FORMS OF WORK INTENSIFICATION AND
ECONOMIC PERFORMANCE IN FRENCH
MANUFACTURING

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INTRODUCTION

A pronounced trend towards work intensification has been emerging in France since the mid-1980s. French surveys of working conditions have highlighted the rapid extension and proliferation of constraints on employees’ work rate [Cézard, Dussert, and Gollac, 1991; Bué and Rougerie, 1999]. These developments are not confined to France. There has also been a significant increase in work intensification in Great Britain since the early 1980s, as is shown by a study summarizing the findings of a number of statistical surveys [Green, 2001a]. More widely, increased time pressures have been affecting workers in all European Union (EU) member states since the 1980s [Dhondt, 1998]. The trend was maintained throughout the 1990s, as is shown by European surveys of working conditions [Green and McIntosh, 2001; Merllié and Paoli, 2001].

Numerous factors have contributed to this increase in work intensification: changes in the organization of production, particularly those linked to the spread of just-in-time or lean production systems; changes in work organization, particularly those arising out of the development of multiskilling and task flexibility; the technological changes linked to advances in automation and computerization; new human resource management policies that seek to increase employees’ involvement through individual evaluation systems or financial incentives; downsizing policies that reduce manning levels without reducing overall workloads; the introduction of working-time reductions without any compensatory increases in new hires; the decline of trade union power; increasing job insecurity; and the pressure of unemployment [Burchell, 2002; Gollac and Volkoff, 1996; Green, 2001b].

Recent organizational and technological changes have contributed particularly to work intensification [Green, 2001b]. At the same time, they have tended to change the forms it takes. The diffusion of the Taylorist principles of work organization has long played a decisive role in work intensification in manufacturing industry by increasing work rates and reducing lost time in production. Even though the trend towards the Taylorist rationalization of work is continuing or even hardening in many firms, often in ways that are modified somewhat by the introduction of a certain degree of flexibility into production systems [Boyer and Durand, 1998], this is not sufficient by itself to explain the degree of work intensification that has been observed over the past twenty
years. New forms of work intensification, referred to here as market-driven and incident-driven forms, are now affecting manufacturing industry.

The market-driven forms of work intensification are a product of greater exigencies on the demand side, particularly time pressures, which make themselves felt throughout firms’ production processes and are themselves a response to changes in markets and forms of competition. These work rate constraints imposed from the demand side are usually combined with the traditional industrial constraints linked to production norms or the automatic work rates of machines or product flows, giving rise to a process of hybridization between industrial and market-driven modes of organization [Cartron, 2000; Gollac and Volkoff, 1996].

The incident-driven forms of work intensification have developed as a result of the increased pressure to deal urgently with technical incidents or problems (breakdowns, faults, missing parts or products, etc.) that disrupt production flows [Valeyre, 2001]. They are particularly significant in automated activities, especially in process industries. They reflect the imperatives of productive efficiency, in which the reliability of equipment that is so crucial in capital-intensive activities plays a central role. The increased significance of the incident-driven dimension of work in the new organizational models [Veltz and Zarifian, 1993] tends to reinforce this form of work intensification when it is combined with the demand for continuous and rapid production flows.

The market-driven and incident-driven forms of work intensification arise out of the principles of productive efficiency, competitiveness, and economic profitability, which are different from those that predominate in the more traditional forms of work intensification, such as the Taylorist forms. Market-driven forms of work intensification give priority to reactivity and the rapidity with which production flows circulate, and incident-driven forms attach great importance to the efficiency of equipment. Taylorist forms of work intensification, on the other hand, emphasize the time required to perform basic operations. This has led to a change in the type of relationships that currently exist between forms of work intensification and firm economic performance.

This article examines work intensification in manufacturing industries in France. It begins with an outline of the data sources and the indicators of work intensification used (section 2). This is followed by an examination of the various forms of work intensification and their organizational and technological determinants. The persistence of Taylorist forms of work intensification, the rise of incident-driven forms of work intensification linked to the development of automation, and the extension of market-driven forms of work intensification linked to the spread of just-in-time production systems are all highlighted (section 3). Finally, the economic factors underlying the development of work intensification are examined. To this end, the relationship between the increased constraints on work rates and the evolution of economic performance in terms of labor productivity and economic profitability are analyzed (section 4).

