Productivity and days of the week

Discussion paper

Productivity and Days of the Week

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Abstract

Despite much debate about the productivity effects of flexible working and the regulation of working hours little attention is paid to temporal variance in productivity. This paper explains why one might expect to see productivity differences across days of the week. Although there is scant direct evidence on day-of-week productivity effects, studies suggest that the timing of labour inputs across and within days, such as the sequencing of work and rest periods, affect productivity-related outcomes such as illness, injury, sickness absence and error rates. The implications of these studies for government policy and managerial practice are discussed together with suggestions for future research.

Key words
Labour productivity; days of the week; temporal variation.
JEL classification: J22, J24.

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Introduction

Productivity is the output a worker, firm or country generates per unit of labour and capital inputs. Usually measured in terms of sales or 'value added' relative to the quantity or cost of inputs, it is the building-block for wealth creation. In the UK there are perennial concerns about the extent to which the country's productivity lags behind that of major competitors in the advanced world, notably the United States and some of our European counterparts (HM Treasury / DTI, 2006). Although there is some discussion about the relative effectiveness of firms in putting capital to effective use, most of the debate focuses on labour productivity, namely the output or value-added per unit of labour input. This is because, although governments do seek to influence the quantity and quality of capital and land inputs through tax breaks, grants and other policy levers, it is commonly believed that labour productivity is more amenable to alteration through managerial and governmental policy intervention in a readily discernable way. Furthermore, there does appear to be substantial variance in labour productivity across workers and across firms (Oulton, 1998).

The majority of empirical studies investigating variance in labour productivity consider variance across countries (where the issues relate to the education system, the role of the finance and banking sectors, sectoral composition of the economy, managerial competencies and the like) and across firms (arising from factors such as ownership, unionization, human resource management practices). These studies sometimes consider changes in labour productivity over time. Interest in time-variance is generated by concerns about the effect of the business cycle on consumption, production and wages, the intended and unintended effects of government policies, changes in management practices at workplace and firm level, and the maturation of businesses and economies.

Debate regarding changes in individual workers' productivity over time has traditionally focused on the productivity of individuals over the life-cycle, with particular interest occasioned by the role of ageing and life-course events such as marriage, childbearing and childrearing; the effects of job and employer tenure, occasioned by interest in the time it takes new workers to become competent and the profile of productivity as workers acquire firm-specific skills; and worker responses to managerial or governmental interventions, such as the debate occasioned by the effects of the national minimum wage. One area that has received much less attention is the effect of time itself on variance in labour productivity, by which we mean the extent to which workers' productivity is affected directly or indirectly by time-specific factors. Our primary interest in this paper is the effect of days of the week, but we shall also consider temporal variance across other periods relevant to working patterns (e.g. days or shifts).

Most readers will be aware of stories in the popular press about 'how hard workers work' on different days of the week. These stories, some of which we discuss later, are usually based on evidence from office workers collated by recruitment agencies, and lead to wild speculation as to why patterns of effort and/or output can seemingly be accounted for by 'day effects'. These effects are often presented as a curiosity and nothing more. "After all", some people muse, "you can't go about changing the days of the week". In fact, there are good reasons for investigating this issue more thoroughly. First, one needs to establish if there really are day-specific variations in productivity and, if so, what is causing them. It is possible that there are daily patterns in productivity, but that these are caused by something other than time-related factors themselves. However, if day-specific variation in labour productivity is caused by temporal factors and that variation is substantial, this may have implications for a country's wealth creation and for firms' business success. Second, it may be practical to vary labour inputs over time to effect productivity improvements. For instance, one may be able to persuade or even require workers to redistribute their working time towards moments when they are most likely to be productive. There are a variety of ways in which this might be achieved, from direct interventions such as moving away from a 'weekend' towards rest days more evenly spread across the week and altering the days on which Bank Holidays fall, through to changes which might have an indirect effect on working patterns such as revising schedules for school opening. Technological innovations such as the wider adoption of ICT, advances in storage facilities and so on mean that it is increasingly technically feasible for workers to adjust the timing of their labour inputs over the course of a week whilst continuing to meet the '24/7' product and service demands from customers (White et al., 2004: 109).

Even if productivity does vary by day of the week, and even if it is practical to redistribute working time towards more productive moments in time, it may only be desirable from a societal perspective if workers want to alter their working patterns. On the face of it this may not appear to be an important constraint since workers have become increasingly flexible in supplying their labour, a trend which is apparent in the growth of previously atypical working patterns associated with zero hours and annual hours contracts, shift-working, Sunday working, home-working, part-time and temporary working (Bryson, 2007). But if workers do have preferences for the current arrangement of working time, the attendant social costs of reorganising work schedules must be weighed against any economic benefits.

The remainder of the paper is structured as follows. The next section describes how and why labour inputs may vary over time. This is followed by a section which outlines some of the potential reasons as to why productivity may vary across the days of the week. The penultimate section presents the empirical evidence on temporal variations in labour productivity. The final section discusses the policy implications.

