Plant Operating Times and Competitiveness

The average number of hours that industrial plant is in use per week – here termed plant operating time – has been put forward as an important indicator of the competitive position of a national economy. According to EU figures, the Federal Republic of Germany has the shortest operating time of all the European countries. This is seen as a competitive disadvantage. Yet empirical evidence in support of such an interpretation is difficult to find, and it seems dubious in theoretical terms. More importantly, it is not the length, but rather the flexibility, of operating and working times that should be the focus of attention.

For an economy that is as highly integrated into global markets as the German economy, competitive jobs producing a high value-added are vital if the country's high living standards in international terms are to be maintained. The conditions under which competition between countries and regions occurs are changing constantly. The liberalisation, intensification and extension of goods and capital trade are relevant in this context, as are the political upheaval in eastern Europe and, not least, the dynamic technological and organisational changes occurring in production processes. Clearly, German industry must face up to these challenges if it is to be successful in international competition.

Plant operating times play a significant role in this context. The task must be to ensure an optimal allocation of the scarce resources of capital, labour, energy and intermediate goods. To this end the optimal use of productive plant – buildings and machinery – over a given time period (week or year) is a necessary condition.

Yet this optimal – in terms of a company's operating results – operating time can only be determined in the context of the entire range of cost factors. If weekly operating times are increased, fixed costs (depreciation and interest payments) per unit of output decline. At the same time, other, non-proportional variable costs, such as wage costs, may increase due to the pay bonuses for non-standard working hours (shift-work, night-work, Sunday and bank holiday working). The cost curves vary depending on whether demand is rising or is constant. Under certain conditions longer plant operating times may reduce total and unit capital costs even if demand is constant. In the case of new jobs, the costs of which tend to be substantially above average, investment decisions may well be based, among other things, on achieving operating times in excess of those usually practised.

Wear and tear on plant may increase more than proportionately if annual average operating times are extended. This aspect is of secondary importance, however, because plant working life is not usually determined by technical characteristics, but rather by the limits set by profitability considerations. The usually shorter fiscal depreciation periods are also important in the context of profitability. Generally speaking, it is advantageous to use a comparatively small capital stock more intensively over a given period. The smaller volume of sunk capital also serves to reduce the risk of incorrect decisions.

In the final analysis it is the specific competitive conditions facing the individual firm that determine the optimal plant operating time. A production location can only be considered "uncompetitive" if an enterprise can only realise its optimal plant operating time at another location.

Changes in plant operating times as a cost-cutting strategy

Depending on such factors as the branch and size of the enterprise, the volume of capital employed per job varies considerably. It is important to distinguish between capital intensity "per working place" and capital intensity as usually measured, i.e. the value of plant per employee. Generally, in branches where capital costs are high, capital intensity per working place is higher than capital intensity per employee, because it is there that each working place is occupied for as long as possible, which can only be achieved by filling each working place with two or more employees (i.e. shift-work). In other words, plant operating times are an expression of the time during which working places are manned. In a two-shift system each working place is filled for around twice as long than if only one shift is worked. Only if all firms were one-shift enterprises would the number of working places equal the number of employees and would capital intensity per working place be equal to capital intensity per employee.

As can be seen from table 1, capital intensity in the basic-good industry was (in 1994) more than 50% above the average for industry as a whole and around twice as high as in the investment-good industry. In view of the prevailing production conditions there, capital cost per working place is far higher in many basic-good industries (examples include the iron-producing industry, chemicals and, notably, oil refining) than in the investment-good industry. This leads to heavy concentration on large plants. All the empirical evidence indicates that plant operating times in the basic-good industry are sig-

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Capital Intensity[1]

Manufacturing Industry[2]

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Source: Görzig u.a.: Produktionsvolumen und -potential, Produktionsfaktoren des Bergbaus und des verarbeitenden Gewerbes, Statistische Kennziffern, 37. Folge, 1970 bis 1994, DIW, Berlin 1995.

nificantly longer than the average for industry as a whole. Consequently, the ranking of operating times is likely to correlate positively with the ranking of sectoral capital intensity and enterprise size.

In a number of basic-good industries, plant is in use 24 hours a day, frequently with a very small workforce. In such cases plant operating times cannot be extended further, or only marginally so. In the investment-good sector the below-average capital intensity is an argument in favour of relatively short operating times.

The increase of capital intensity is important, too; above all, it is here, and in some sections of the consumer-good sector, that the rise in capital intensity has been more than proportionate over recent years. The scope for an extension of plant operating times is considerable. The sharper the rise in costs per job, the more likely a firm is to react by extending operating times. Accordingly, it is investment-good – and in some cases consumer-good – industries that are considering longer plant operating times, particularly for new working places. For a given level of output, the number of working places is reduced, the length of time for which they are manned is extended, curbing the rise in capital intensity. Other things being equal this slows the decline in (potential) capital productivity and improves the return on real capital.

Longer or more flexible operating times?

