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The effects of mergers on company employment in the USA and Europe

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Abstract

We systematically analyse the effects of mergers and acquisitions on the demand for labour in the USA and Europe. We do not find adverse effects of mergers on labour demand in the USA, however we do find negative effects in Europe of the order of −10% compared to pre-merger levels. We attribute this significant difference to more rigid labour markets in Europe than in the USA.

JEL classification: G34; L2

Keywords: Mergers and acquisitions; Labour demand; Restructuring; International comparison

1. Introduction

The last two decades saw a dramatic increase in unemployment within the European Union (EU). The average unemployment rate peaked at 11.5% in 1985 and is not much lower currently at 9.2% (see OECD, 2000). Although the United States (US) has also experienced a rise in unemployment over parts of this period, US unemployment never reached EU levels and, what is more, always returned to lower rates eventually. High labour adjustment costs in Europe have long been held responsible for this poor labour market performance, which has been termed "*Eurosclerosis*".[1]

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[1] Labour turnover costs are many and diverse; they range from the costs of job search, screening, training, and firing; to negotiation costs, including the expected loss of profits due to the implementation of strike threats and work-to-rule activities (see Lindbeck and Snower, 1989). In this paper by analysing the effects of mergers and acquisitions on employment, we emphasise firing costs such as costs arising due to rules of collective dismissal involving, e.g. advance notification of dismissals or non-negligible severance payments to laid off employees.

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Studies analysing the effects of adjustment costs on the demand for labour abound, and all find that the US labour market adjusts more quickly to shocks than its European or Japanese counterparts. For example, while there are differences across broad industrial sub-sectors and the adjustment of hours worked is quite similar in the USA and Germany, Abraham and Houseman (1989, 1993) show that employment level adjustment is much faster in the US manufacturing sector than in Germany or Japan. Balakrishnan and Michelacci (2001) find that most differences in unemployment dynamics arise because of differences in responses to economic shocks. The US labour market is quicker to adjust than the EU labour markets (in the study these are the UK, German, French and Spanish markets).[2] Interestingly and perhaps surprisingly, the UK labour market adjusts slowest among the countries depicted, at least when the authors use their preferred specification.[3] Finally, Hamermesh and Pfann (1996) compare studies based on firm-level data and conclude that the adjustment of employment in response to demand shocks is slower in Europe than in North America.

Therefore, the verdict seems clear: high labour adjustment costs in Europe prevent firms from reaching their optimal employment level in the aftermath of an economic shock, at least in the short-run. An excess labour burden is the likely outcome. In this paper, we argue that high labour adjustment costs in Europe imply a testable implication for the effects of mergers and acquisitions on the demand for labour. If in the wake of mergers and acquisitions the adjustment of employment is facilitated (we will argue below, that this is quite plausible), "sclerotic" labour markets in Europe imply that mergers and acquisitions have differential effects on the demand for labour in the USA and Europe. In particular, we expect that the combined firm sheds (excess) labour after a merger by *more* in Europe than in the USA. This is so because US firms do not need (or need less) the restructuring effects (merits) of mergers and acquisitions to optimally adjust to shocks. US labour markets allow for a continuous adjustment of labour at low cost.[4] In contrast, high adjustment costs of the workforce in Europe prevent firms from reaching the optimal employment level without reneging on (explicit or implicit) contracts. Mergers and acquisitions are a major event in the life of a company and often go hand in hand with substantial restructuring and even closure of divisions within the combined entity. Incumbent target management is likely to be replaced and the new managerial team is less likely to be committed to upholding past contracts with stakeholders (Shleifer and Summers, 1988). We present evidence that European mergers are different from US mergers

[2] For related papers using only US data, see Blanchard and Diamond (1989); Blanchard and Diamond (1990).

[3] The authors rationalise this result with the time period analysed (1972–1990), when labour markets in the UK were fairly rigid. Below, we have some more words to say about the UK.

[4] An, admittedly extreme but nevertheless instructive, example of this are the layoffs of 5000 people (approximately 1.5% of the total workforce) by IBM in June 2002. According to press releases (*Der Standard*, 1 June 2002), these layoffs were *not* publicly announced. There were also no announcements of takeovers or restructurings by IBM.

insofar as the demand for labour is reduced by more after a merger or acquisition in Europe than in the USA.[5]

Recent evidence by Conyon et al. (2002a,b,c) (henceforth CGTW) indicates that mergers and acquisitions significantly reduce the demand for labour in the UK in the years following an acquisition. The authors interpret their results as being consistent with significant rationalisation in the use of labour as firms reduce joint output and increase efficiency post-merger.

This paper provides a systematic analysis of the effects of mergers and acquisitions on the demand for labour in three countries/regions of the world, the USA, UK and Continental Europe. This allows us to test the above hypothesis and go beyond CGTW. Consistent with CGTW, we find a significant drop in employment post-merger in the UK, holding constant output as well as accounting for firm fixed effects. However, we do not find a significant reduction in labour demand in the USA, post-acquisition. The overall results for the USA even point to increased demand for labour (albeit insignificantly so). Similar to the overall results for the UK, Continental European mergers reduce the demand for labour. However, here we find interesting differences in the UK for some aspects of mergers such as the relatedness of acquirers' and targets' assets as measured by their industrial classification. In particular, we find (similar to CGTW) that related mergers reduce employment by more than unrelated mergers in the UK. However, this pattern is reversed when we look at Continental European mergers. Here, managers reduce employment by more after unrelated mergers than after related mergers. The difference in employment effects between UK related mergers and Continental European related mergers is significant at the 10% level. In contrast to both UK and Continental European mergers, the effects of US mergers on labour demand appear independent of the relatedness of the assets involved. We also find differences in effects of tender offers as compared to other deals. These results underline the importance of institutions in determining the effects of mergers and acquisitions on employment, since labour markets are highly regulated and specific national institutions play a prominent role.

Previous studies of mergers' effects on employment neglect the fact that firms undertake multiple mergers and divestitures. We address these methodological shortcomings in the following ways. First, by tracking the entire *history* of mergers and acquisitions undertaken by the acquiring firm under consideration, we make sure that additional acquisitions of this firm do not artificially inflate acquiring firm employment figures.[6] Second, by also collecting information on all divestitures of acquiring firms, we

[5] The flip side is that necessary restructurings are sometimes delayed and insufficient. For example, Deutsche Telekom (DT), after suffering a record loss of 4.7 Bill Euro in 2001 and a projected loss of 5.5 Bill Euro in 2002, announced a reduction of the total workforce by 22,000 or 8.5% until the *end of 2004*. According to Ron Sommer, then the CEO of DT, this reduction in the workforce "should be achieved without layoffs as in the past." One could speculate that if DT were the target of a takeover or incorporated in the USA, employment reduction would be much faster. Moreover, the union representatives on the supervisory board of DT insisted that the successor to Ron Sommer must come from within the firm. The reason was that they expected less employment reduction, since an insider would be less likely to revise the decisions she has approved of in the past.