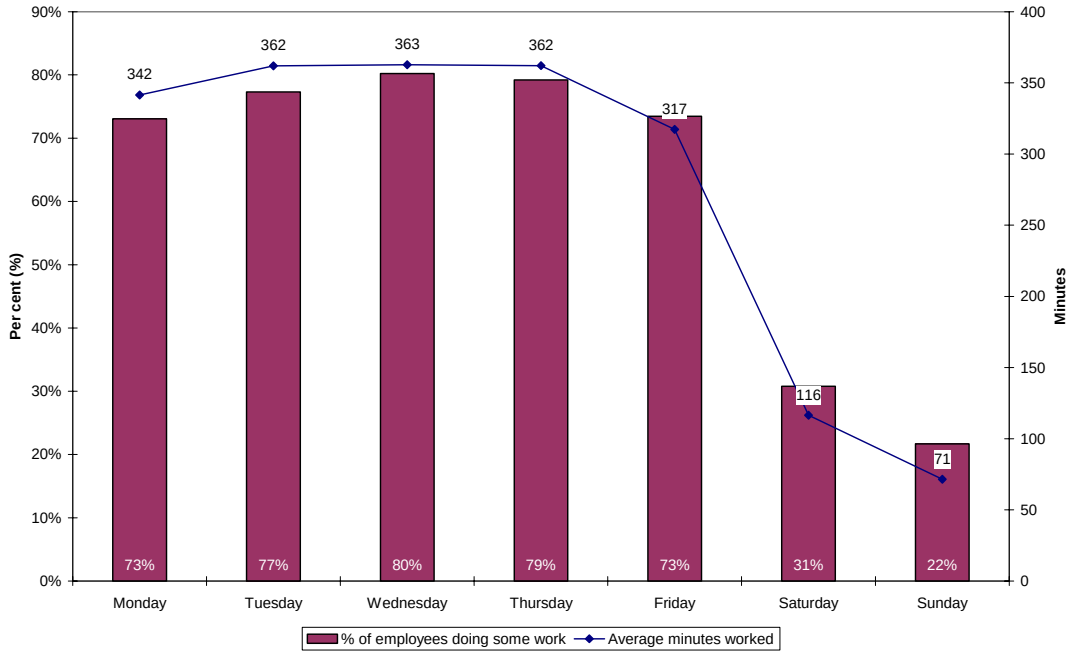
How Do Labour Inputs Vary with Time?

Before we consider the evidence on temporal variations in labour productivity, and thus before we come to any judgements about the desirability of redistributing labour inputs over the days of the week, we first consider how labour inputs currently vary with time. The focus on labour inputs arises from an appreciation that the productive potential of capital equipment cannot be expected to vary from day to day over a period as short as a week. It may vary over longer periods as individual pieces of capital equipment near the end of their useful life and become prone to failure. But one would expect that, over the course of any one week, the principal source of variation in the productivity of capital would be variations in the extent of its utilisation by labour. Accordingly, any efforts towards maximising productivity via a redistribution of inputs seems best focused on the distribution of worker effort.

As it is difficult to directly measure 'effort', attempts to measure labour inputs typically focus on measuring working time. The most detailed information on the distribution of working time across the week is provided by surveys which use diary-based methods to collect information on how people spend their time. The UK Time Use Survey, conducted in 2000, asked a representative sample of individuals to record their activities in 10-minute time-slots across the course of two days (see Williams, 2004, for further details). The sample was evenly distributed across the days of the week, enabling this information to be used to examine day-by-day variations in the extent to which people engage in paid work. The data show that, in 2000, between 73 per cent and 80 per cent of all those in employment (including the self-employed) engaged in some paid work on an average week day (Figure 1).[1] Just under one third of those in employment engaged in some paid work on an average Saturday and just under one quarter did so on an average Sunday. Complementary data from the Labour Force Survey indicate that 63 per cent of those in employment in the UK work a five-day week, with a further 12 per cent working six days and seven per cent working four days (Hill, 2000: 44).

[1] The remaining 20-27% are those who work part-time on a day other than the one in question and those absent from work at the time of the survey due to illness, annual leave and so on.