DATA SOURCES AND INDICATORS OF WORK INTENSIFICATION

In an attempt to highlight the diversity of forms of work intensification and to be sufficiently representative of manufacturing industry as a whole, this study is based
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principally on a statistical approach. Whenever possible, however, the results of the statistical analysis are set alongside those of case studies providing, in their particular sphere, much more detailed analyses of the phenomena under investigation. Thus our approach takes advantage of the complementary nature of quantitative and qualitative data [Volkoff and Molinié, 1982].

Data Sources and Field of Investigation

The statistical analysis draws on two data sources in order to examine the various forms of work intensification and their technological, organizational, and economic determinants. The first of these is the working conditions surveys, which constitute valuable sources of data on constraints on work rate and provide much information on the content and technological and organizational characteristics of work. It also draws on the data provided by the SUSE data system, which make it possible to introduce data on firms’ economic and financial characteristics.

The field of the statistical analysis is manufacturing industry, broadly defined to include construction, but excluding energy. It encompasses twenty separate industries defined in accordance with the NAP40 classification of activities and products. The decision to carry out a study at the individual industry level was made necessary by the data sources selected, since the working conditions surveys make it impossible to adopt a firm-based approach. The analysis of industry dynamics relates mainly to the period from 1984 to 1991. A detailed analysis by industry cannot be carried out for the period between 1991 and 1998 because of the major change to the industrial classification introduced in 1993.

Indicators of Work Rate Constraints and Work Intensification

Work intensification in the various industries is assessed in terms of the evolution of the constraints on work rates. Compared with indicators of subjective work intensity—for example, when employees state that they are always or often forced to hurry in carrying out their work or have to cope with high work rates or tight deadlines—indicators based on exposure to constraints on work rates have the advantage of being less sensitive to the subjectivity of questionnaire responses. Furthermore, subjective measures of work intensity are ultimately dependent on work rate constraints. This is confirmed by the logistic regressions carried out on the basis of data from the 1998 French Working Conditions Survey [Cartron and Gollac, 2002] or the 2000 European Working Conditions Survey [Boisard et al., 2003].

Six types of constraints on work rate are identified on the basis of the working conditions surveys:

1. Automatic constraints imposed by the automatic speed of machinery, product flows, or assembly-line work;
2. Incident-driven constraints linked in particular to technical incidents or problems (breakdowns, faults, missing products, etc.);
3. Constraints arising out of production norms and deadlines that have to be met within a day at most;
4. Hierarchical constraints imposed by direct monitoring or supervision by management;
5. Horizontal constraints imposed by dependency on colleagues’ work; and

Each type of constraint is linked to an indicator giving the share of workers exposed to it. A further, global indicator is used to represent the overall burden of constraints; it is the average of the six indicators identified above. This indicator equates, therefore, to the total number of work rate constraints per employee, divided by six. Finally, another synthetic indicator, namely the “industrial” constraints on work rates, is used to represent the constraints that are most characteristic of Taylorist and bureaucratic forms of work organization [Gollac and Volkoff, 1996]. It is the average of the indicators of automatic constraints and constraints linked to production norms and deadlines.

The evolution of the different indicators of work rate constraints is measured by differences over time in the share of workers who state that they are subject to particular work rate constraints.6

FORMS OF WORK INTENSIFICATION AND THEIR TECHNOLOGICAL AND ORGANIZATIONAL DETERMINANTS

Work in manufacturing industry turns out to have intensified considerably during the last two decades, and to have done so in a variety of different ways. Pressures on employees’ work rates increased significantly in manufacturing activities between 1984 and 1998 (Table 1). All forms of work rate constraints were affected by this rapid increase, particularly those linked to production norms and deadlines and to the demands of the market. The sharp increase in these various time pressures was frequently accompanied by an accumulation of constraints. Thus workers in manufacturing industry saw the number of work rate constraints they were subjected to rise from an average of 1.2 in 1984 to 2.0 in 1991 and then to 2.4 in 1998 (out of a maximum of six constraints). Twenty-five percent of workers are now subject to at least four constraints and 10 percent to five or six constraints.