The increasing scope for working time flexibility – in many cases supported by collective agreements – has facilitated the fine-tuning of plant operating times. On the basis of the flexibilisation agreements reached with the trade unions, the collectively agreed weekly working hours of each individual worker must not be maintained week for week, but only as an average figure over a period that varies under the different collective agreements, but one that is steadily being extended. Shift duration and the number of shifts per week are no longer tied to individual weekly working time. Whereas previously it was only possible to change operating times in "lumps" it is now possible to adjust times virtually continuously, at least in large enterprises. In generalised shift-systems, employees (or employee teams) are allocated to working places (or groups of working places), so that virtually any desired operating time can be achieved, without the need for permanent overtime. By this means it is easy to take into account in a systematic way a wide range of requirements pertaining to shift duration and the number of employees at work at any time in the course of a day, week or year.

Thus two parameters are decisive for operating time per unit of time: the duration and extent of employee deployment. Weekly operating times, for instance, are determined by the number of working places filled and at what times of the day and days of the week. In order to determine annual operating time, monthly and other fluctuations in attendance times and intensity, plant closing times etc. would have to be taken into account. The increased flexibilisation of working time means that the contours of machine operating times become increasingly highly differentiated, exacerbating the problem of statistical coverage.

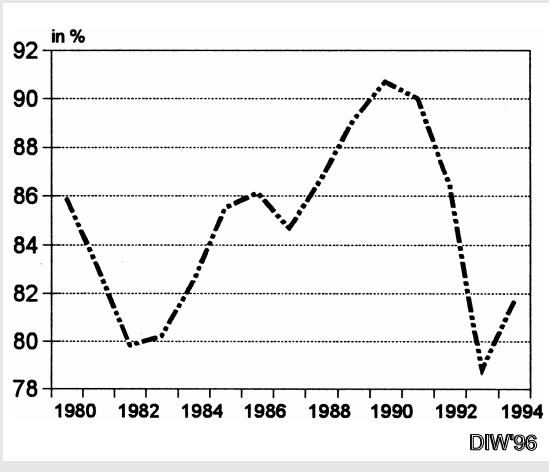
Alongside the average duration of operating times, their cyclical and seasonal adjustment are gaining in importance for firms. Flexibility with respect to the volume of orders is increasingly becoming a central guideline for entrepreneurial activity. By varying operating and working times it is possible to perform cyclical and seasonal adjustment more easily and at less cost than by varying the capital stock and workforce level.

The option of varying individual working times over longer periods and the scope under collective agreements signed since 1994 to set average plant working time at a different level from the collectively agreed average (working time corridors) have brought about further improvements in firms' time-related flexibility potential. Variation in both shift duration and the number of shifts has been facilitated. It is easier to draw up a plan for the entire year, one in accordance with production needs, by means of "working time accounts" than using traditional instruments such as overtime and supplementary shifts on the one hand, short-time working and free shifts in lieu on the other. Such instruments have increasingly proved both too rigid and too costly. Use of the increased scope for flexibility enables firms to avoid paying overtime bonuses and the (since the start of 1994) higher costs of short-time working. This was an important aspect for VW when it drew up its employment-maintenance model.[1] This enables variable costs – and thus also employee incomes – to be reduced if capacity is underutilised for cyclical reasons, although fixed costs clearly remain unaffected.

As a rule, variations in operating times are determined by the degree of capacity utilisation (cf. figure 1). Thus when interpreting survey data to determine actual operating times it is vital to consider at what phase in the business cycle the data were collected.

During the so-called "unification boom" west German productive capacity was utilised at a level in excess of "normal" full capacity. Initially plant was used more intensively. Overtime was worked and additional labour recruited, without prior investment in additional capacity. Subsequently, in the course of their decisions on additional investment to expand capacity, firms took into account the experiences gained with longer operat-

Figure 1
Capacity Utilisation[1]
in Manufacturing Industry[2]



1) Effective gross-value added in % of potential gross-value added (both at 1985 prices); firm's full capacity set at 90%. — 2) Firms with 20 and more employees.

Source: Görzig u.a.:, op. cit. (cf. table 1).

[1] Cf. Meinhardt, Volker, Frank Stille and Rudolf Zwiener: Weitere Arbeitszeitverkürzungen erforderlich – Zum Stellenwert des VW-Modells. In: *Wirtschaftsdienst,* Nr. 12, 1993, pp. 639-644.

ing times and new forms of work organisation. Thus it seems plausible that, following the unification boom, firms to some extent converted the initially temporary increase in operating times into a permanent and general increase in plant utilisation and thus in productive capacity. Thus it is possible that to some extent the reduction in unit capital costs achieved by raising the intensity of plant use has been maintained over the medium term.

Inadequate empirical base

Despite the importance of plant operating times for the development of productive capacity, the scope for empirical analysis remains very limited: neither time series nor sufficiently highly disaggregated data are available. The official statistics contain virtually no information on working time organisation and operating times; an exception here are the questions on shift-work, night-work, Saturday, Sunday and bank holiday working that were reincluded in the official microcensus in 1989. Such data refer only to manufacturing industry as a whole and it is virtually impossible to draw conclusions from them with regard to operating times, as the approach taken by the microcensus – population-oriented rather than enterprise-oriented – is such that the required enterprise-level information cannot be derived.