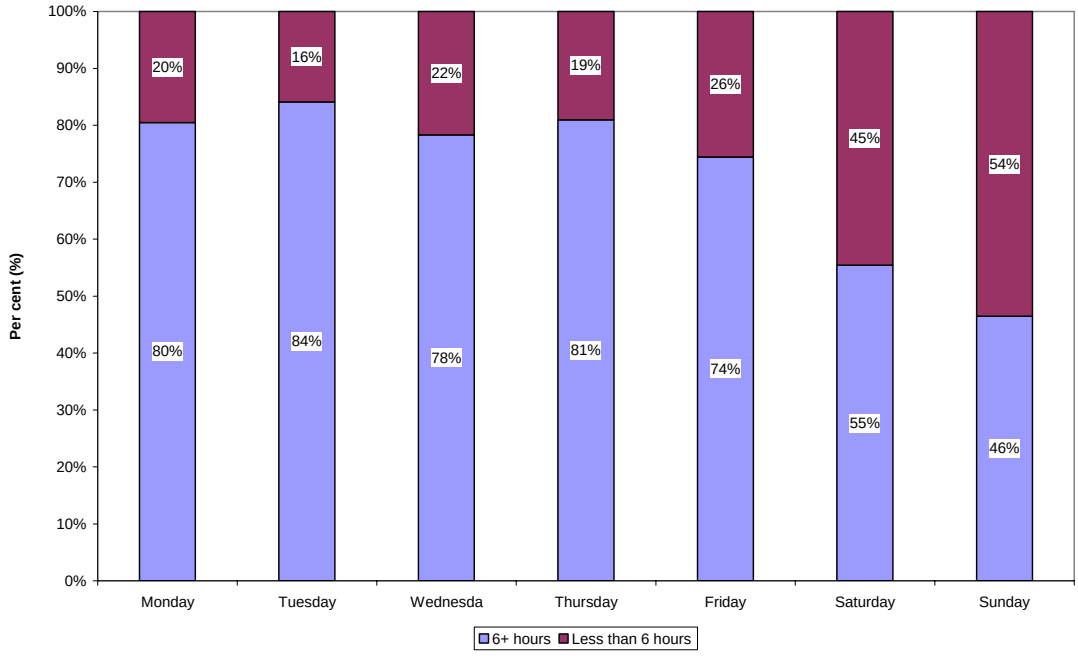
Figure 1: Percentage of those in employment working and average minutes worked by day of the week



Source: Authors' calculations from UK Time Use Survey 2000

The Time Use Survey 2000 further indicates that the average number of minutes worked per person is around 360 minutes (6 hours) on Tuesdays, Wednesdays and Thursdays, falling to 342 minutes on Mondays and 317 minutes on Fridays. This implies that people work the longest days, on average, in the middle of the week. The average number of minutes worked per person falls to 116 minutes on a Saturday and just 71 minutes on a Sunday. The latter figures naturally include a large number of zeros from those who do no work at weekends: data from the Labour Force Survey indicates that 45 per cent of men and 27 per cent of women never work at weekends (Hill, 2000: 42). The average work time on Saturdays and Sundays also reflect a greater incidence of part-time work at weekends when compared with Monday through Friday. Figure 2 shows that, among those working on a particular day, the proportion who work six or more hours falls from around 80 per cent on weekdays to around 50 per cent on Saturdays and Sundays.

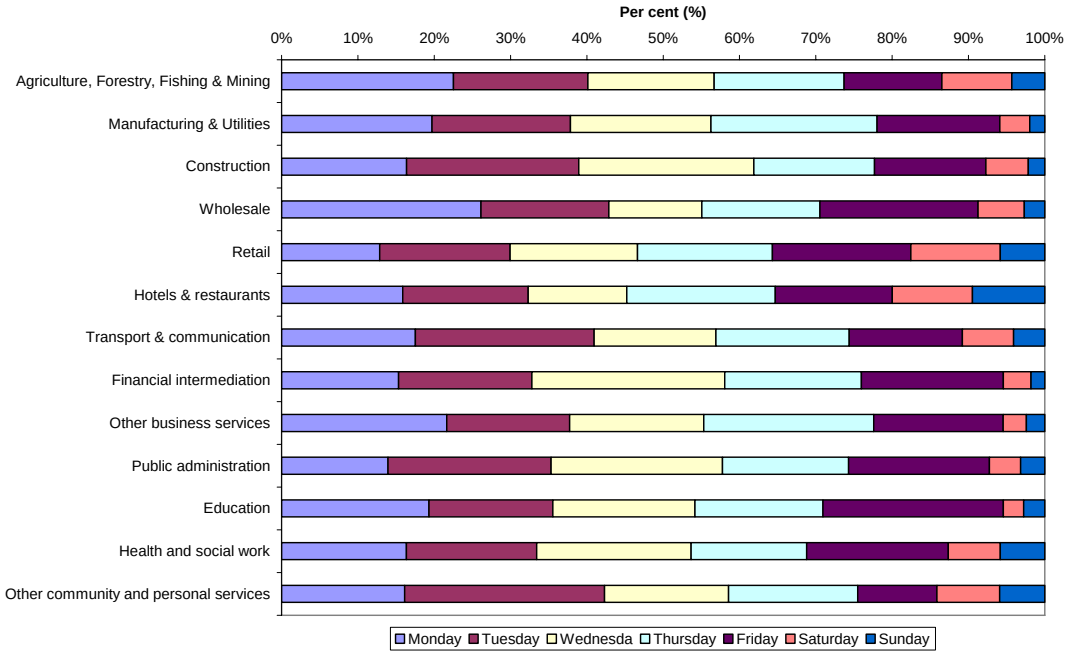
Figure 2: Percentage of those in employment working six or more hours, by day of the week



Source: Authors' calculations from UK Time Use Survey 2000

By combining the incidence of work with the average amount of work provided on any one day, one can obtain the distribution of working time across the seven days of the week. The traditional working days of Monday through Friday each account for around one sixth of the working time supplied in aggregate in the UK across a typical week. Among these five days, Tuesday accounts for the largest share of working time (18.8 per cent) and Friday the lowest (16.8 per cent). The share of working time that is supplied on Saturdays is considerably lower, standing at 5.9 per cent, whilst Sundays account for the lowest share of all – just 3.8 per cent. This pattern does, of course, vary considerably by industry sector. Figure 3 shows that weekends account for a relatively large share of total working time in sectors such as Hotels and restaurants (20 per cent) and Retail (18 per cent), but a relatively small share in sectors such as Financial intermediation, Other business services and Education (each 5 per cent).