<table>
<thead>
<tr>
<th>Work rate constraints</th>
<th>In 1984</th>
<th>In 1991</th>
<th>In 1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic</td>
<td>17</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Norms and deadlines</td>
<td>30</td>
<td>52</td>
<td>61</td>
</tr>
<tr>
<td>Hierarchical</td>
<td>21</td>
<td>29</td>
<td>34</td>
</tr>
<tr>
<td>Horizontal</td>
<td>17</td>
<td>32</td>
<td>38</td>
</tr>
<tr>
<td>Incident-driven</td>
<td>11</td>
<td>18</td>
<td>27</td>
</tr>
<tr>
<td>Market-driven</td>
<td>28</td>
<td>47</td>
<td>59</td>
</tr>
</tbody>
</table>

Sources: DARES working conditions surveys.
A principal components analysis of the configurations of work rate constraints in the various manufacturing industries leads to the identification of three main categories of constraints: industrial constraints, the core of which is made up of automatic constraints and those linked to production norms and deadlines, which are usually associated with hierarchical and horizontal constraints; market-driven constraints; and, finally, incident-driven constraints [Valeyre, 2001]. This section is concerned mainly with the more recent forms of work intensification, that is, those that are incident and market driven. However, there is some value in examining briefly the persistence of the Taylorist and Fordist forms that lie at the heart of the industrial forms of work intensification.

The Persistence of Taylorist and Fordist Forms of Work Intensification

The multiple technological and organization innovations of the last twenty years have not led to the disappearance of Taylorist or Fordist systems of work organization. Indeed, their use has become widespread in many manufacturing companies, either in their traditional forms or in the modified forms of “flexible Taylorism” or “computer-aided Taylorism.” Such modified forms are characterized by the incorporation of a certain degree of flexibility into production processes, made possible largely by the application of information technology to production and production management [Boyer and Durand, 1998; Cézard, Dussert, and Gollac, 1992; Linhart, 1994].

One indication that these forms of work organization have persisted in manufacturing industry is the fact that the work rate constraints imposed by the automatic tempo of machines or the automatic movement of products or parts have intensified. From 1984 to 1998, the share of workers exposed to constraints linked to machinery rose from 11 to 19 percent, while the share of those exposed to constraints linked to flows rose from 7 to 16 percent. During the same period, repetitive work continued to increase, with the share of workers affected rising from 31 to 38 percent. Similarly, assembly-line work continued to spread, with the share of workers affected rising from 8 to 10 percent. It is spreading particularly rapidly in certain industries, such as food processing industries, where the share of workers affected almost doubled, from 12 to 22 percent, during the period in question.

Automation and the Rise of Incident-Driven Forms of Work Intensification

Automation, which was already widespread in process industries, increased considerably in mass production industries from the end of the 1970s onwards. The development of automation, both in production operations themselves, with the spread of numerically-controlled machine tools and robots, and in the control of production systems, with the spread of programmable machines and, more generally, the computerization of process control, has gone hand in hand with a trend towards integrated and flexible production systems [Coriat, 1990]. In view of the high capital cost of automated production systems, equipment reliability is an essential factor in the determination of productive efficiency. The efficiency, and the rate of utilization, of equipment
become key objectives. Moreover, the integration of automated production systems increases the importance of these issues, since the risk of disruption is heightened by the interconnectedness of machinery [Berry, 1988; Veltz, 2000]. The result is a significant increase in the pressure to deal quickly with breakdowns and other incidents and to regulate slippage, in order to reduce downtimes and slow running as much as possible. The development of automation, therefore, leads to a rise in the incident-driven forms of work intensification.

Interindustry statistical analysis confirms this point. The analysis shows that the increase in incident-driven constraints on work rates is positively correlated with certain characteristics linked to the development of automation, such as the rate of growth in capital intensity (Figure 1) and the increased use of robots (statistically significant at the 1 percent and 5 percent levels, respectively). The increase in incident-driven work rate constraints is also positively associated with the increased use of shift systems with three or more alternating shifts (significant at the 5 percent level). The increase in incident-driven constraints, therefore, has gone hand in hand with the development of continuous or semicontinuous work processes, which are widespread in areas in which automation is introduced, as case studies have shown [Durand, 1988; Mahieu, 1986]. The increase in incident-driven constraints on work rates and the increased use of continuous or semicontinuous work processes are interdependent phenomena that have their roots in the maximum productivity of equipment, which is all the more crucial when capital intensity is high.