The patchy data that are available derive from enterprise surveys conducted by research institutes: the ifo/IAB survey of 1984;[2] the ifo surveys of 1989[3] and 1994[4] that were cofinanced by the EC and the representative, broad-based enterprise survey going beyond the boundaries of the industrial sector of the Institut zur Erforschung Sozialer Chancen (ISO) in cooperation with the DIW in 1990.[5]

The above publications clearly show how difficult it is to draw conclusions on plant operating times from the enterprise-level information. Scarcely any figures are available on individual machines: rather, firms provide estimates of their overall machine operating times or indicate how many employees work in various shift systems. Operating times must then be estimated on the basis of this information.

The survey results can be processed in a variety of ways. The calculation on the basis of the enterprise reports on working time regimes can be weighted using either the number of employees (employment concept) or the (estimated) number of working places (working-place concept). If the number of working places is used to weight the findings, the long operating times in multi-shift enterprises receive a lower weighting than under the employment concept. Consequently, the operating time calculated according to the working-place concept is usually lower than when calculated using the employment concept.

Table 2 lists the operating times in west German industrial branches in 1984 and 1989. Over the intervening period operating times have remained virtually constant under the working-place concept, and have increased by 5% according to the employment concept.

Given the fact that the 1989 figures do not include occasional shift-work and special shifts, unlike those for 1984, while their importance probably increased in view of the higher level of capacity utilisation in 1989 than in 1984, it seems plausible to assume that plant operating times increased on average. Even on these calculations, and according to the working-place concept, a number of branches extended their plant operating times (chemical industry, oil refining, production of plastic goods, rubber processing, metal production and processing). The reduction in average individual working time over the period did not lead to a corresponding reduction in operating times, due to the simultaneous increase in working time flexibility. The flexibility agreements were used particularly intensively by multiple-shift enterprises.

According to the working-place concept their operating time rose by an average of almost 6% and by substantially more than 10% in branches such as metal production and processing, production of plastic goods, and rubber processing. This suggests that firms facing a sharp rise in fixed costs per working place were able to realise the – obvious – strategy of lengthening operating times. The average weekly operating time in single-shift enterprises, on the other hand, declined slightly.

In the light of the findings of the survey commissioned by the EU,[6] it seems likely that these trends continued until 1994. According to the working-place concept the average operating time in west German industry is given as 50 hours per week, and at 61 hours

[2] Reyher, Lutz and Eugen Spitznagel, Wolf Rüdiger Streck, Bernhard Teriet, Kurt Vogler-Ludwig, Zu den Beschäftigungspotentialen einer Entkoppelung von Arbeits- und Betriebszeiten, *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung,* 1/1985, pp. 30-40.

[3] Vogler-Ludwig, Kurt, Betriebszeit der Produktionsanlagen, *ifo-Schnelldienst,* 1-2, pp. 3-8, 1990.

[4] Ifo has yet to publish details.

[5] Groß, Hermann, Frank Stille and Christa Thoben with the collaboration of Frank Bauer, *Arbeits- und Betriebszeiten 1990*. Ergebnisse einer aktuellen Betriebsbefragung zu Arbeitszeitformen und Betriebszeiten in der Bundesrepublik Deutschland (Ed. Ministry of Labour, Health and Social Affairs of the state of North-Rhine-Westphalia).

[6] *European Economy – Reports and Studies,* no. 3, 1995, Performance of the European Union Labour Market. Results of an ad hoc labour market survey covering employers and employees, Luxembourg, 1995.

Table 2

Industrial Plant Operating Times

West Germany

	Employment concept		Working place concept			
			All firms		Multiple-shift firms	
	1984	1989	1984	1989	1984	1989
	hours per week					
Chemical industry, oil refining	74.3	97.4	52.6	65.8	122.7	129.9
Plastic goods, rubber processing	68.8	79.1	54.0	58.2	102.5	113.9
Quarrying	59.2	59.4	48.4	47.0	110.5	111.8
Wood, paper, cardboard processing	80.3	79.4	57.3	56.9	107.2	111.5
Metal refining and processing	78.8	89.0	58.6	61.1	108.0	122.1
Steel, engineering, vehicles	57.5	55.0	51.0	48.6	80.5	77.1
Electrical engineering, optics	52.8	55.1	46.9	45.4	86.8	96.2
Wood processing	42.4	45.8	41.4	41.5	80.4	98.5
Printing	63.9	60.3	53.0	47.2	95.1	94.4
Textiles	81.3	75.9	62.3	58.9	106.2	101.2
Leather, clothing	41.3	42.4	40.7	40.8	99.2	105.8
Food, drink and tobacco	54.5	55.8	47.4	46.8	93.3	94.2
Total	60.6	63.6	50.1	49.7	91.2	96.3

Source: Kurt Vogler-Ludwig, see footnote 3.

according to the employment concept. Assuming that these data are comparable with the ifo figures for 1989, operating times remained constant under the working-place concept and declined slightly under the employment concept. In view of the sharp decline in capacity utilisation over this period, this is a remarkable finding. It seems that over the medium term manufacturing firms have probably extended their operating times, although in the short term they did not exploit this potential to the full in view of the unsatisfactory state of demand.

The EU survey indicates that between 1989 and 1994 industrial enterprises operating shift-work increased as a proportion of the total by eight percentage points – the sharpest rise in the EU; at 73% it was slightly above average. The increase was particularly pronounced with respect to two-shift firms, but also among those operating "around the clock". The structural data on operating times[7] indicate that in this respect, too, the average figures conceal a duality between single-shift and multiple-shift enterprises. In single-shift firms weekly operating times are almost 1½

hours below the European average and they account for 60% of total employment as compared with an EU average of 47%.