Figure 3: Distribution of working time across days of the week, by industry sector



Source: Authors' calculations from UK Time Use Survey 2000

What determines the pattern of working time?

If work was paid on a daily basis and each day's pay accurately reflected a workers' marginal product for that day, one would expect workers to maximise their earnings by supplying their labour at the most productive times of the week. One would also expect employers to support this in order to maximise output. In practice, however, workers do not have unfettered freedom to schedule their hours, not least because there are interdependencies in production (and leisure) which require people to work (and not work) at same time. In the service sector, the provision of services also needs to be synchronised with patterns of demand. And there are also customs regarding when to work and not to work.

A number of factors may help to explain the current pattern of paid work across the working week. The predominance of the Christian religion naturally explains the tradition of Sunday as a rest day in the UK and the rest of Europe more generally. In Islam the day of public worship is Friday and so the work week tends to run either from Saturday to Wednesday (as in Algeria, Kuwait, Oman and Saudi Arabia) or from Sunday to Thursday (as in Egypt and the United Arab Emirates). In Judaism, the day of public worship is Saturday and so the work week in Israel also tends to run from Sunday to Thursday.

The tradition of a five-day work week has its origins more in industrial history. The early industrial period in Europe tended to involve a six-day working week.

However, campaigns by trade unionists in the late nineteenth and early twentieth century led to a reduction in the length of the working week and Saturday commonly became a day of rest alongside Sunday. Another impetus came from employers such as Henry Ford who introduced a shorter working week in his car factories in combination with higher pay. Ford argued that a shorter week was no less productive, as workers came back to work fresher after a two-day holiday.[2] Moreover, Ford believed that an increase in leisure time was necessary to drive an increase in the demand for consumer goods. He saw the five-day week then as a means to greater prosperity (Crowther, 1926).

The current focus is increasingly on departures from the Monday-Friday 9am-5pm model of working, with the discourse over the '24/7 society' giving the impression of a greater spread of working time into weekends, evenings and nights (so-called atypical hours). A detailed examination of how the daily distribution of paid work has varied over time is beyond the scope of this report. Detailed trends are also obscured by inconsistencies in survey data over time. However, whilst there has been an overall reduction in working time (Gershuny, 2005), data also indicate that the incidence of Sunday working increased in the UK over the 1990s (Franco and Winqvist, 2002; EOC, 2004), a phenomenon one would expect to be partly related to the relaxation of restrictions on Sunday trading in the mid-1990s. The incidence of evening work and shift work also rose in the 1990s (Harkness, 1999; Parliamentary Office of Science and Technology, 2005). A further feature of the changing pattern of work is the increasing availability of flexitime arrangements (TUC, 2005).

A number of factors arguably lay behind such trends. One is increasing competitive pressures which encourage employers to maximise use of capital equipment and to seek new market opportunities by serving customers over a wider portion of the day. In contrast to the nineteenth century practice of extending working hours, the current means of achieving this is to obtain a more flexible supply of hours from a larger number of workers, including many part-time workers. A second factor, linked to the first, is increasing consumer demand for out-of-hours services, seen most prominently in the retail sector. A third factor is the greater degree of female participation in the labour force and, associated with it, a greater level of employee demand for flexible working hours, which has in turn been supported by government policy to encourage employers to offer such flexibility.

This is not to say that such trends are uni-directional, however. It is notable that the incidence of night work saw no increase in the 1990s, and the incidence of Sunday working appeared to fall back slightly between 2000 and 2004 (EOC, 2004). Moreover, it is also apparent that some cultures do not abide by traditional ideas of what constitutes a working week at all. It is said that the Kapauku of Papua New

[2] Those in favour of a four-day week have made similar arguments (Lajeunesse, 1999).

Guinea think it is bad luck to work for two consecutive days and that the Kalahari Bushmen work just two and a half days per week (Wikipedia, 2007).

Why Might Productivity Vary Across the Days of the Week?

There are a number of possible reasons as to why productivity may vary across the week. In order to examine these, it is necessary to identify some of the attributes of different days.

The first of these attributes relates to the sequencing of each of the seven days. The most common pattern of work in the UK, as discussed above, is represented by a five-day working week which begins on a Monday and ends on a Friday. Monday is then typically the first day in the working week, whilst Friday is typically the last. This has a number of possible implications. On the one hand, it is feasible that productivity may decline over the course of the week as a result of increasing fatigue. The two-day weekend then provides the opportunity to rest before beginning the working week again the following Monday. On the other hand, productivity may be depressed to some degree on Mondays by the need to reorient oneself after two days away from the work process. It is also feasible that workers may lack motivation on a Monday as a consequence of this day being the point furthest from the next available day of rest or leisure (so-called 'Monday blues'). The proximity of Friday to the weekend may thus result in higher levels of motivation – particularly if there is a requirement or perceived advantage in completing tasks before the weekend. It is unclear as to how these various sequencing effects may balance out, but one possibility is that productivity may be at its peak in the middle of the working week, say on a Tuesday or Wednesday.