[6] Take for example Siemens AG, which took over another firm in *each* of the years 1987–1998, however, we have only data for two of these targets. We have to exclude Siemens AG, therefore, from the analysis, since we would artificially attribute increased labour demand to these two mergers when in fact the increased employment of Siemens AG stems in part from the additional acquisitions.

are able to control for divestiture activity of these firms. This gives us a more accurate estimate of the net effect of mergers and acquisitions on firm labour demand.[7]

The rest of the article is structured as follows. Section 2 provides the theoretical background and empirical evidence so far on the effects of mergers on labour demand. Section 3 presents our estimation strategy. Section 4 describes the database, Section 5 presents the regression results, and Section 6 discusses robustness checks. The last section concludes. The Appendix A derives the labour demand function following Bresson et al. (1996).

2. Theoretical background and empirical evidence

Employment protection laws vary significantly across countries by length of service, firm size, employee status (blue-collar/white-collar). These differences have produced several stylised facts in the literature on employment protection (see, e.g. OECD, 1996, 1997, 2000; Nickell, 1997; Siebert, 1997).

(1) The USA has the least restrictive employment protection rules. Several studies (see Section 1) and statistics underline this. For example, the OECD (2000), p. 57, ranks the USA as the least restrictive country among 27 OECD countries with respect to overall protection against dismissals of regular employees.
(2) European countries, in particular Southern European countries along with Germany and France, stand out for having relatively strict employment protection. Among the European countries the UK and the Netherlands appear to have the least restrictive employment regulation. However, the UK has very strict regulation concerning collective dismissals. For example, while Germany defines a collective dismissal as one where more than 30 employees are laid off within 30 days, the UK defines a collective dismissal as one where more than 20 workers are laid off within 90 days. To compare, in case of layoff (plant closure), the USA defines a collective dismissal as one where more than 500 (50) workers lose their jobs, or 50–499 workers if they make up at least one third of the workforce, over a period of 30 days. Moreover, the consequences of a collective dismissal appear to be more stringent in the UK than in Germany (or the USA). While in Germany only a consultation with the works council and a notification of the local employment office is required, companies in the UK have the duty to inform and consult with the recognised trade union as well as make a notification to the Department of Trade and Industry. Moreover, Freeman (1998), p. 16, states that while Mrs. Thatcher's legislation to curb union excesses in the UK helps account for the drop in union density in the UK, the legislation is "small" in the sense that it did not seek to change the essential features of British labour relations.[8]

[7] Gugler et al. (2003) also account for the effects of additional mergers and of divestitures in their analysis of the effects of mergers on profits and sales.

[8] There was also not much wage restraint in the UK nor was labour market performance as measured, e.g. by the unemployment rate, much better or different from the experience of other EU countries. Unit labour costs increased by an annual average rate of 4.4% over the period 1987–1997 in the UK as compared to 2.9% in the EU and 2.3% in the USA (see OECD, 2000, p. 16). Nickell (1997), p. 57, states for the period 1989–1994 that "Britain … has an average unemployment rate higher than half of its European neighbours."

(3) Stricter employment protection laws are associated with lower turnover in the labour market, with both periods of work and unemployment spells lasting longer. Here again doubt must be expressed that the UK has a very flexible labour market. OECD (1997), p. 163, reports that the UK has the second *lowest* job turnover rate[9] (15.3%) over the period 1985–1991.[10] To compare, the USA has a job turnover rate of 23.4% and Germany one of 16.5%.

This discussion leads us to conclude that European labour markets are much more highly regulated than their counterparts in the USA. It also casts doubt on the notion that the UK labour market is substantially more flexible than other European labour markets.

In general, the a priori predictions on the effects of mergers on labour demand are ambiguous. A merger may lead to a reduction in output, e.g. because the merger increased market power or the technologies of the acquiring and acquired company exhibit increasing returns to scale, and a consecutive reduction in employment. A merger may, on the other hand, lead to an increase in output, e.g. because the merger significantly increased the efficiency of the combined firm or led to product improvements and demand shifts. Thus, the employment of the combined entity may rise or fall relative to the sum of the pre-merger employment levels.[11]

If, however, mergers are used as a general device to restore a firm's optimal employment level, we would expect *differential* effects depending on labour market institutions. While ambiguities exist whether high labour adjustment costs increase the unemployment *level*, it seems safe to argue that the speed of *adjustment* with which firms respond to shocks decreases with adjustment costs.[12] High labour adjustment costs make hiring a worker a somewhat irreversible decision. Therefore, it appears likely that in countries with very rigid labour markets some firms carry excess labour. Fewer such firms are expected to exist in countries whose labour markets allow quick adjustment of the workforce. Mergers and acquisitions are an effective means to achieve a desired restructuring, since the managerial team is likely to be new and therefore less likely to be committed to upholding past contracts with stakeholders (Shleifer and Summers, 1988). Since Europe has more rigid labour markets than the USA, mergers may be used as a device to reduce excess labour. Thus, we expect that the demand for labour is reduced by *more* after a merger or acquisition in Europe than in the USA.[13]

[9] Job turnover is the sum of over-the-year changes in employment levels across all establishments as a proportion of total employment, and is one indicator of the extent of change in the external labour market.

[10] The studies in Barrell (1994) support this view.

[11] Predictions are also ambiguous when one assumes that managers maximise something else than profits, e.g. sales or growth.

[12] See Bertola (1990), who argues that employment appears more stable and unemployment more *persistent* in high job security countries, while no strong relationship emerges between job security and unemployment *levels*. See also Modesto and Thomas (2001); Bentolila and Bertola (1990); Bentolila and Saint-Paul (1994) among others. However, see Boeri (1999) emphasising the importance of job-to-job shifts and "short-term" jobs in Europe as a means to attain flexibility in the presence of tight labour market regulations.

[13] An example is the planned privatisation of the Austrian Postbus AG in 2002. The union fears that a third of the workforce of Postbus AG will be laid off in case of privatisation and currently tries to prevent it.