FIGURE 1
Evolution of Incident-Driven Work Rate Constraints and of Capital Intensity
The Rise of Market-Driven Forms of Work Intensification and the Pressure on Production Flows

Faced with changes in market environments, with the intensification and diversification of requirements on the demand side and with ever harsher competition, many manufacturing companies have, since the mid-1980s, adopted just-in-time or lean production systems. Since the aim of these systems is to reduce stocks, deadlines, and sources of waste or dysfunction as much as possible, they are powerful factors affecting productivity, competitiveness, and economic profitability.

The shortening of production cycles, which is linked to the reduction of deadlines and stocks, serves as an indicator of the increased pressure on production flows. The shortening of production cycles that can be observed in most manufacturing industries confirms how widespread just-in-time or lean production systems have become (Figure 2). The trend is particularly strong in the automotive industry, where production cycles were reduced from seven to four weeks between 1984 and 1991—that is, by more than 40 percent. This result is consistent with fieldwork observations that underline the extent of just-in-time practices in manufacturing at the end of the 1980s in France [Besson et al., 1988; Clot, Rochex, and Schwartz, 1990], as well as internationally [Womack, Jones, and Roos, 1990]. More generally, the largest reductions in production cycles have been concentrated in those industries involved in the production of complex products—not just the automotive industry, but the electrical, electronic, and mechanical engineering industries as well.
Just-in-time and lean production systems are based on two main principles: the optimization of production flows and the downstream control of production flows. The flow optimization principle seeks to make flows simpler, more continuous, and quicker, and to reduce the number of disruptive incidents or problems. It leads, concomitantly, to the spread of a whole series of production management methods such as linearization, reduction of batch size and of tool changeover times, total quality management, total productive maintenance, partnerships with suppliers, and multiskilling and task flexibility among the workforce. The principle of downstream control of production flows, in real time and in accordance with the needs generated by actual customer demand, is applied by means of computerized ordering systems or manual systems such as kanban. Implementation of these two principles in tandem tends to bring demand-generated time pressures to bear on all parts of the production process. Just-in-time and lean production systems, therefore, considerably intensify the work rate constraints imposed by demand. Many examples may be found in case studies carried out in the automotive [Gorgeu and Mathieu, 1996; Lehndorff, 1997] and textile industries [Jacquot, 1999]. Generally, the rise in the market-driven forms of work intensification is very closely linked to the adoption of just-in-time or lean production systems [Gollac and Volkoff, 1996].

Interindustry statistical analysis confirms these findings. It reveals a strong relationship between pressure on production flows and demand-linked time pressures, as is shown by the high correlation (significant at the 0.05 percent level) between the rate

FIGURE 2
Evolution of Market-Driven Work Rate Constraints and of Production Cycle Duration
of production cycle shortening and the increase in market-driven work rate constraints (Figure 2). The extension of such constraints is also positively correlated (significant at the 5 percent level) with the development of job rotation in accordance with firms’ needs, which is a characteristic of work organization in just-in-time production systems. The new plants operated by automotive component suppliers working on a just-in-time basis for their customers are particularly representative of the development of the imposed task flexibility linked to demand pressures [Gorgeu and Mathieu, 1996].

WORK INTENSIFICATION AND ECONOMIC PERFORMANCE

The rise in work rate constraints and the ensuing intensification of work, both of which are linked to recent technological and organizational changes, fall within the scope of firms’ attempts to improve economic performance. In this section, we examine the relationship between work intensification and two types of performance indicators—namely, labor productivity and economic profitability.

Work Intensification and Labor Productivity

The intensification of work is a significant source of labor productivity, as much as technological or organizational innovations, the substitution of capital for labor, or an increase in skill levels [Petit, 1998]. Thus the extension in work rate constraints is likely to contribute to the improvement of labor productivity, both through its direct effect on work intensification and as an element in technological and organizational innovations intended to improve productive efficiency for a given level of work intensity. Nonetheless, interindustry statistical analysis reveals no statistically significant correlation between the extension of overall work rate constraints and the rate of growth in labor productivity (Figure 3).