The reverse is true of those west German firms which do operate shift-work. They utilise their plant more than three hours longer per week than the overall European average. Yet in 1994 only 40% of employees were working in multi-shift enterprises, 13 percentage points below the European average. This pattern – below-average operating times in single-shift enterprises, above-average hours in multi-shift firms – applies consistently to the basic, investment and consumer-good sectors and across virtually all enterprise-size categories. Consequently it is the relatively large number of single-shift enterprises that "pull down" the average operating time in west German industry.

Caution required with international comparisons

At the current state of empirical knowledge, the above calculations of operating times are to be taken as approximate values. In view of the problems of measurement and the non-availability and non-comparability of the data, care is clearly required in interpreting the figures as calculated.

This is also true of the 1994 EU survey. Although this survey is based on a harmonised questionnaire, evaluation remains extremely difficult for as long as the micro-data remain unavailable and little information is provided on representativeness and the extrapolation procedures used. In particular, the inconsistencies between the labour market survey of industrial employers in 1994, on which the calculations of operating times are based, and the EC labour force survey of 1992 need to be cleared up.[8]

Yet there are other reasons why caution needs to be exerted in comparing the available figures. The EU itself states this explicitly. This is due both to the asynchronism of the cyclical situation and differences in the economic structure in the various countries.

The fact that west German average industrial operating times are comparatively low, for example, partly merely reflects the dominant role played by the investment-good sector within west German industry (cf. table 3). In Luxembourg, by contrast, the basic-good industry accounts for a large proportion of industrial output, and in Belgium, too, the relative importance is higher. According to EU figures, average weekly operating times in European basic-good industries amounted to 87 hours per week, compared to 58 hours in the investment-good sector and an overall average of 60 hours.

Given this fact – which in principle calls for much more highly differentiated analyses, as even within these industrial sectors there are substantial differences (e.g. the importance of the oil-refining industry, with the longest operating times of all) – the figures in the table appear in a very different light. Another factor, partly

Table 3
Industrial Plant Operating Times in European Countries

	Operating times in hours per week		Relative importance of the investment-good sector[1]
	Employment concept	Working place concept	
	1994		1990
Luxembourg	108	87	17*
Belgium	105	93	35
Spain	94	74	33
Italy	83	77	37**
Netherlands	69	52	37
EU-average	68	56	–
Greece	67	55	24
West Germany	61	50	57
France	60	51	45
Portugal	57	53	19
UK	55	51	48
Ireland	52	46	34

1) Employment in the investment-good sector (ISIC 38) as a proportion of total industrial employment. — *) 1980. — **) 1989.
Source: Claus F. Hofmann, see footnote 7; OECD, Labour Force Statistics, 1972 - 92, Paris 1994.

7 Cf. Claus F. Hofmann, EU-Arbeitsmarktumfrage/Teil I. Beträchtliche Flexibilisierungspotentiale, *Bundesarbeitsblatt* 10/1995, pp. 9-12, here p. 12.

8 Cf. Hartmut Seiffert: Spielräume für Betriebsnutzungszeiten. In: *WSI-Mitteilungen* 10/1995, S. 641-646

related to this, also needs to be taken into account: the different relative importance of single-shift firms. German industry is dominated by small and medium-sized firms characterised by relatively short, but flexible operating times: this can hardly be interpreted as a competitive disadvantage.

Finally, in making an overall evaluation plant operating times should be compared over an entire 12-month period; different closure practices (company holidays) can lead to substantial changes in the initial rankings. The proportion of German industrial firms closing down over holiday periods is the lowest in the entire European Union (31% compared with an average of 57%); moreover, plant holiday closures are shorter than the EU average and the trend is towards a further reduction.[9]

Conclusions

It is inadmissible to evaluate European industrial locations on the basis of a single average figure for "national" plant operating times. Such figures are neither directly comparable, nor is their informational content sufficient to rank the competitiveness of industrial production locations. Further improvements in the state of knowledge on working time organisation is urgently required. Enterprise surveys should not only focus at traditional shift-work but also at the various elements of working time flexibilisation relevant to plant operating times.

Moreover, closer analysis of the available figures reveals that west Germany is now in a not unfavourable position with regard to the length and variability of plant operating times.

In the case of single-shift firms, the trend towards working time reduction appears to be exerting a corresponding effect on operating times. This is probably partly due to the methodological approach taken by the studies, however. A rise in operating times that does not involve the transition to a two-shift system has not so far been covered by the surveys – with the exception of the ISO/DIW survey.

Given their lower capital intensity (per working place), longer operating times is not such a priority for single-shift firms. The transition to a two-shift system inevitably entails a loss of flexibility. To this extent the implementation barriers for single-shift firms contemplating changing to a two-shift system are likely to be particularly high. Even single-shift firms have the option of lengthening their operating times by introducing phased working hours, extending daily individual hours up to the legal maximum of ten hours and by adopting part-time employment solutions. As far as flexibility is concerned, a single-shift enterprise can scarcely be beaten.