Table 1
Summary of results of previous studies

Study	Country	Sample and time period	Form of ownership change	Main results
Brown and Medoff (1988)	USA	Large sample of firms including also very small, unlisted firms in Michigan; 1978–1984	"Assets only" acquisitions: "True mergers":	Wages 5% higher, employment 5% lower Wages 4% lower, employment 2% higher
Bhagat et al. (1990)	USA	62 takeovers; 1984–1986	Hostile takeovers	In 28/62 cases workers laid off involving 5.7% of work force
Lichtenberg and Siegel (1990a)	USA	Auxiliary Establishment Reports of the 1977 and 1982 economic censuses	All ownership changes	−15.7% in employment in auxiliary establishments, but only −4.5% in production establishments
McGuckin et al. (1995); McGuckin and Nguyen (2000)	USA	Longitudinal Research Database (LRD); 1977–1987	All ownership changes	Positive, but insignificant effect on employment at firm-level; +16.1% at plant level
Conyon et al. (2002a,b,c)	UK	277 listed firms; 1975–1996	442 mergers; Related: Unrelated: Hostile: Friendly: Foreign:	 −19% in employment −8% in employment −17% in employment −9% in employment +13% in labour productivity

Note, that for this prediction to be valid, it is not important whether the excess labour employed is the result of "implicit" or "explicit" contracts. If implicit contracts are more sustainable in more rigid labour markets, a potential for ex-post expropriation is created. Shleifer and Summers (1988), in particular, express the concern that hostile takeovers can lead to a "breach of trust". A raider may break implicit contracts if it is in its interest ex-post (i.e. after firm-specific investments have been made), and lay off people or reduce their wages. Rigid labour markets also provide protection to insider employees who did not necessarily build up firm-specific human capital, and merger activity also offers an opportunity for firms to renegotiate these labour contracts.[14]

Evidence on the impact of mergers on employment is extremely limited, especially outside the Anglo-Saxon world (see Table 1). Brown and Medoff (1988) analyse a large sample of firms in the state of Michigan for the period 1978–1984, and find that firms that are part of "assets only" acquisitions have wages about 5% higher but

[14] It should be noted, however, that the efficiency consequences may differ. If stakeholders anticipate that (particularly hostile) takeovers increase the probability that they are expropriated ex-post, they provide a sub-optimal level of relation-specific investment ex ante. "At least in part, therefore, the gains are wealth redistributing and not wealth creating." (Shleifer and Summers, 1988, p. 42). If a merger is merely used to restore optimal employment level and no other inefficiencies are involved, on the other hand, the merger is likely to be efficiency enhancing.

employment about 5% lower than would otherwise be the case. "True mergers" are associated with wage declines of about 4% and employment *growth* of about 2%. Bhagat et al. (1990) examine 62 hostile takeovers in the USA between 1984 and 1986, and find that in 28 of the 62 cases workers were laid off after the takeover involving 5.7% of the work forces of these firms. These redundancies account for 10–20% of the premium paid. Based on a comprehensive analysis of thousands of US manufacturing plants, Lichtenberg and Siegel (1990a) conclude that job losses after mergers are largely confined to central office staff. McGuckin et al. (1995) find increased employment in acquired plants and insignificant effects in firm-level regressions for the USA. In a more recent study, McGuckin and Nguyen (2000) also conclude that ownership changes are not a primary vehicle for cuts in employment and wages, or closing plants. Instead, ownership changes are associated with increases in employment for the entire US manufacturing sector for the 1977–1987 period.

As already mentioned, Conyon et al. (2002a,b,c) find for the UK between 1967 and 1996 that mergers and acquisitions significantly reduced the demand for labour in the years following an acquisition. The negative effects on employment are particularly pronounced for related and hostile transactions.

We are not aware of any systematic studies of the effects of mergers on employment in Continental Europe nor in other parts of the world.

3. Estimation strategy

If a merger results in an optimal employment level different from the total employment of the merging firms, then a profit maximising firm will adjust its labour force via an active policy of hiring or firing. Dynamic models of labour demand place great emphasis on the costs of this adjustment process.

While a dynamic labour demand function can be specified in several ways, we employ the following equation assuming that output constrained firms face continuous quadratic adjustment costs and use a Cobb–Douglas technology:

$$l_{it} = \alpha l_{it-1} + \beta_1 q_{it} + \beta_2 q_{it-1} + \delta_1 (w/c)_{it} + \delta_2 (w/c)_{it-1} + \gamma_t D_t + f_i + \varepsilon_{it} \quad (1)$$

where l_{it}, $(w/c)_{it}$ and q_{it} denote the logarithms of employment, real wages relative to user cost of capital and real output of firm i in period t. We proxy real output by real total sales. D_t are a set of time dummies to account for technical progress and business cycle effects, and f_i isolates firm-specific fixed effects.[15,16]

[15] In Section 6 we directly account for technical progress and/or "skill-biased" technological change by including the R&D intensity of the firm as an additional determinant of labour demand as well as estimating (1) for R&D intensive and R&D unintensive industries.

[16] We sketch the major steps in the derivation of (1) in the appendix. See, Bresson et al. (1996) or Nickell (1984) for a full exposition.

Our method of estimating the impact of mergers on employment is by the introduction of dummy variables. For example, to test whether there are differences in the effects of mergers on employment between US and European mergers, we estimate the following regression equation

$$l_{it} = \alpha l_{it-1} + \beta_1 q_{it} + \beta_2 q_{it-1} + \lambda_0 U_{it} + \lambda_1 E_{it} + \delta_0 DU_{it} + \delta_1 DE_{it} + \gamma_t D_t + f_i + \varepsilon_{it} \quad (2)$$

where $U_{it} = 1$ if the country of incorporation of firm i taking over another firm in t is the USA, and zero elsewhere; and $E_{it} = 1$ if the country of incorporation of firm i taking over another firm in t is a (Western) European country, and zero elsewhere. Note that employment and sales are defined as the sum of acquiring firm and target company employment (sales) before the merger and as employment (sales) of the acquiring firm post-merger. That is, the data series used apply to the combined entity, which controls for any spurious impact of merger on employment.