This paradoxical result is linked to the diversity of models of productive efficiency at work in the various industries. In process industries, and in highly automated activities in general, growth in labor productivity has become a secondary objective in technical/economic efficiency compared with the key challenge of improving equipment efficiency through better control of disruptive hazards and incidents [Veltz, 2000]. The result is a decoupling of labor productivity from work intensity. Work rate constraints, such as incident-driven constraints, may contribute to the increase in capital productivity and simultaneously be an obstacle to the increase in labor productivity. This is the case when problems with the reliability of equipment give rise to vicious circles, in which attempts to repair breakdowns quickly and often temporarily in order to meet short-term production targets, without taking the time to eliminate the underlying causes, lead only to further breakdowns [Berry, 1988; Freyssenet, 1992]. Thus the frequency of breakdowns or incidents may intensify incident-driven constraints on work rate while at the same time harm production and labor productivity.

If we set aside those industries dominated by process activities, which operate in accordance with different productivity principles, the expected relationship between the increase in overall work rate constraints and the rate of growth in labor productivity is confirmed by a positive correlation significant at the 2 percent level (Figure 3).
The simultaneous growth of these two variables turns out to be very high in the automotive industry, which is hardly surprising given the extent of the organizational and technological changes that have taken place in this industry.

**FIGURE 3**

**Evolution of Overall Work Rate Constraints and of Labor Productivity**

(process industries indicated in italics)

It is important to note that not all work rate constraints serve to increase labor productivity. It is mainly industrial and hierarchical constraints that do so, as shown by their positive correlation with the rate of growth of labor productivity (significant at the 5 percent level) (Table 2). The other work rate constraints do not have any significant correlation with productivity.

The dynamic relationship between work intensity and labor productivity is still statistically significant among these industries if the influence of capital intensity is taken into account. This can be verified on the basis of a linear regression of the rate of interindustry growth rates in labor productivity \( p \) on capital intensity \( k \) and overall constraints on work rates \( c \):

\[
dp/p = 0.305 \, dk/k + 0.520 \, dc/c - 0.022 ,
\]
in which the t-statistics on the coefficients of the two explanatory variables are significant (t = 2.3 and 2.1, respectively). Similar relationships are found between the rates of growth in work intensity and of labor productivity in the British economy from 1992 to 1997 [Green, 2001a] and in American manufacturing industry from 1983 to 1994 [Askenazy, 2002].

**Forms of Work Intensification and Economic Profitability**

The relationship between work intensification and economic profitability is examined with the aid of two measures of profitability—namely, the return on fixed capital and the return on capital invested. Compared to the first measure, the second has the advantage of capturing both fixed and working capital. It is therefore able to take account of the growing economies of working capital that result from the increase in the speed of production flows linked with the extension of just-in-time or lean production systems [Besson et al., 1988].

Interindustry statistical analysis shows that the growth in the return on fixed capital is indeed linked to the extension of overall constraints on work rate (Table 2). This relationship arises out of the links between the increase in overall constraints and the evolution of two variables that determine the return on fixed capital, namely labor productivity and personnel costs per employee. As the results in Table 2 show, the extension of overall work rate constraints is indeed positively correlated with the rate of increase in labor productivity and negatively correlated with the rate of growth in personnel costs per employee. On the other hand, it has no significant correlation with the rate of growth in capital productivity. Moreover, as in the analysis of the growth of labor productivity, it is industrial constraints and, to a lesser extent, hierarchical constraints that play a major role in raising the return on fixed capital, as the correlations in Table 2 demonstrate. There is no significant correlation with the other types of constraints. The industrial and hierarchical forms of work intensification, therefore, contribute most to the growth in the return on fixed capital.