Of course, such issues of lapsed time and sequencing apply differently to those who do not follow a traditional pattern of Monday-Friday work. Saturday presents an interesting case, since it is commonly a working day for those who work only one or two days per week, but is also commonly a working day for those who work six days a week (Hill, 2000: 42), with obvious implications for variations in levels of fatigue between the two groups. In relation to sequencing, some sectors such as retail or transport commonly require customer-facing staff to work a portion of weekends, with rest days then falling at other points in the week. If sequencing were a key determinant of temporal variations in productivity, one would expect to see the high and low points falling on different days but nonetheless at the same point in the sequence. Equally, in situations where the pattern of work does not follow the traditional pattern of five days' work followed by two days' rest, as in some types of shift work, one might expect to see different levels of productivity to that observed under the traditional framework. But equally one would expect no differences between working patterns that had the same sequencing but which operated on different days of the week. That is, unless there are particular factors associated with

working at the weekend. It is conceivable, for instance, that workers allocated to weekend shifts may exert lower levels of discretionary effort if they are discontent with being at work when family and friends are enjoying leisure time.

A second set of factors that may bring about observed differences in productivity across days of the week are so-called selection effects. These are effects which variously affect the types of work and types of worker who are engaged in productive activity on different days of the week. In a sense, they can be thought of as confounding factors which may obscure attempts to identify true variations in productivity across the days of the week when observations are aggregated across multiple workers. The act of working at particular times or on particular days is not randomly determined but is instead a function of various preferences and constraints. Specifically, the pattern of working is determined to some degree by employee choice over when he/she wishes to work or enjoy leisure time, with these choices in turn being constrained by the availability of certain working patterns. It is possible to discern particular aspects of this process.

In the first instance, it is apparent that weekend working is generally not preferred by those employees who have the choice of when to schedule their hours, as weekend hours are typically regarded as 'unsocial hours' along with evenings and nights. This reflects the fact that employees prefer to synchronise their leisure time with others, and indicates that the timing of work is one aspect of the overall package of rewards (Hamermesh, 1996). The ability to avoid weekend working is most likely to be enjoyed by higher income workers, as they are more able to resist the wage premiums offered for unsocial hours. Accordingly, one may expect some degree of selection out of weekend work by higher productivity workers as they seek to avoid unsocial hours and some degree of selection into weekend work by lower productivity workers as they accept this disamenity in order to raise the wage/effort bargain.[3]

As an extension of this principle of weekend avoidance, Fridays and, to a lesser extent, Mondays, may also be tacked onto the traditional two-day weekend to form a 'long weekend'. Such extended rest breaks are likely to be enjoyed to a greater extent by higher income (and thus typically higher-skilled) workers, as such workers tend to be given larger annual leave allowances. This may affect the composition of the workforce on Fridays and Mondays to some small degree and hence affect productivity comparisons across the days of the week.

[3] A similar argument can be made in respect of bank holidays, which tend to fall on a Monday. The types of work carried out on bank holidays are akin to those carried out at weekends and so the nature of Monday work (and the Monday workforce) will vary across the year. This may have a small impact on the level of productivity for Mondays relative to other days when averaged across the year.

One is also likely to observe selection out of Sunday working by Christians, and so on for other religions with their respective holy days.[4] This may imply a particular reluctance among those with religious convictions to enter front-line work in sectors that operate throughout the week, such as retail, hospitality or healthcare. This type of selection may have no obvious consequence for productivity, except that religious observance may imply something about an individuals' level of motivation (and thus effort) when required to work on a holy day.

Selection out of work may also occur more generally towards the end of the week among workers who operate towards the achievement of a particular income target. In these forms of work – perhaps most common in sectors with high levels of self-employment such as taxi driving – it may be common to observe a higher proportion of low productivity workers towards the end of the week (say on a Thursday or Friday).[5] In more traditional forms of work that operate more towards output targets, a similar effect may occur whereby those working at the weekend may include a high share of relatively unproductive workers who have been unable to complete the required tasks within the normal five-day framework and are working unpaid overtime.

The selection effects noted above concern worker preferences. But selection into working on particular days is also determined in part by patterns of labour demand. The patterns are determined by the nature of the production process, by wage costs and also by variations in consumer demand. In the first respect, employers are to some extent constrained in the amount of flexibility they can offer to employees because of the need to synchronise worker effort, which results from the reliance of many production processes on worker interaction.[6] These effects also transmit themselves between firms or industries as supply chains also rely to a large extent on interaction between workers. In the second respect, worker distaste for working unsocial hours raises the wage cost to employers of staffing the workplace during those hours. Finally, a concern to synchronise working time with consumer demand will be apparent among employers in industries where goods and services cannot be stored (or where storage is costly). This is most obviously the case in service sectors, but is also increasingly the case in manufacturing due to the growth of just-in-time production systems.

