2} > 0$ .

<sup>24</sup>From (26) we have  $\frac{\partial C^*}{\partial b} = \frac{c(\phi-1)(1+\phi)}{2\beta\phi^2(\theta+1)} > 0$ .

<sup>25</sup>From (11) we have that  $\frac{\partial\left(\frac{w_2^*}{\phi}\right)}{\partial b} = \frac{1}{\phi(\theta+1)}$ , which is decreasing in  $\phi$ .

<sup>26</sup>See Dowrick and Spencer (1994) and Lommerud, Meland and Straume (2006) for a more thorough discussion of the relationship between the labour demand elasticity and the labour demand response to better technology.

<sup>27</sup>From (11) we see that  $\frac{\partial w_2^*}{\partial b} = \frac{1}{1+\theta}$ , which is positive but decreasing in  $\theta$ .

<sup>28</sup>Notice, however, that this argument relies on the assumption that inside and outside options are equal in the absence of trade union power. If, in a competitive labour market, workers are paid according to their marginal productivity and the equilibrium wage is disconnected from outside options, then outside options will not influence technology investments. In this case the conclusion might be the opposite, insofar as

We can trace the relationship between employment protection and incentives for technology investments in a similar way. Using (24)-(25), it is possible to show that an increase in  $c$  will have an ambiguous effect on the first-period profit gain<sup>29</sup> and total downsizing costs<sup>30</sup>, while the effect on the gain in second-period operating profits is unambiguously negative.<sup>31</sup> The effect on the first-period profit gain is ambiguous due to two counteracting effects. Stronger employment protection increases the distortion of the first-period employment/production decision, but this effect is counteracted by a lower first-period wage. Regarding downsizing costs, stronger employment protection will increase the cost of firing each single worker, but fewer workers will lose their jobs so the effect on total downsizing costs is ambiguous. The decisive effect with respect to technology incentives is that the gain in second-period operating profits is lower when employment protection is stronger. The reason is that employment protection makes second-period employment excessively high, and more so the higher the degree of protection. Since the benefits of better technology can be fully exploited only by laying off a sufficient number of workers, employment protection naturally makes it more costly for the firm to reap the full benefits of technological progress. Thus, the more costly it is for the firm to downsize employment, the less attractive it is to install a new labour-saving technology. Once more, notice that this effect holds for all  $\theta \geq 0$  and is thus not qualitatively dependent on the magnitude of union wage responses.

As a secondary result, we also notice that a more wage oriented union reduces the profitability of technological progress. This is partly due to the fact that a more wage oriented union will enforce a larger wage increase following a technological progress (cf. (11)), a result that clearly resembles the well-known results by Grout (1984) and Manning (1987) about the investment-detering effects of trade unions. When seeing Propositions 2 and 3 in conjunction, notice that more wage oriented unions will reduce union opposi-

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trade union power is necessary to establish a link between outside and inside options.

<sup>29</sup>From (24) we have  $\frac{\partial(\pi_1^* - \hat{\pi}_1)}{\partial c} = \frac{\theta(\alpha - b - 2c) - c}{2\beta(\theta + 1)^2} \leq 0$ .

<sup>30</sup>From (26) we have  $\frac{\partial C^*}{\partial c} = \frac{(\phi - 1)(\alpha\phi - b(1 + \phi)) - 2c(\phi^2 + 1)}{2\beta\phi^2(\theta + 1)} \leq 0$ .

<sup>31</sup>From (25) we have  $\frac{\partial(\pi_2^* - \hat{\pi}_2)}{\partial c} = -\left(\frac{\theta(\alpha\phi + 2c - b) + c}{2\beta\phi^2(\theta + 1)^2}\right) < 0$ .

tion to technological change, but at the same time reduce firm incentives for technology investments.

### *Redundancy payments*

So far in the analysis we have assumed that employment protection is due to ‘red tape’ firing costs. Let us briefly consider the case where part of the firing costs are redundancy payments to laid-off workers. Since redundancy payments add to the outside option of workers that are currently employed by the firm, this naturally creates a positive link between the degree of employment protection and the reservation wage. More specifically, we let the reservation wage be given by

$$b := b_0 + \gamma c, \quad (27)$$

where  $\gamma \in (0, 1)$  represents the share of firing costs that are due to redundancy payments. This means that an increase in the degree of employment protection will also increase the reservation wage (by a factor of  $\gamma$ ).<sup>32</sup>

It is straightforward to show that this reformulation will not qualitatively affect the results in Section 4; an increase in the degree of employment protection will still make the union more willing to accept technological change.<sup>33</sup> However, the relationship between employment protection and firm incentives for technology investments might qualitatively change. Using (27) in (19), the relationship between  $c$  and investment incentives is given by

$$\frac{\partial(\Delta\Pi)}{\partial c} = - \left( \frac{(\phi - 1)(1 - \gamma)(\alpha\phi - b_0(1 + \phi)) - c \left( (1 - \gamma)^2 + \phi^2(1 + \gamma(2 - \gamma)) \right)}{2\beta\phi^2(\theta + 1)^2} \right) \leq 0.$$

<sup>32</sup>With this reformulation, the condition  $L_2^* < L_1^*$  is satisfied for  $c < \frac{(\phi-1)(\alpha\phi-b_0(1+\phi))}{1-\gamma+\phi^2(\gamma+1)}$ .