The key statistics of interest are the λ's measuring the contemporaneous impact of mergers on labour demand of the combined entity in (approximately) percentage terms relative to the sum of the pre-merger employment levels of acquirer and target. We deliberately focus on the short-run effects, since they capture the immediate restructuring effects of mergers. This should disentangle restructuring effects from medium to longer run product market effects.[17]

Since our main motivation is to see whether rigid labour markets in Europe lead to larger restructuring effects of mergers, we stress the *difference* in the λ's across countries/country groups. We hypothesise that since Europe has more rigid labour markets than the USA and if mergers are used as a means of restructuring, the demand for labour is reduced by more after a merger or acquisition in Europe than in the USA, i.e. $\hat{\lambda}_0 > \hat{\lambda}_1$. Note, that even if the λ's are estimated with bias[18], the estimated differences in effects $\widehat{\lambda_0 - \lambda_1}$ are unbiased estimates of the true differences, if the bias is the same across countries/groups of countries.

Eq. (2) controls for firm fixed effects (f_i) as well as for year fixed effects (D_t). The latter allow for differential employment growth over the business cycle. Fixed firm effects subtract firm-specific means from all variables removing all time invariant determinants of labour demand growth. Thus, fixed firm effects leave the merger dummy variables to pick up the effects of within firm variation in merger activity on employment.

Unlike the literature on the effects of mergers on employment so far, we control for divestiture activity by introducing dummy variables taking the value one if acquiring firm i made a divestiture in year t, and zero if it did not. In the example of Eq. (2),

[17] There are a number of arguments suggesting that product market effects take time, for example, switching costs, brand loyalty, delayed reaction of rivals, entry etc. (see Gugler et al., 2003).

[18] Say, because the within firm variation in merger activity is (partially) endogenously determined, or because merger years are a self-selected sample of observations. However, GMM estimation should at least in part correct for that.

$DU_{it}=1$ if the US firm i makes a divestiture in t, and zero elsewhere, and $DE_{it}=1$ if the European firm i makes a divestiture in t, and zero elsewhere. Note that we again control for the entire divestiture history of the firm. We introduce dummy variables for divestiture activity instead of subtracting the employment (sales) of the divested units from the combined entity, since most divestitures are spin- or split-offs of divisions of a company and these data are not available. By introducing divestiture dummies we correct for the average effects of divestitures on employment of the combined entity, leaving the λ's to measure the net effect of merger activity.

Eq. (2) can be modified by introducing appropriately defined dummy variables to test for the effects of mergers in other geographical regions of the world or various additional aspects of merger activity such as the relatedness of assets, the hostility of the transaction etc.

Eq. (2) contains a lagged dependent variable and OLS would be inconsistent in the presence of unobserved firm-specific effects. Therefore, we estimate it by a systems GMM estimator developed by Arellano and Bond (1991).[19] This estimator eliminates firm effects by first-differencing as well as controls for possible endogeneity of current explanatory variables. Endogenous variables lagged two or more periods will be valid instruments provided there is no second-order autocorrelation in the first-differenced idiosyncratic error terms. We present tests for autocorrelations and the Sargan test of over-identifying restrictions in the tables that follow. We also provide a goodness of fit measure for our models, which is the squared correlation between the predicted and the actual value of the dependent variable. This measure is equivalent to the standard R^2 for OLS regressions and has been suggested as a goodness of fit measure for Instrumental variables (IV) regressions (Windmeijer, 1995).

The next section presents the database used as well as summary statistics.

4. The database

Our principal source of data is the *Global Mergers and Acquisitions* database of *Thompson Financial Securities Data* (*TFSD*). This company collects merger and spin-off data using a variety of sources such as financial newspapers, Reuters Textline, the Wall Street Journal, Dow Jones etc. The database covers all transactions valued at US $ 1 million or more. We define a merger as a transaction where more than 50% of the equity of a target firm is acquired. We include also deals where a part of a company, say in the form of a division, was sold to another company.[20] Thus, we include not only listed but also privately held targets. During the period 1981–1998, there were 200,480 announcements of such M&A transactions. Our merger data for the US begin in the late 1970s, for all other countries in the mid-80s.

Of the more than 200,000 announced mergers across the world, 140,289 were actually completed with almost half of these taking place in the US. The samples used for our analysis

[19] See Anderson and Hsiao (1982) for a different consistent estimator of the parameters of dynamic panel models with fixed effects.

[20] Symmetrically we define a spin-, split- or sell-off as a transaction where more than 50% of the equity are disposed off. We use the term "divestitures" interchangeably.

are much smaller than these numbers might indicate for the following reasons. First, acquiring company employment and sales data stem from the *Global Vantage/Compustat* database, which include only listed firms. Out of the 140,000 completed mergers we could match 31,696 made by 9092 acquiring firms to one of these databases over the period 1987–1998.[21] Missing employment or sales data for acquiring firms and/or targets further reduces the sample to 6206 mergers. Some acquiring companies acquire more than one target in a given year, and since our balance sheet information for acquiring companies is on a yearly basis, we aggregate the relevant variables of these targets. This further reduces the merger sample to 4106 merger years. Finally, we take great care in tracking the whole merger history of the firm. This is important since if one does not account for multiple mergers or acquisitions of a single company over time, serious bias is introduced. To be included in the final sample, therefore, we require that *all* data on *all* targets are available from year $t-1$ to $t+3$ with merger year t. This further reduces the final sample to 646 mergers made by 550 acquiring firms for which we have the full set of data.

The control sample is the whole universe of *Global Vantage* firms that did not make an acquisition over the period 1987–1998. Since we account for (almost) all mergers that happened during this period, we are confident that this control sample is as "clean" as possible.[22] In total, we include 10,282 firms in the estimation. Our dummy variable that controls for divestitures is defined for 1577 of these firms making 2332 divestitures.

It should be noted here that our criteria for inclusion of mergers and divestitures in the final sample are solely based on data availability. While our databases include only listed *acquiring* firms, they include unquoted targets as well as divested divisions.[23] The sample is therefore as representative for the underlying population of mergers and divestitures as feasible with commercially available databases.