The pattern of consumer demand varies across the week in most industries. The relevance for the identification of true day effects in studies of productivity is most

[4] The weekly cycle of mortality among Jews in Israel which declines on Sabbath (Saturday) and rises to a peak on Sundays (Anson and Anson, 2000) is strongly suggestive of timing of effort (and thus exposure to risk) among Jews in accordance with their religious beliefs.
[5] Farber (2003) discusses the prevalence of target earning behaviour and its implications for choices as to when to start and stop work among taxi drivers, street vendors and others with substantial discretion over the supply of their labour.
[6] As noted by Weiss (1996: 158), there are externalities that arise from the potential for communication and co-ordination among workers who work at the same time.

obvious in respect of the retail trade. Here, the speed with which a shop worker serves a customer can be expected to depend to some degree on the number of other customers waiting in the queue. And so the level of productivity (when measured as output per unit of working time) can be expected to vary to some degree in line with patterns of demand for a business's products or services. Businesses supplying goods or services to other businesses are likely to see most demand (and thus to some extent higher productivity) between Monday and Friday, whilst those serving the general public are likely to see most demand at the weekend. Nevertheless, this pattern might also alter seasonally, as businesses operating in the tourist trade may see less variance in demand (and thus to some extent productivity) between weekdays and weekends in the summer months. Equally, those in leisure industries may see less variation between weekdays and weekends in school holiday periods.

It is therefore apparent that estimation of the true variation in productivity across the days of the week may be difficult because days have a number of separate attributes which determine their role in the work domain. Such estimation is also difficult because the productivity of individual workers is rarely measured on a daily basis. Indeed, individual-level productivity is rarely observed across any time-dimension: it is usually aggregated to the level of a work group or team, a workplace, firm, industry or whole economy. Furthermore, productivity data is not usually available at any level on a day-by-day basis: again, it is usually aggregated to larger time-units such as weeks, months and accounting years. Individuals' productivity on a daily basis may be collected by firms where they are using it to track worker performance, make performance-related payments, or administer inventory or production systems. Examples include check-out assistants and fruit-pickers. However, as will become apparent in the next section, these data are rarely available to the analyst.

Evidence on Temporal Variation in Labour Productivity

This section reviews the empirical evidence relating to temporal variation in labour productivity. The direct evidence on variance in labour productivity by days of the week is extremely limited for reasons noted at the end of the last section. The evidence for day variance in productivity-related outcomes such as sickness, absence and injury is a little more extensive. There is also evidence of temporal variance in productivity-related outcomes for time-periods other than days, including during the course of the day, by shift-patterns, working weeks, and so on. Once again, direct evidence on productivity is limited, however. Below we separate out the evidence relating to days of the week from other temporal dimensions, as well as distinguishing between evidence relating directly to productivity and evidence on productivity-related outcomes.

Direct evidence on productivity variation by day of the week

Most of the studies that assess variation in productivity by days of the week are not particularly robust since they rely on descriptive univariate or bivariate analyses of self-reported work effort among unrepresentative non-random samples of workers. A recent example is the survey conducted by Robert Half Finance and Accounting (2006) among finance professionals in eleven countries including the UK. Of the 1,765 professionals responding to the survey, just under half (45 per cent) said they were equally productive every day of the week. Of the remaining 55 per cent, the start of the week (Monday and Tuesday) was viewed as the most productive while the end (Thursday and Friday) was viewed as the least productive. Almost half the workers said it took them at least two days to be productive after a holiday, reflecting the time taken to reorient oneself to work after a significant break. Without detailed information about the sampling for the survey and with no effort to take account of possible confounding factors in assessing responses to the productivity question it is difficult to know what to make of such findings. However, they do tend to contribute to general perceptions that worker productivity does differ across days, even if it is hard to establish why this might be.

There is a small body of research which uses more objective measures of productivity and, although the studies are careful and informative, they tend to rely on samples taken from a single work-site, firm or industry so that extrapolation beyond the immediate population can be problematic.

In his investigations into the nature and causes of worker fatigue among industrial workers undertaken during the First World War Kent (1917) presents evidence of low output on Monday and high output on Saturday. The low output he attributes to a "loss of the special co-ordination which resulted from the prolonged performance of a particular set of actions" (p.35), whereas high Saturday output was attributed to "the anticipation of the week-end rest" (p.27). Both these effects were also reflected in accident rates. More generally, Kent pointed to the role of fatigue in declining output over periods of sustained effort. Vernon (1917a, 1917b) cited fatigue as the primary reason why the British munitions industry had failed to respond to increased demand for output during the First World War despite sufficient funds to reward overtime working. Fatigue was also cited as the reason for declining productivity in the latter part of the working week among workers in the cotton weaving industry during the 1920s (Medical Research Council, 1923). Reviewing this informative though, admittedly, rather old empirical literature, Oi (2001) suggests that daily output reaches a peak in mid-week and tails off toward the weekend. The rise in output in the first part of the week is consistent with "practice efficiency" whereby the rate of output climbs as the worker gets more efficient with the practice. However, the accumulation of work tires the worker, leading to a drop in output by Friday. Vernon (1921: 27-28) explains patterns in his data in precisely this way:

"The cessation of work between Saturday afternoon and Monday morning naturally causes a greater loss of neuro-muscular co-ordination than that observed between each week day, and consequently the output on Monday morning tends to be lower than that observed for any other morning of the week. The loss of practice-efficiency owing to the week-end rest is so considerable that the remainder of the week may be needed for recovery, but…the fatigue induced by the daily round of labour gradually accumulates…first to neutralize the improvement due to practice-efficiency and then to overpower it."