<sup>33</sup>Using (27) in (16), we have that

$$\frac{\partial(\Delta U)}{\partial c} = \frac{\theta^\theta \left[ (1 - \gamma)(\alpha\phi - b_0 + c(1 - \gamma))^\theta + \gamma\phi^2(\alpha - b_0 - \gamma c)^\theta \right]}{2(\theta + 1)^\theta \beta\phi^2} > 0,$$

which implies  $\frac{\partial\theta^*}{\partial c} < 0$ .

The sign of this effect is generally ambiguous and depends crucially on the parameter  $\gamma$ . Since the numerator is positive for  $\gamma = 0$ , negative for  $\gamma = 1$ , and monotonically increasing in  $\gamma$ , the following result can be established:

**Proposition 4** *If a share  $\gamma$  of the firing costs are redundancy payments to laid-off workers, there exists a critical value  $\gamma^* \in (0, 1)$  such that stronger employment protection reduces (increases) technology investment incentives if  $\gamma < (>) \gamma^*$ .*

The intuition is fairly straightforward. Since redundancy payments creates a positive link between employment protection and workers' outside options, stronger employment protection has an a priori ambiguous effect on investment incentives, since the negative effect of higher firing costs are compensated by the positive effect of a higher reservation wage. Interestingly, the counteracting effect of a higher reservation wage more than compensates for the higher firing costs for a value of  $\gamma$  that is strictly less than 1.

## VI. Concluding remarks

Recent opinion polls indicate that workers in the Nordic countries fear globalisation less than workers in other rich countries.<sup>34</sup> This could of course stem from the fact that they are better insured against adverse events in the labour markets. But in addition the flexicurity type labour market arrangements in these countries could have paved the way for structural change and technological improvements. In turn, this could mean that the bulk of Nordic workers now have high productivity jobs that are less challenged by globalisation than jobs with less technology content. Annenkov and Madaschi (2005) report that since the mid-1990s the Nordic EU countries have experienced stronger labour productivity growth than the larger EU countries. They claim that innovation and technological changes lie behind this fact. Flexicurity is of course only one element in the social model that has produced this outcome, but perhaps an important one. It is beyond the scope of this paper to try to disentangle why adoption of new technology has been so rapid in Northern Europe. Rather, the purpose of this paper has been to contribute to this debate by carefully analysing the

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<sup>34</sup>Scheve and Slaughter (2006).



effect of social insurance and employment protection on trade union behaviour, on wages and employment in the industry in question, and on the union's willingness to accept new technology. The basic flavour of our results is a confirmation that flexicurity is good for change. Notably, trade unionism is important for this result. The employer side is typically willing to install labour-saving technology. Organised workers can be harder to persuade. Flexicurity can be important because it contributes to build down that barrier to technology adoption that trade unions can represent.

Flexicurity is a two-legged policy, with reduced employment protection and a better situation for laid-off workers as the two legs. Of course, the flexicurity package can be unbundled, and the separate parts can be introduced separately. This paper is not meant to contain a full cost-benefit analysis of the two policy instruments involved. However, we have hinted that better outside options for laid-off workers is instrumental to the 'flexibility' part of 'flexicurity'. Both firms and unions get to be more willing to accept labour-saving technology change when outside options are good. Building down employment protection may be good because employers dare to hire more people for any given level of technology. Its role to promote more flexible views towards technological change, though, can less be taken for granted. If workers through their union have a strong direct influence over technology adoption, they would be more inclined to veto labour-saving innovations when employment protection is bad, simply because labour-saving technology in that case would imply more job losses. This conclusion is changed if workers only have an indirect influence over technology, through the way technology influences wage demands. Firms benefit more from labour-saving the less employment protection there is, because then they have a chance to get more out of a costly investment meant to reduce the number of employees. So when union influence over technology is indirect in this sense, both legs of a flexicurity package is good for technology adoption.

By way of conclusion, we would like to emphasise that our results generalise beyond the simple monopoly setting, which has been chosen for analytical clarity. Consider, for example, a homogeneous goods Cournot duopoly where wages are set by an industry-wide

trade union. Maintaining all other assumptions, it can be shown that our main results are qualitatively similar in the presence of downstream competition.<sup>35</sup> Regarding union opposition to an exogenous technological shock, it can be shown that the critical degree of union wage orientation, below which the union will oppose technological change, is identical in the monopoly and duopoly cases<sup>36</sup>, implying that the effect of employment protection and workers' outside options are also the same. Regarding firm incentives for technology investments, the presence of downstream competition will create strategic interaction at the investment stage. In a two-stage game where the firms simultaneously (and independently) decide whether to invest or not in a labour-saving technology before playing a two-period Cournot game, investment by both firms is a Nash equilibrium if – for each firm – the profit difference between investing and not investing when the other firm invests is higher than the investment costs. It is possible to show that, except for extreme cases where innovation is very drastic (labour productivity more than doubles) *and* employment protection is very low, our results are qualitatively unchanged in the sense that less employment protection and/or better outside options will increase the parameter space for which technology investment by both firms is a Nash equilibrium.

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<sup>35</sup>Details are available from the authors upon request.

<sup>36</sup>In fact the threshold value of  $\theta$  is independent of the number of downstream firms. This is related to the quite general result shown by Dhillon and Petrakis (2002), that the wage set by an industry-wide union is independent of the number of firms in the industry.

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