Table 2 presents a breakdown of mergers by year, some specific aspects of mergers, and by country. The last column of the table contains statistics from the whole population of mergers of *Global Vantage* firms. From the 646 analysed mergers, 364 (56.3%) are undertaken by US acquiring firms, 104 by UK companies and the remaining 178 by firms of Continental European origin. There are 65 mergers undertaken by German firms, for which sample size allows separate estimates below. Similar to Conyon et al. (2002a), mergers are classified into related and unrelated depending on whether the acquired and acquiring firms belong to the same two-digit SIC industrial code. Some 333 mergers (51.5%) fall into the related category, a percentage which is close to the population value of 53.2%. Interestingly, more than 60% of UK mergers are classified as unrelated as compared to only 43.7% of US mergers. We define a transaction as "hostile" if the incumbent target board rejected the first bid by the subsequently successful acquirer. This is a very strict requirement, since it is a very risky strategy for incumbent management to

[21] That is, on average acquiring firms acquired more than three firms during the 12 year period 1987–1998. UK firms acquired on average 3.4 firms. Conyon et al. (2002a) report an average of 1.4 firms for their sample of UK firms over the period 1967–1996. It is likely, therefore, that Conyon et al. (2002a) did not account for all mergers occurring, and their estimates are likely to be biased in favour of finding *positive* effects of mergers on labour demand. Conyon et al. (2002a) did also not account for divestitures.

[22] As an additional check, we eliminate all firms in the control group that experienced fixed assets growth of more than 100% in a given year.

[23] They are, however, underrepresented as compared to quoted targets or regular mergers.

Table 2
Sample composition: Number of mergers if not stated otherwise

Year	USA	UK	Continental Europe	Total	Population*
Panel A: by year					
87	31	2	0	33	881
88	28	5	0	33	1181
89	29	4	6	39	1398
90	18	8	6	32	1569
91	15	3	5	23	1684
92	14	2	6	22	1847
93	43	14	12	69	2019
94	36	14	33	83	2478
95	32	15	26	73	2670
96	42	15	28	85	3054
97	43	8	16	67	3252
98	33	14	40	87	2122
Total	364	104	178	646	25,379
					Population* (%)
Panel B: by specific aspects of mergers					
Related	205	41	87	333	53.16
Unrelated	159	63	91	313	46.84
Friendly	350	98	175	623	99.41
Hostile	14	6	3	23	0.59
No tender	296	66	155	517	95.38
Tender	68	38	23	129	4.62
Domestic	298	82	94	474	92.84
Cross border	66	22	84	172	7.16
	Sample	Population*			
Panel C: by country					
Luxemburg	2	15			
Austria	4	120			
Norway	4	161			
Denmark	5	108			
Spain	5	131			
Finland	5	210			
Ireland	6	151			
Italy	8	232			
Belgium	10	159			
France	12	430			
Netherlands	16	437			
Sweden	16	393			
Switzerland	20	289			
Germany	65	928			
UK	104	4433			
USA	364	17,159			

* Population of mergers of *Global Vantage* firms.

Table 3
Summary statistics: means

	Acquiring firm (A)	Target (T)	T/A (%)	Difference significant? (10% level)	Population* (T/A, %)
Panel A: number of employees					
All	13,149	2617	19.9	Yes	17.9
USA	12,199	2173	17.8	Yes	16.2
UK	12,026	4116	34.2	Yes	35.7
Continental Europe	15,749	2648	16.8	Yes	11.5
Related mergers					
All	12,605	3041	24.1	Yes	22.7
USA	11,001	2703	24.6	Yes	21.1
UK	10,666	6660	62.4	No	52.8
Continental Europe	17,298	2133	12.3	Yes	13.5
Unrelated mergers					
All	13,729	2166	15.8	Yes	12.8
USA	13,744	1491	10.8	Yes	9.8
UK	12,911	2460	19.1	Yes	25.2
Continental Europe	14,268	3141	22.0	Yes	9.6
Panel B: the level of labour productivity					
All	0.226	0.272	120.3	Yes	131.1
USA	0.243	0.274	113.1	No	120.4
UK	0.200	0.290	144.8	Yes	155.5
Continental Europe	0.171	0.230	134.5	No	161.3
Related mergers					
All	0.232	0.311	134.1	Yes	137.8
USA	0.239	0.307	128.5	Yes	129.3
UK	0.250	0.366	146.6	No	172.7
Continental Europe	0.165	0.274	166.2	No	151.3
Unrelated mergers					
All	0.218	0.227	103.9	No	123.0
USA	0.247	0.229	92.5	No	107.8
UK	0.169	0.242	143.1	No	142.5
Continental Europe	0.177	0.191	108.3	No	171.4

Year	Sample			Population	
	USA	Europe		USA	Europe
Panel C: industry–country adjusted levels of labour productivity					
$t-1$	1.022	0.909	Yes	1.012	0.899
t	0.985	0.968	No	0.998	0.970
$t+1$	1.025	0.984	No	0.978	0.981
$t+2$	1.010	0.961	No	1.020	0.953
$t+3$	1.018	0.973	No	1.011	0.942

Number of employees is the total average annual number of employees. Labour productivity is defined as total sales per worker in 1995 Mio USD. Industry–country adjusted labour productivity is the ratio of acquiring firm labour productivity to the average labour productivity of non-merging firms in the same country and two-digit industry of the acquiring firm.

*Population of mergers of *Global Vantage* firms.

formally reject a bid. Thus, only 23 deals are so classified as hostile. While 20% of all mergers are tender offers, more than a third of UK transactions are tender offers, some of which may bear a hostile element.[24] Finally, 26.7% of all final sample mergers are cross border deals, thus cross border deals are somewhat over-represented when compared to the population of mergers. Nearly 50% of Continental European mergers are cross border, while only 18.1% of US mergers are cross border deals.

Table 3 presents basic statistics on the number of employees as well as on absolute levels of labour productivity (sales/worker) and industry/country adjusted labour productivity. Again, the last column displays population statistics. Panel A shows, that on average, acquiring firms employ 13,149 people. Their targets employ around a fifth of this workforce (2617).[25] Both in absolute terms and relative to their acquiring firms, UK targets are largest (4116 employees or 34.2%). Strikingly, UK targets involved in related mergers are *not* significantly smaller than their acquirers. Population statistics very closely resemble our sample statistics.

Panel B suggests that targets achieve higher labour productivity than their acquirers. This is true for the analysed sample as well as for the population of mergers. Targets of related mergers exhibit significantly higher labour productivity than targets of unrelated mergers.