As Oi notes (2001: 8), underlying these observations is an implicit model whereby "the labour required to produce one unit of output …is smaller the larger are the stocks of practice-efficiency and energy". Under this model a worker obtains, as a by-product of performing a task, an increment to her stock of practice-efficiency capital. The worker's stock of practice-efficiency depletes during periods of extended rest, leading to the "Monday effect". The accumulation of output increases the stock of practice-efficiency capital as the week progresses, but more output reduces her stock of energy, "to the point where it eventually produces the Friday dip in the daily output rate" (Oi, 2001: 8).

However, Vernon also identified a third factor, alongside practice-efficiency and fatigue, which affects workers' productivity over time. This third factor is the "end spurt" whereby workers increase their effort just prior to a break or rest. In the case of piece-rate workers this 'end spurt' may be particularly pronounced towards the end of periods over which output is measured – for instance, on Friday as the end of the working week approaches.

Some more recent studies provide direct evidence on variance in labour productivity by day of the week but, because this is a by-product of the research rather than its focal point, this aspect of the studies is rarely explored or interpreted. One such example is Cockburn et al. (1999) which analyses the productivity (insurance claims per day processed) of 6,000 clerks in large US insurance company between 1993-95 to show how productivity is higher among those using non-sedating compared with 'sedating' antihistamines among nasal allergy sufferers. In the course of the study they present multivariate analyses with day-of-week and day-of-month controls, both of which are jointly significant in their models. Although they present no coefficients the authors say: "Compared with Mondays, there was a very pronounced drop in output on Fridays (-5%) and Saturdays (-24%)". However, they do not seek to comment on these results so it is difficult to know how to interpret them. Furthermore, their models only account for a small percentage (8 per cent) in daily productivity variance.

Reviewing the impact of long weekly working hours on productivity and task performance, Kodz et al (1999) conclude that productivity and work performance do decline with longer weekly hours – thus implying a dip in productivity towards

the end of the week – but they stop short of specifying the causes of this bivariate association.

Indirect evidence on productivity variation by days of the week

Worker absence patterns, error and injury rates are negatively related to productivity and thus can provide indications as to how productivity itself may vary. Psychological well-being may also influence task performance so studies on temporal variance in job satisfaction and happiness may be informative with respect to productivity.

Absence patterns

Absence from work places substantial costs on employers since workers continue to receive wages and other benefits without undertaking productive work. Furthermore, the absence of one worker has implications for overall productivity since the loss of a skilled or experienced worker may interrupt the interdependencies between workers that is an integral part of the production process (even if the absent worker is replaced by another, this person is likely to need time to 'get up to speed'). Although absence is usually due to sickness, illness or another legitimate reason for taking leave such as care-related duties, some absence may be due to workers taking time off as a form of leisure. Since absence is costly and, at least in some cases, may be prevented, analysts have long explored patterns in absence data. Those analyses that explore variations by day of the week generally tend to find that absence is higher at the beginning of the week and lower at the end.[7]

Behrend (1951: 46 104-6) developed an index to "measure absence as a form of conscious withdrawal". The index is the difference between absence rates on the best and worst days for attendance. In her study Friday was consistently the best day (i.e. had the lowest absence rates) and Monday the worst, leading her to refer to the index as the "Blue Monday syndrome". Other studies have uncovered evidence consistent with such a pattern (Edwards and Scullion, 1982).[8]

Using data for male workers from a single continuous process plant in south-east England Pocock (1973) found sickness absence durations were associated with the

[7] Oi (2001: 8) cites conflicting early evidence on absence rates over days of the week. Vernon (1921: 165) reported absence rates were highest on Mondays, falling to half of its Monday level by Friday. Baldamus (1961) found a similar pattern of absence among industrial workers. However, Oi (2001) says the pattern is the reverse among grammar school teachers, though he offers no insights into why this might be so.

[8] In a similar vein, Liddell's (1954) analysis of colliery worker absence in the West Midlands in 1948 found it to be highest on a Monday. Although the lowest absence days varied they were usually towards the end of the week. Edwards and Scullion (1982) identified a pattern of single-day absences in their clothing plant data, particularly on Mondays. More recently Boggis (2000) investigated absence as a response to increased managerial control over work processes via technology in a clothing manufacturing plant. The intensification of labour through just-in-time and lean production techniques was met with an increase in single day absences, but these were most likely on Mondays and Fridays.

day on which the spell began. The tendency of absences to last whole weeks was attributable to the high frequency of absences beginning on a Monday and the tendency to delay return until after the weekend. However, one would expect greater sickness absence on a Monday than on other days of the week because Mondays incorporate illness spells beginning on a Saturday or Sunday (which are not observed in the data). Once this is accounted for absence starts are higher than expected for Tuesdays and lower than expected for Thursdays and Fridays. The study therefore accords with Behrend to some degree in finding that absence tends to be lowest towards the end of the week.