German multiple-shift firms have increased their plant operating times faster than those in the other EU countries; by 1994 they were above the EU average. Firms with high capital costs per working place clearly were able, notwithstanding the reduction in individual working hours, to extend their plant operating times.

For both single-shift and multiple-shift enterprises the optimal operating times can only be determined in the context of the entire range of cost factors and of enterprise goals. Even if, in terms of sectoral averages, German plant operating times turn out to be shorter than in other countries, this may well be due to differences in enterprise size structures and market segments. It is inadmissible to draw conclusions regarding the quality of Germany as a production location from a figure indicating a below-average operating time for west German industry as a whole, all the more so in view of the fact that in the majority of cases the figure is not significantly different from that in its leading European competitors.

Sunday work constitutes a specific problem. It seems that it is set to increase throughout German industry in future: more and more applications are being made for permission to work on Sundays, not only in the basic-good, but also in the investment-good and consumer-good sectors. The scope for an expansion of Sunday work created by the new working time law is being utilised by firms in the textile industry, tyre-producers, wood-processing companies and the electrical engineering industry. Under the law (§13, Paragraph 5), the public authorities are to permit Sunday working if firms would otherwise face an unacceptable disadvantage vis à vis foreign competitors. It seems likely, therefore, that any need for German firms to "catch up" in this respect will soon have been fulfilled.

The survey indicates that enterprise-level codetermination and collective forms of regulation place more or less stringent restrictions on managerial freedom in all EU countries. Such regulation is the outcome of a bargaining process, the aim of which is to establish a balance between competing interests. As such these regulatory frameworks are indispensable and not only for the parties to the agreements.

Moreover, in the case of Germany, such frameworks are subject to rapid change. In fact the considerable increase in the scope for flexibility under collective agreements is not being fully exploited at enterprise level. This is true not least with regard to plant operating times. Flexible and innovative forms of working

[9] Cf. *European Economy,* op. cit., table 7.

time organisation should be implemented in order to reduce the still excessive use of overtime and to permit additional recruitment. More generally, the emphasis on the duration of weekly plant operating times is a "red herring": what is urgently required is greater flexibility and not the longest possible operating times.

Frank Stille

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The increase of capital intensity is important, too; above all, it is here, and in some sections of the consumer-good sector, that the rise in capital intensity has been more than proportionate over recent years. The scope for an extension of plant operating times is considerable. The sharper the rise in costs per job, the more likely a firm is to react by extending operating times. Accordingly, it is investment-good – and in some cases consumer-good – industries that are considering longer plant operating times, particularly for new working places. For a given level of output, the number of working places is reduced, the length of time for which they are manned is extended, curbing the rise in capital intensity. Other things being equal this slows the decline in (potential) capital productivity and improves the return on real capital.

Longer or more flexible operating times?

The increasing scope for working time flexibility – in many cases supported by collective agreements – has facilitated the fine-tuning of plant operating times. On the basis of the flexibilisation agreements reached with the trade unions, the collectively agreed weekly working hours of each individual worker must not be maintained week for week, but only as an average figure over a period that varies under the different collective agreements, but one that is steadily being extended. Shift duration and the number of shifts per week are no longer tied to individual weekly working time. Whereas previously it was only possible to change operating times in "lumps" it is now possible to adjust times virtually continuously, at least in large enterprises. In generalised shift-systems, employees (or employee teams) are allocated to working places (or groups of working places), so that virtually any desired operating time can be achieved, without the need for permanent overtime. By this means it is easy to take into account in a systematic way a wide range of requirements pertaining to shift duration and the number of employees at work at any time in the course of a day, week or year.

Thus two parameters are decisive for operating time per unit of time: the duration and extent of employee deployment. Weekly operating times, for instance, are determined by the number of working places filled and at what times of the day and days of the week. In order to determine annual operating time, monthly and other fluctuations in attendance times and intensity, plant closing times etc. would have to be taken into account. The increased flexibilisation of working time means that the contours of machine operating times become increasingly highly differentiated, exacerbating the problem of statistical coverage.

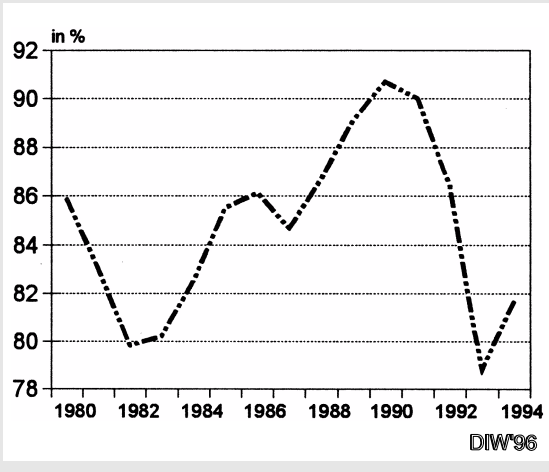
Alongside the average duration of operating times, their cyclical and seasonal adjustment are gaining in importance for firms. Flexibility with respect to the volume of orders is increasingly becoming a central guideline for entrepreneurial activity. By varying operating and working times it is possible to perform cyclical and seasonal adjustment more easily and at less cost than by varying the capital stock and workforce level.