If mergers are used as a restructuring device to reduce excess labour, one would expect a rise in the labour productivity of the acquiring firm in the year of the merger and possibly in following years. Panel C presents summary statistics on industry/country-adjusted labour productivity in the years $t-1$ until $t+3$. Our reference is the average labour productivity of non-merging firms in the country and two-digit industry of the acquiring firm in years $t-1$ until $t+3$. Adjusted labour productivity of US companies is insignificantly different from one in all years from $t-1$ until $t+3$: US companies do not appear to use mergers to achieve dramatic increases in labour productivity, on average. In contrast, European companies start out with relative labour productivity around 9% less than their industry peers in year $t-1$ (this difference is significant at the 5% level), and use the merger to lift labour productivity to the average level of non-merging firms in the same industry. While the differences to the control group are insignificant, labour productivity remains below that of industry peers until $t+3$, however. There is no difference in adjusted productivity between European and US acquiring firms from year t onwards. Again, population statistics confirm these results. Thus, we are confident that sample selection bias is of no major concern in our study.

5. Empirical results

Table 4 presents our estimation results for Eq. (2) using the Arellano/Bond one step *GMM* estimator. The *GMM* technique corrects for simultaneity and firm effects biases. The Sargan tests do not suggest rejection of the overidentifying restrictions at conventional

[24] A tender offer is a formal offer of determined duration to acquire a public company's shares made to equity holders. The offer is often conditioned upon certain requirements such as a minimum number of shares being tendered.

[25] Population statistics for absolute sizes are very similar (not shown in Table 3).

Table 4
Basic results

Dependent variable: ln(Employment) (t)	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value
Panel A: GMM estimates for Eq. (2)								
ln(Employment) ($t-1$)	0.341	8.61	0.345	8.69	0.341	8.59	0.341	8.58
ln(Output) (t)	0.347	43.41	0.346	43.16	0.347	43.35	0.347	43.35
ln(Output) ($t-1$)	−0.045	−3.07	−0.047	−3.17	−0.045	−3.06	−0.045	−3.06
Merger (t)	−0.029	−2.74						
Divest (t)	−0.050	−6.21						
Merger USA (t)			0.010	0.73				
Merger Europe (t)			−0.100	−5.39				
Divest USA (t)			−0.062	−6.50				
Divest Europe (t)			−0.022	−1.46				
Merger USA (t)					0.010	0.75		
Merger UK (t)					−0.124	−4.63		
Merger CEU (t)					−0.079	−3.15		
Divest USA (t)					−0.062	−6.49		
Divest UK (t)					0.013	0.59		
Divest CEU (t)					−0.054	−2.61		
Merger USA (t)							0.010	0.75
Merger UK (t)							−0.124	−4.63
Merger Germany (t)							−0.076	−1.79
Merger CEUwG (t)							−0.081	−2.63
Divest USA (t)							−0.062	−6.49
Divest UK (t)							0.013	0.59
Divest Germany (t)							−0.094	−2.29
Divest CEUwG (t)							−0.040	−1.66
Pseudo R^2	0.131		0.130		0.134		0.134	
Sargan test	0.41		0.45		0.42		0.47	
AR(1)	0.00		0.00		0.00		0.00	
AR(2)	0.77		0.79		0.75		0.68	

	Merger	Divestiture
Panel B: Chi-squared tests of differences in merger and divestiture impact (*P-values*)		
USA-Europe	0.000	0.024
USA–UK	0.000	0.002
USA–CEU	0.002	0.741
USA–GER	0.054	0.448
USA–CEUwG	0.007	0.404
UK–CEU	0.213	0.025
UK–GER	0.340	0.021
UK–CEUwG	0.283	0.102
Germany–CEUwG	0.936	0.260

The total number of firms in the estimation is 10,282; the total number of firms making mergers is 550; the total number of mergers is 646; the total number of firms making divestitures is 1577; the total number of divestitures is 2332; the total number of observations is 48,363. All regressions include a full set of time and firm dummies. CEU is continental Europe, CEUwG is continental Europe without Germany. The estimation method is one-step GMM. Pseudo R^2 is the squared correlation coefficient between predicted and actual values of the dependent variable. "Sargan test" is the P-value of a Sargan–Hansen test of overidentifying restrictions; AR(k) is the P-value of a test that the average autocovariance in residuals of order k is zero. Instruments include lagged levels of the dependent and the predetermined variables dated $t-2$ or earlier.

levels for either specification estimated. While there is evidence of first order serial correlation in the residuals, the AR(2) test statistics reveal absence of second-order serial correlation in the first-differenced errors and thus that the instruments are valid.

All estimations in Table 4 confirm the predictions of models of dynamic labour demand. Increases in sales cause the level of derived labour demand to increase, the positive and significant coefficient on the lagged dependent variable implies inertia in firm employment. The pattern of wage coefficients for the subsample of firms with wage data is also consistent with the models of dynamic labour demand (not presented in Table 4, see Section 6).

In column (1) in Panel A of Table 4, we present parameter estimates of Eq. (2) using a single merger variable, *Merger* (*t*), a dummy variable equal to one if the firm undertook a merger in year *t* and zero else, as well as a single divestiture variable, *Divest* (*t*), a dummy variable equal to one if the firm divested a part in year *t* and zero else. We estimate a significant drop in labour demand of 2.9% of the combined entity relative to the sum of the pre-merger employment levels of the acquiring firm and the acquired firm in the year following a merger. Divestitures cannot be responsible for this result, since we control for their impact on employment.

In column (3) in Panel A of Table 4, we define *Merger* (*t*) for the USA and Europe, separately. While mergers in the USA leave derived labour demand virtually constant (the coefficient is even positive albeit insignificant), merger activity reduces employment in Europe by 10.0% ($z = 5.39$). More or larger divestitures in Europe cannot be responsible for this result, since we correct for their differential impact. Interestingly, not only are the effects of mergers significantly different in the USA from Europe, so too are the coefficients on *Divest* (*t*) (see Panel B of Table 4).

The same picture emerges when we further differentiate among US, UK and Continental European mergers and divestitures in column (5), or if we differentiate among the USA, the UK, Germany and the rest of Continental Europe in column (7). US mergers are different from their European counterparts as far as their effects on labour demand are concerned. Interestingly, UK mergers reduce derived labour demand by most, namely by 12.4% ($z = 4.63$), while Continental European mergers reduce labour demand by 7.9% ($z = 3.15$). German mergers are not different from the rest of Continental European mergers. Continental European divestitures have similar effects as US divestitures, but they are significantly different from UK divestitures.

Table 5 presents further results on specific aspects of merger activity. Since results on German and the rest of Continental European mergers were very similar, we consider only a split between the USA, UK and Continental Europe (where sample size allowed this). The estimations in Table 5 again include but do not report the dummies on divestiture activity.