**TABLE 2**

<table>
<thead>
<tr>
<th>Linear correlation coefficients</th>
<th>Extension of work rate constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall</td>
</tr>
<tr>
<td>Growth of return on fixed capital</td>
<td>0.58*</td>
</tr>
<tr>
<td>Growth of return on capital invested</td>
<td>0.64**</td>
</tr>
<tr>
<td>Rate of growth in labor productivity</td>
<td>0.58*</td>
</tr>
<tr>
<td>Rate of growth in personnel costs/emp.</td>
<td>-0.55*</td>
</tr>
<tr>
<td>Rate of growth in capital productivity</td>
<td>0.22</td>
</tr>
<tr>
<td>Rate of inc. in production cycle duration</td>
<td>-0.16</td>
</tr>
</tbody>
</table>

** or * denote linear correlation coefficients significant at the 1 percent or 5 percent level, respectively. In calculating returns, growth is measured by the difference over time between the values.
The growth in the return on capital invested is also linked to the extension of overall work rate constraints (Figure 4), with a higher correlation than for the return on fixed capital, as Table 2 shows. It is linked essentially to the increase in two particular forms of work rate constraints, namely industrial and market-driven constraints. The relationship between these two forms of constraints and the return on capital invested differs profoundly, however. As can be seen from Table 2, the increase in industrial constraints on work rate is positively correlated with the rate of growth in labor productivity and negatively correlated with the rate of growth in personnel costs per employee. It is through these two labor-related variables that the relationship with the growth in return on capital invested is established, as with the return on fixed capital. The rise in market-driven work rate constraints is negatively correlated with the rate of growth in the duration of the production cycle. And it is mainly through this variable, which relates to working capital, that the influence on the growth in the return on capital invested is exerted. By quickening the pace of production flows and therefore contributing to savings in working capital, the market-driven forms of work intensification are significant factors in improving returns on capital invested.

FIGURE 4
Evolution of Overall Work Rate Constraints and of Return on Capital Invested

![Graph showing the relationship between overall work rate constraints and return on capital invested for different industries.](image-url)
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The industrial, incident-driven, and market-driven forms of work intensification are positively associated with profitability, but through different determinant processes. In contributing to the growth in labor productivity and by exerting downward pressure on the wage bill, the industrial forms of work intensification affect profitability through the labor factor. Market-driven forms of work intensification contribute to profits through the shortening of production cycles and the enhanced efficiency of working capital. The incident-driven forms of work intensification are associated mainly with automated activities, and in particular with process industries, where profitability is linked essentially to the efficiency of fixed capital. Although acting through different determinant processes, the various forms of work intensification are typically combined, with the industrial, incident-driven, or market-driven forms predominating depending on whether the industries in question are labor-intensive, capital-intensive, or dominated by the manufacture of complex products.

CONCLUSION

French manufacturing industries have seen a significant increase in work intensification over the last twenty years. This work intensification has taken various forms: Taylorist forms, but also market-driven forms, resulting in greater time pressures on the demand side, and incident-driven forms, resulting in increasing pressures to deal urgently with technical incidents or problems that disrupt production flows. The analysis reveals the persistence of Taylorist forms of work intensification, the rise of incident-driven forms of work intensification linked to the development of automation, and the extension of market-driven forms of work intensification linked to the diffusion of just-in-time or lean production systems.

The relationships between work intensification and economic performance are also examined. Relationships between work intensification and the increase in labor productivity are identified in manufacturing industries, except in process industries. In the latter, labor intensity and labor productivity are unconnected. Relationships between work intensification and the increase in economic profitability are also established. There are various relationships between the work intensification forms and the sources of economic profitability: the industrial forms mainly influence the labor factor, the event-driven forms influence the fixed capital factor, and the market-driven forms influence the working capital factor.

NOTES

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1. The article is based on the findings of research presented at a conference on organization, intensity of work, and quality of work [Valeyre, 2002].
2. The working conditions surveys are carried out periodically (in 1978, 1984, 1991, and 1998) by DARES (Department of Research and Statistics of the French Ministry of Labor) and INSEE (French National Institute for Statistics and Economic Research) in conjunction with the employment surveys. They are random, representative samples of the economically active population in employment. The samples include almost 20,000 employees. The individuals surveyed are questioned face to face at their residence. The response rates exceed 80 percent.
3. The SUSE data system (Unified Company Statistics System) is produced by INSEE on the basis of the annual company surveys and tax returns relating to industrial and commercial/noncommercial profits. Bringing together these two sources gives access to a considerable volume of coherent structural information on companies, particularly on their profit and loss accounts and their balance sheets. The data cover the main elements of the commercial productive system, excluding agriculture. Consequently, the coverage rates for manufacturing industries are very high.