The option of varying individual working times over longer periods and the scope under collective agreements signed since 1994 to set average plant working time at a different level from the collectively agreed average (working time corridors) have brought about further improvements in firms' time-related flexibility potential. Variation in both shift duration and the number of shifts has been facilitated. It is easier to draw up a plan for the entire year, one in accordance with production needs, by means of "working time accounts" than using traditional instruments such as overtime and supplementary shifts on the one hand, short-time working and free shifts in lieu on the other. Such instruments have increasingly proved both too rigid and too costly. Use of the increased scope for flexibility enables firms to avoid paying overtime bonuses and the (since the start of 1994) higher costs of short-time working. This was an important aspect for VW when it drew up its employment-maintenance model.[1] This enables variable costs – and thus also employee incomes – to be reduced if capacity is underutilised for cyclical reasons, although fixed costs clearly remain unaffected.

As a rule, variations in operating times are determined by the degree of capacity utilisation (cf. figure 1). Thus when interpreting survey data to determine actual operating times it is vital to consider at what phase in the business cycle the data were collected.

During the so-called "unification boom" west German productive capacity was utilised at a level in excess of "normal" full capacity. Initially plant was used more intensively. Overtime was worked and additional labour recruited, without prior investment in additional capacity. Subsequently, in the course of their decisions on additional investment to expand capacity, firms took into account the experiences gained with longer operat-

Figure 1
Capacity Utilisation[1]
in Manufacturing Industry[2]



1) Effective gross-value added in % of potential gross-value added (both at 1985 prices); firm's full capacity set at 90%. — 2) Firms with 20 and more employees.

Source: Görzig u.a.:, op. cit. (cf. table 1).

[1] Cf. Meinhardt, Volker, Frank Stille and Rudolf Zwiener: Weitere Arbeitszeitverkürzungen erforderlich – Zum Stellenwert des VW-Modells. In: *Wirtschaftsdienst,* Nr. 12, 1993, pp. 639-644.

ing times and new forms of work organisation. Thus it seems plausible that, following the unification boom, firms to some extent converted the initially temporary increase in operating times into a permanent and general increase in plant utilisation and thus in productive capacity. Thus it is possible that to some extent the reduction in unit capital costs achieved by raising the intensity of plant use has been maintained over the medium term.

Inadequate empirical base

Despite the importance of plant operating times for the development of productive capacity, the scope for empirical analysis remains very limited: neither time series nor sufficiently highly disaggregated data are available. The official statistics contain virtually no information on working time organisation and operating times; an exception here are the questions on shift-work, night-work, Saturday, Sunday and bank holiday working that were reincluded in the official microcensus in 1989. Such data refer only to manufacturing industry as a whole and it is virtually impossible to draw conclusions from them with regard to operating times, as the approach taken by the microcensus – population-oriented rather than enterprise-oriented – is such that the required enterprise-level information cannot be derived.

The patchy data that are available derive from enterprise surveys conducted by research institutes: the ifo/IAB survey of 1984;[2] the ifo surveys of 1989[3] and 1994[4] that were cofinanced by the EC and the representative, broad-based enterprise survey going beyond the boundaries of the industrial sector of the Institut zur Erforschung Sozialer Chancen (ISO) in cooperation with the DIW in 1990.[5]

The above publications clearly show how difficult it is to draw conclusions on plant operating times from the enterprise-level information. Scarcely any figures are available on individual machines: rather, firms provide estimates of their overall machine operating times or indicate how many employees work in various shift systems. Operating times must then be estimated on the basis of this information.

The survey results can be processed in a variety of ways. The calculation on the basis of the enterprise reports on working time regimes can be weighted using either the number of employees (employment concept) or the (estimated) number of working places (working-place concept). If the number of working places is used to weight the findings, the long operating times in multi-shift enterprises receive a lower weighting than under the employment concept. Consequently, the operating time calculated according to the working-place concept is usually lower than when calculated using the employment concept.

Table 2 lists the operating times in west German industrial branches in 1984 and 1989. Over the intervening period operating times have remained virtually constant under the working-place concept, and have increased by 5% according to the employment concept.

Given the fact that the 1989 figures do not include occasional shift-work and special shifts, unlike those for 1984, while their importance probably increased in view of the higher level of capacity utilisation in 1989 than in 1984, it seems plausible to assume that plant operating times increased on average. Even on these calculations, and according to the working-place concept, a number of branches extended their plant operating times (chemical industry, oil refining, production of plastic goods, rubber processing, metal production and processing). The reduction in average individual working time over the period did not lead to a corresponding reduction in operating times, due to the simultaneous increase in working time flexibility. The flexibility agreements were used particularly intensively by multiple-shift enterprises.

According to the working-place concept their operating time rose by an average of almost 6% and by substantially more than 10% in branches such as metal production and processing, production of plastic goods, and rubber processing. This suggests that firms facing a sharp rise in fixed costs per working place were able to realise the – obvious – strategy of lengthening operating times. The average weekly operating time in single-shift enterprises, on the other hand, declined slightly.