In column (1) in Panel A of Table 5, we differentiate between related and unrelated mergers within the three country groups. Neither related nor unrelated mergers reduce employment in the USA. Strikingly, UK related mergers reduce employment by *more* than unrelated mergers (similar to Conyon et al., 2002a), while Continental European related mergers reduce employment by *less* than unrelated mergers. The effects of related mergers in the UK are significantly different from the effects of related mergers in Continental Europe at the 6.5% level of significance.

Table 5
Specific aspects of merger activity

Dependent variable: ln(Employment) (t)	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value
Panel A: GMM estimates for Eq. (2)								
ln(Employment) ($t-1$)	0.342	8.60	0.341	8.59	0.348	8.66	0.341	8.60
ln(Output) (t)	0.347	43.27	0.347	43.23	0.346	42.64	0.347	43.33
ln(Output) ($t-1$)	−0.046	−3.07	−0.045	−3.06	−0.048	−3.19	−0.045	−3.07
Related merger USA (t)	0.017	1.00						
Unrelated merger USA (t)	−0.001	−0.05						
Related merger UK (t)	−0.161	−4.14						
Unrelated merger UK (t)	−0.094	−2.75						
Related merger CEU (t)	−0.067	−2.02						
Unrelated merger CEU (t)	−0.089	−2.60						
Friendly merger (t)			−0.028	−2.60				
Hostile takeover (t)			−0.082	−1.17				
No tender USA (t)					0.021	1.52		
Tender USA (t)					−0.082	−2.02		
No tender UK (t)					−0.141	−4.63		
Tender UK (t)					−0.084	−1.65		
No Tender CEU (t)					−0.072	−2.75		
Tender CEU (t)					−0.145	−2.00		
Domestic USA (t)							0.015	1.04
Cross border USA (t)							−0.017	−0.52
Domestic UK (t)							−0.137	−4.46
Cross border UK (t)							−0.085	−1.64
Domestic CEU (t)							−0.073	−2.20
Cross border CEU (t)							−0.086	−2.37
Pseudo R^2	0.133		0.132		0.135		0.134	
Sargan test	0.39		0.41		0.45		0.40	
AR(1)	0.00		0.00		0.00		0.00	
AR(2)	0.65		0.62		0.66		0.68	

Panel B: Chi-squared tests of differences in specific aspects of merger activity (*P-values*)

Related USA–related UK	0.000							
Related USA–related CEU	0.025							
Related UK–related CEU	0.065							
Unrelated USA–unrelated UK	0.018							
Unrelated USA–unrelated CEU	0.025							
Dependent variable: ln(Employment) (t)	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value
Unrelated UK–unrelated CEU	0.921							
Friendly–hostile	0.440							
Tender USA–no-tender USA	0.016							
Tender UK–no-tender UK	0.322							
Tender CEU–no-tender CEU	0.331							
No-tender USA–no-tender UK	0.000							
No-tender USA–no-tender CEU	0.002							
No-tender UK–no-tender CEU	0.085							

Time, firm and divestiture dummies are included but not reported.

In column (3) we show that outright hostile takeovers have a more adverse effect on labour demand than more friendly transactions, however due to the small number of hostile transactions the coefficient is insignificant. In column (5) we differentiate between tender offers and other deals. Tender offers can be assumed to bear a larger element of hostility than other deals.[26] Tender offers have a significantly different effect in the USA than other mergers. Their effect on labour demand is very similar (around -8%) in the "market-based" systems of the USA and UK. This is consistent with the "breach-of-trust" hypothesis of Shleifer and Summers (1988). The effects of non-tender offers in the UK and Continental Europe are significantly different at the 8.5% level of significance.

Finally, in column (7) we differentiate between domestic and cross border deals. While no differences are significant, domestic mergers reduce employment by much more than cross border deals made by UK acquiring firms (-13.7% vs. -8.5%).[27]

6. Robustness

Since we lack data for wages and the user cost of capital on a comparable international basis for around 50% of the merger sample, we presented the main results excluding them as in Eq. (2).[28] This implicitly assumes that the difference between firms in the wage to capital cost ratio remains constant over time, and subsumes its effects under f_i. However, for a sub-sample of 299 mergers we have average wages, defined as total expenditures on employees divided by total employment. The coefficients on the logarithms of average wages in period t and $t-1$ take on the coefficients -0.31 and 0.11, which is the expected negative/positive pattern. The t-values indicate significance at the 1% level or better. More importantly, none of our inferences on the effects of mergers is altered by the inclusion of average wages.

We want to explain the effects of mergers on labour demand by differences in adjustment costs across countries. It is natural to assume, therefore, that the average speeds of adjustment, the α's in Eq. (2), differ across countries. More generally, country-specific parameter heterogeneity may arise in Eq. (2). Therefore, we estimate (2) separately for the countries/country groups. While the α and β parameters appear to differ across countries, this parameter heterogeneity does not change our main conclusions on the effects of mergers.

As a final robustness check on our basic results we address a possible omitted variable bias in Eq. (2), namely the exclusion of investment in R&D. Although we controlled for exogenous technological change by introducing a full set of time dummies as well as firm

[26] Schwert (2000) considers unnegotiated tender offers as a measure of the hostility of US deals. He also argues that bidders are more likely to be perceived as hostile when they use tender offers rather than merger proposals.

[27] Indeed, the largest negative labour demand effects are obtained for related *and* domestic mergers in the UK (-18.6%; $z=3.90$). Given the small sample size, the coefficient is statistically significantly different from other mergers in the UK only at the 11.1% level of significance.

[28] Interestingly, the *Global Vantage* database lacks the information on employee expenditures predominantly for US companies and not for European companies, since US companies are not obliged to report this information, whereas for most other variables the reverse is the case.

fixed effects in (2), a concern may remain that merger activity and technological change are endogenously related.[29] In the literature on "skill-biased" technological change it is common to include a proxy for technological change in a labour demand equation such as (2).[30] We will follow this route here. When we include the R&D to sales ratio in (2), the coefficient on it is positive and highly significant (0.575, z-value of 11.92). The coefficients on the merger dummies for the USA (0.002, z-value of 0.13) and Europe (-0.138, z-value of -4.15) indicate no change in results from Table 4. Thus, the difference in merger effects between the USA and Europe remains highly significant once we control for R&D expenditures of the firm. Unfortunately, R&D data is only available for less than half of the sample, and mostly so for US firms. Thus we cannot make a finer disaggregation into Continental Europe and UK samples. Therefore, we divided the sample into "R&D-intensive" industries (average industry R&D-intensity larger than 3%, which is approximately the median value across four-digit industries) and "R&D-unintensive" industries (R&D-intensity less than 3%), and estimated Eq. (2) for the different subsamples. For R&D-unintensive industries, mergers reduce employment demand even in the USA (-4.2%, z-value of -2.40), however much more so in the UK (-20.1%, z-value of -8.22) and in Continental Europe (-11.5%, z-value of -4.04). The differences are all significant at the 5% level. For R&D-intensive industries mergers do not decrease labour demand in the USA (coefficient of 0.005, z-value of 0.24), however, do significantly so in the UK (-0.091, z-value of -3.75) and insignificantly so in Continental Europe (-0.050, z-value of -0.99). Thus, our main results on the effects of mergers on firm labour demand are not altered by more explicitly recognising technological change in Eq. (2).