4. Overall, the manufacturing field used in the analysis covered 5.7 million workers in 1984, 5.5 million in 1991, and 4.8 million in 1998.

5. The following is the question relating to constraints on employees' work rates that is asked in the working conditions surveys: “Is your work rate imposed by (more than one answer possible): (a) the automatic movement of a product or part; (b) the automatic speed of a machine; (c) other technical constraints; (d) direct dependence on the work of one or more colleagues; (e) production norms or deadlines that have to be met within an hour at most; (f) production norms or deadlines that have to be met within a day at most; (g) an external demand (customers, public) requiring an immediate response; (h) an external demand (customers, public) not requiring an immediate response; (i) permanent (or at least daily) monitoring or supervision by management; (j) other (please specify).”

6. Measuring the evolution of constraints on work rates in terms of the rate of growth of the shares produces similar results.

7. All the differences over time between the proportions of employees exposed to work rate constraints are highly statistically significant (at the $10^{-4}$ level).

8. The principal components analysis is based on the six indicators of work rate constraints in the twenty manufacturing industries. The first component of the analysis, which accounts for 52 percent of the total variance, is mainly based on four constraints—namely, the automatic, production norms and deadlines, hierarchical, and horizontal constraints—in opposition to the market-driven constraints. The second component of the analysis, which accounts for 21 percent of the total variance, is mainly based on the incident-driven constraints, similarly in opposition to the market-driven constraints [Valeyre, 2001].

9. The duration of production cycles is defined broadly as the average time that elapses between the supply of materials, parts, and components and the delivery of the finished product. It corresponds to the working capital rotation time, which is usually calculated in terms of the ratio of stocks to production.

10. The analysis here focuses on how work intensification improves the economic performance of firms. Work intensification, however, often exerts a negative effect on working conditions by increasing physical strains and risk exposures and affects employees' health, particularly by increasing musculoskeletal disorders and stress-related problems [Boisard et al., 2003; Brenner, Fairris, and Ruser, 2004; Cartron and Gollac, 2002]. Therefore, it has an ambiguous effect on employees' welfare: positive due to the increase in wages resulting from the improvement of the economic situation of firms, and negative due to the deterioration of working conditions, safety, and health. This raises the more general question of the social welfare consequences of work intensification, a question that is addressed notably by Fairris in this volume.

11. The industries dominated by process activities are iron and steel, non-ferrous metals, construction materials, glass, chemicals, and paper and board.

12. Work intensification in the American manufacturing industries is indirectly measured through high growth in work injury rates.

13. Return on fixed capital is measured as the ratio of gross operating surplus to gross tangible assets. Return on capital invested is measured as the ratio of gross operating surplus to the sum of gross tangible assets and stocks.

14. The statistical analysis excludes process industries because of the specific nature of their mode of production, which is linked to the dominance of fixed capital, as already noted above.

15. The return on fixed capital ($r$) can be expressed in the form of a function that increases with labor productivity ($p$) and the productivity of capital ($pk$) and decreases with personnel costs per employee ($w$): $r = (1 - w/p)p^pk$.

16. The paradoxical negative correlation between the increase in work rate constraints and the rate of growth of personnel costs per employee can be explained by the role played by the evolution of the age structure of the workforce in the various industries. The industries that have high work
intensification are also the ones that have a high turnover of their workforce and hire young employees. Therefore, the increase in personnel costs per employee is lower in these industries than in industries that have a low turnover and an ageing workforce and generally low work intensification.

17. This is probably linked to the fact that the analysis excludes process industries, which are the ones most affected by the productivity of capital.

18. Return on capital invested ($r^2$) can be expressed in the form of a function that increases with labor productivity ($p$), capital productivity ($pk$), and the rate of production integration ($a$), and decreases with personnel costs per employee ($w$) and the duration of the production cycle ($t$): $r^2 = \frac{(1 - w/p)}{(1/pk + t/a)}$.

REFERENCES