In the light of the findings of the survey commissioned by the EU,[6] it seems likely that these trends continued until 1994. According to the working-place concept the average operating time in west German industry is given as 50 hours per week, and at 61 hours

[2] Reyher, Lutz and Eugen Spitznagel, Wolf Rüdiger Streck, Bernhard Teriet, Kurt Vogler-Ludwig, Zu den Beschäftigungspotentialen einer Entkoppelung von Arbeits- und Betriebszeiten, *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung,* 1/1985, pp. 30-40.

[3] Vogler-Ludwig, Kurt, Betriebszeit der Produktionsanlagen, *ifo-Schnelldienst,* 1-2, pp. 3-8, 1990.

[4] Ifo has yet to publish details.

[5] Groß, Hermann, Frank Stille and Christa Thoben with the collaboration of Frank Bauer, *Arbeits- und Betriebszeiten 1990*. Ergebnisse einer aktuellen Betriebsbefragung zu Arbeitszeitformen und Betriebszeiten in der Bundesrepublik Deutschland (Ed. Ministry of Labour, Health and Social Affairs of the state of North-Rhine-Westphalia).

[6] *European Economy – Reports and Studies,* no. 3, 1995, Performance of the European Union Labour Market. Results of an ad hoc labour market survey covering employers and employees, Luxembourg, 1995.

Table 2

Industrial Plant Operating Times

West Germany

	Employment concept		Working place concept			
			All firms		Multiple-shift firms	
	1984	1989	1984	1989	1984	1989
	hours per week					
Chemical industry, oil refining	74.3	97.4	52.6	65.8	122.7	129.9
Plastic goods, rubber processing	68.8	79.1	54.0	58.2	102.5	113.9
Quarrying	59.2	59.4	48.4	47.0	110.5	111.8
Wood, paper, cardboard processing	80.3	79.4	57.3	56.9	107.2	111.5
Metal refining and processing	78.8	89.0	58.6	61.1	108.0	122.1
Steel, engineering, vehicles	57.5	55.0	51.0	48.6	80.5	77.1
Electrical engineering, optics	52.8	55.1	46.9	45.4	86.8	96.2
Wood processing	42.4	45.8	41.4	41.5	80.4	98.5
Printing	63.9	60.3	53.0	47.2	95.1	94.4
Textiles	81.3	75.9	62.3	58.9	106.2	101.2
Leather, clothing	41.3	42.4	40.7	40.8	99.2	105.8
Food, drink and tobacco	54.5	55.8	47.4	46.8	93.3	94.2
Total	60.6	63.6	50.1	49.7	91.2	96.3

Source: Kurt Vogler-Ludwig, see footnote 3.

according to the employment concept. Assuming that these data are comparable with the ifo figures for 1989, operating times remained constant under the working-place concept and declined slightly under the employment concept. In view of the sharp decline in capacity utilisation over this period, this is a remarkable finding. It seems that over the medium term manufacturing firms have probably extended their operating times, although in the short term they did not exploit this potential to the full in view of the unsatisfactory state of demand.

The EU survey indicates that between 1989 and 1994 industrial enterprises operating shift-work increased as a proportion of the total by eight percentage points – the sharpest rise in the EU; at 73% it was slightly above average. The increase was particularly pronounced with respect to two-shift firms, but also among those operating "around the clock". The structural data on operating times[7] indicate that in this respect, too, the average figures conceal a duality between single-shift and multiple-shift enterprises. In single-shift firms weekly operating times are almost 1½

hours below the European average and they account for 60% of total employment as compared with an EU average of 47%.

The reverse is true of those west German firms which do operate shift-work. They utilise their plant more than three hours longer per week than the overall European average. Yet in 1994 only 40% of employees were working in multi-shift enterprises, 13 percentage points below the European average. This pattern – below-average operating times in single-shift enterprises, above-average hours in multi-shift firms – applies consistently to the basic, investment and consumer-good sectors and across virtually all enterprise-size categories. Consequently it is the relatively large number of single-shift enterprises that "pull down" the average operating time in west German industry.

Caution required with international comparisons

At the current state of empirical knowledge, the above calculations of operating times are to be taken as approximate values. In view of the problems of measurement and the non-availability and non-comparability of the data, care is clearly required in interpreting the figures as calculated.

This is also true of the 1994 EU survey. Although this survey is based on a harmonised questionnaire, evaluation remains extremely difficult for as long as the micro-data remain unavailable and little information is provided on representativeness and the extrapolation procedures used. In particular, the inconsistencies between the labour market survey of industrial employers in 1994, on which the calculations of operating times are based, and the EC labour force survey of 1992 need to be cleared up.[8]

Yet there are other reasons why caution needs to be exerted in comparing the available figures. The EU itself states this explicitly. This is due both to the asynchronism of the cyclical situation and differences in the economic structure in the various countries.

The fact that west German average industrial operating times are comparatively low, for example, partly merely reflects the dominant role played by the investment-good sector within west German industry (cf. table 3). In Luxembourg, by contrast, the basic-good industry accounts for a large proportion of industrial output, and in Belgium, too, the relative importance is higher. According to EU figures, average weekly operating times in European basic-good industries amounted to 87 hours per week, compared to 58 hours in the investment-good sector and an overall average of 60 hours.