7. Conclusions

Much public concern has been expressed about the influence of merger and takeover waves on the welfare of employees. Do they lose from takeovers?

We analyse this question using a large sample of mergers and acquisitions from the USA and Europe. We do *not* find significantly adverse effects of mergers on labour demand in the USA, on average. However, European mergers significantly reduce the demand for labour by around 10% on average. This is consistent with mergers being used as a restructuring device in "sclerotic" European labour markets. Mergers need not be used as a vehicle to restore optimum employment in the USA, since company managers can do so at any time at fairly low cost. The only category of mergers that also reduce labour demand in the USA is takeovers via tender offers. This is consistent with a "breach of trust" hypothesis of mergers' effects on labour.

The paper reports interesting additional evidence on the effects of mergers on labour demand. UK acquiring firms reduce their demand for labour after related mergers by more

[29] See Hall (1988); Hall (1990); Hall (1999); Lichtenberg and Siegel (1990b) for studies on the effects of mergers and corporate control changes on R&D. See Kleinknecht (1998); Petit and Soete (2001) for a discussion of the relation between labour market flexibility and technological change.

[30] See for example Van Reenen (1997). For a comprehensive survey, see Chennells and Van Reenen (1999).

than Continental European acquirers. The sharpest decline in labour demand was witnessed after domestic and related mergers in the UK. Cross border deals are not significantly different from domestic deals what concerns their effects on employment.

Finally, a methodological contribution of this paper is the simultaneous consideration of the whole merger and divestiture histories of the acquiring firm. Studies that fail to account for this introduce serious bias.

This paper reports on a neglected issue in merger analysis: the role of mergers as a restructuring device. Mergers enable companies to reduce what they view as excess labour in otherwise rigid labour markets. At least some mergers may, therefore, be viewed as the optimal endogenous response to high labour adjustment costs.

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Appendix A. The derivation of the labour demand function

We follow Bresson et al. (1996) and assume that firms are output constrained, have a Cobb–Douglas technology, and face quadratic adjustment functions. Firms determine the path of their future employment by minimising the expected discounted value of their costs

$$C_t = E_t \sum_{s=0}^{\infty} \rho^s \left[c_{t+s} K_{t+s} + w_{t+s} L_{t+s} + \frac{d}{2} (\Delta L_{t+s})^2 + \frac{e}{2} (\Delta K_{t+s})^2 \right] \quad \forall t \tag{A.1}$$

subject to

$$Q_{t+s} = g(K_{t+s}, L_{t+s}) \quad \forall s \tag{A.2}$$

where c_t is the user cost of capital, w_t is the wage rate, and d and e define the quadratic adjustment costs. $E_t[\cdot]$, ρ, and Δ denote the mathematical expectation given the information set available to the firm at period t, the discount rate, and the first-differences operator, respectively. The first-order conditions (Euler equations) for each input are

$$E_t \left(-\rho d(L_{t+s+1} - L_{t+s}) + d(L_{t+s} - L_{t+s-1}) + w_{t+s} + \lambda_{t+s} \frac{\partial g}{\partial L_{t+s}} \right) = 0 \quad \forall s \tag{A.3}$$

for employment and

$$E_t \left(-\rho d(K_{t+s+1} - K_{t+s}) + d(K_{t+s} - K_{t+s-1}) + c_{t+s} + \lambda_{t+s} \frac{\partial g}{\partial K_{t+s}} \right) = 0 \quad \forall s \tag{A.4}$$

for capital.

One can solve this model by working in the neighbourhood of the long-run equilibrium, i.e. where $e=d=0$. The Euler equations can then be written as

$$\left(\frac{\partial g}{\partial L_t}\Big/\frac{\partial g}{\partial K_t}\right)^* = \frac{w_t}{c_t} \tag{A.5}$$

After linearisation of g around the long-run equilibrium,

$$Q_t - Q_t^* = \frac{\partial g}{\partial L_t}(L_t - L_t^*) + \frac{\partial g}{\partial K_t}(K_t - K_t^*) \tag{A.6}$$

we obtain given that at the long-run equilibrium $Q_t - Q_t^* = 0$,

$$K_t = K_t^* - \left(\frac{w_t}{c_t}\right)(L_t - L_t^*). \tag{A.7}$$

One can now derive the optimal path for employment using (A.2), (A.3), and (A.5) as (see Nickell, 1984)

$$L_t = \mu L_{t-1} + (1-\mu)(1-\alpha\mu)\sum_{s=0}^{\infty}(\alpha\mu)^s L_{t+s}^* \tag{A.8}$$

A log approximation to (A.8) can be written as

$$\log(L_t) = \mu\log(L_{t-1}) + (1-\mu)(1-\alpha\mu)\sum_{s=0}^{\infty}(\alpha\mu)^s \log(L_{t+s}^*). \tag{A.9}$$

The expression of the desired levels of employment, L_{t+s}^*, can then be derived from the solution of the firm's optimisation program without adjustment costs. In our context, this depends on the expected production, Q_t^*, on the expected factor price ratio, $(w_t/c_t)^*$, and on technological progress represented by time dummies, D_t,

$$\log L_{t+s}^* = a_1 \log Q_{t+s}^* + a_2 \log\left(\frac{w}{c}\right)_{t+s}^* + a_{3,t+s} D_{t+s} + a_4 + \varepsilon_{t+s} \tag{A.10}$$

Our basic Eq. (1) follows after assuming that the exogenous factors Q_{t+s} and $(w/c)_{t+s}$ follow an AR(2) process (see Bresson et al., 1996, p. 668, which details the derivation).

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