Given this fact – which in principle calls for much more highly differentiated analyses, as even within these industrial sectors there are substantial differences (e.g. the importance of the oil-refining industry, with the longest operating times of all) – the figures in the table appear in a very different light. Another factor, partly

Table 3
Industrial Plant Operating Times in European Countries

	Operating times in hours per week		Relative importance of the investment-good sector[1]
	Employment concept	Working place concept	
	1994		1990
Luxembourg	108	87	17*
Belgium	105	93	35
Spain	94	74	33
Italy	83	77	37**
Netherlands	69	52	37
EU-average	68	56	–
Greece	67	55	24
West Germany	61	50	57
France	60	51	45
Portugal	57	53	19
UK	55	51	48
Ireland	52	46	34

1) Employment in the investment-good sector (ISIC 38) as a proportion of total industrial employment. — *) 1980. — **) 1989.
Source: Claus F. Hofmann, see footnote 7; OECD, Labour Force Statistics, 1972 - 92, Paris 1994.

7 Cf. Claus F. Hofmann, EU-Arbeitsmarktumfrage/Teil I. Beträchtliche Flexibilisierungspotentiale, *Bundesarbeitsblatt* 10/1995, pp. 9-12, here p. 12.

8 Cf. Hartmut Seiffert: Spielräume für Betriebsnutzungszeiten. In: *WSI-Mitteilungen* 10/1995, S. 641-646

related to this, also needs to be taken into account: the different relative importance of single-shift firms. German industry is dominated by small and medium-sized firms characterised by relatively short, but flexible operating times: this can hardly be interpreted as a competitive disadvantage.

Finally, in making an overall evaluation plant operating times should be compared over an entire 12-month period; different closure practices (company holidays) can lead to substantial changes in the initial rankings. The proportion of German industrial firms closing down over holiday periods is the lowest in the entire European Union (31% compared with an average of 57%); moreover, plant holiday closures are shorter than the EU average and the trend is towards a further reduction.[9]

Conclusions

It is inadmissible to evaluate European industrial locations on the basis of a single average figure for "national" plant operating times. Such figures are neither directly comparable, nor is their informational content sufficient to rank the competitiveness of industrial production locations. Further improvements in the state of knowledge on working time organisation is urgently required. Enterprise surveys should not only focus at traditional shift-work but also at the various elements of working time flexibilisation relevant to plant operating times.

Moreover, closer analysis of the available figures reveals that west Germany is now in a not unfavourable position with regard to the length and variability of plant operating times.

In the case of single-shift firms, the trend towards working time reduction appears to be exerting a corresponding effect on operating times. This is probably partly due to the methodological approach taken by the studies, however. A rise in operating times that does not involve the transition to a two-shift system has not so far been covered by the surveys – with the exception of the ISO/DIW survey.

Given their lower capital intensity (per working place), longer operating times is not such a priority for single-shift firms. The transition to a two-shift system inevitably entails a loss of flexibility. To this extent the implementation barriers for single-shift firms contemplating changing to a two-shift system are likely to be particularly high. Even single-shift firms have the option of lengthening their operating times by introducing phased working hours, extending daily individual hours up to the legal maximum of ten hours and by adopting part-time employment solutions. As far as flexibility is concerned, a single-shift enterprise can scarcely be beaten.

German multiple-shift firms have increased their plant operating times faster than those in the other EU countries; by 1994 they were above the EU average. Firms with high capital costs per working place clearly were able, notwithstanding the reduction in individual working hours, to extend their plant operating times.

For both single-shift and multiple-shift enterprises the optimal operating times can only be determined in the context of the entire range of cost factors and of enterprise goals. Even if, in terms of sectoral averages, German plant operating times turn out to be shorter than in other countries, this may well be due to differences in enterprise size structures and market segments. It is inadmissible to draw conclusions regarding the quality of Germany as a production location from a figure indicating a below-average operating time for west German industry as a whole, all the more so in view of the fact that in the majority of cases the figure is not significantly different from that in its leading European competitors.

Sunday work constitutes a specific problem. It seems that it is set to increase throughout German industry in future: more and more applications are being made for permission to work on Sundays, not only in the basic-good, but also in the investment-good and consumer-good sectors. The scope for an expansion of Sunday work created by the new working time law is being utilised by firms in the textile industry, tyre-producers, wood-processing companies and the electrical engineering industry. Under the law (§13, Paragraph 5), the public authorities are to permit Sunday working if firms would otherwise face an unacceptable disadvantage vis à vis foreign competitors. It seems likely, therefore, that any need for German firms to "catch up" in this respect will soon have been fulfilled.

The survey indicates that enterprise-level codetermination and collective forms of regulation place more or less stringent restrictions on managerial freedom in all EU countries. Such regulation is the outcome of a bargaining process, the aim of which is to establish a balance between competing interests. As such these regulatory frameworks are indispensable and not only for the parties to the agreements.

Moreover, in the case of Germany, such frameworks are subject to rapid change. In fact the considerable increase in the scope for flexibility under collective agreements is not being fully exploited at enterprise level. This is true not least with regard to plant operating times. Flexible and innovative forms of working

[9] Cf. *European Economy,* op. cit., table 7.

time organisation should be implemented in order to reduce the still excessive use of overtime and to permit additional recruitment. More generally, the emphasis on the duration of weekly plant operating times is a "red herring": what is urgently required is greater flexibility and not the longest possible operating times.

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