Injuries and accidents

Closely allied to the absence literature is the literature on worker compensation claims for injuries and accidents. These studies, undertaken largely in North America, find an increased probability of injury reports on Mondays compared to any other day. Using a random sample of all lost-time claims from administrative records for Ontario in 1992 Campolieti and Hyatt (2006) find a 'Monday effect' in that easier-to-conceal injury claims (sprains etc.) were more likely on Mondays, *ceteris paribus*, whereas other sorts of injuries were not. They interpret this as evidence of workers attempting to represent non-work-related injuries as work-related to mitigate earnings loss since lost earnings can only be recouped through worker compensation for work-related injuries. However, they suggest that this effect is small. Another explanation is that workers are post-dating weekend injuries to obtain medical care via workers' compensation insurance. However, this explanation makes little sense in the case of Ontario where most workers have access to general medical insurance coverage. A third possibility, supported by evidence that Monday claims are no more likely to be rejected than claims made for other days of the week, is that workers are more susceptible to injuries when they return from time off, a finding that may have implications for worker productivity more generally.[9][10]

Error rates

Error rates have a direct bearing on productivity since increased errors affect product rejection rates and, if it results in faulty products or services being sold to customers, may reduce subsequent sales.[11] A study of daily variance in error rates at a German car manufacturing plant in 2003-2004 found strong variation of errors across the week (Borsch-Supan, Duzgun and Weiss, 2006). Monday had the fewest errors; they increased towards Wednesdays and then decreased again towards Fridays. Perhaps counter-intuitively they also find that workers make fewer or less severe errors when work load is higher, but the pattern of daily variation remains

[9] Card and McCall (1996) come to similar conclusions in their analysis of data for Minnesota.
[10] Oi (2001: 9) also says that "the daily work injury rates are the lowest on Wednesday and Thursday when daily output rates are highest".
[11] However, as Walter Oi has pointed out, the optimal product rejection rate is not zero and depends on the costs incurred in reducing errors.

after controlling for work load. The pattern observed is somewhat different to the general pattern of absence, discussed above, as it implies a U-shaped productivity curve across the week. The paper offers no explanation for this daily variation. However, in a personal communication to us one of the co-authors (Weiss) stated: "My speculation regarding the hump-shaped weekday error pattern is that it might reflect selection. The not-so-diligent workers might be the ones who would rather stay at home on Fridays and Mondays to extend their weekend. Thus, those who work on Mondays and Fridays are positively selected and so make fewer errors." If one believes some of the studies regarding daily variation in absence rates described above, this selection bias may be quite common. It points to the importance of accounting for worker selection bias in any analysis of productivity by day of the week.

Satisfaction and happiness

It is often asserted that job satisfaction can raise worker productivity through its effects on worker morale and organizational commitment. Although studies are rarely able to discount the possibility that the relationship runs in the other direction, many studies do find a positive correlation. If satisfaction and happiness vary by day of the week, this may have implications for labour productivity.

Using British data for the period 1991-2000 Taylor (2006) finds job satisfaction is higher among those interviewed on Fridays and Saturdays than it is among those interviewed in mid-week. Those interviewed on Fridays also have lower stress levels than those working earlier in the week. The panel data allow the analyst to account for unobservable time invariant individual specific effects, thus overcoming some of the drawbacks of other studies where day-of-the-week effects may be confounded by unobservable factors affecting both responses to survey questions and choice of working days. The author cites research substantiating links between satisfaction and productivity and satisfaction and other productivity-related outcomes such as worker morale, absenteeism, and job turnover.

Mihalcea and Liu (2006) analyse blogpost data for the United States from LiveJournal.com annotated with 'happy' and 'sad' moods. These data indicate Saturday is the happiest day. Wednesday is the least happy with a rapid rise in happiness occurring on Thursday. The authors interpret this as an effect of anticipating the weekend. The decline in happiness during Sunday is interpreted as an effect of anticipating a full working week.[12]

[12] The posting of moods is purely voluntary so that mood-annotated posts are likely to reflect the true mood of blogposters. Of course, it remains unclear how representative they are of the wider population. A study of American primary school children found a different daily pattern in their happiness: it was lowest on a Sunday and increased each day afterwards reaching its peak on Saturday (Csikszentmihalyi and Hunter, 2003). The authors suggest the Saturday effect reflects freedom from school which is experienced as liberating, conjecturing that "the effect is probably greater on adults, for whom the working week is presumably even more constraining than it is for teenagers" (p. 189). The study also points to significant variation in happiness by time of day.

Stock returns

Another 'Monday effect' is the negative trading returns associated with Monday equity trading. Some attribute this to psychological links to trading behaviour. For example, there is some experimental evidence of trader pessimism on Mondays leading to a preference for low-risk assets on that day (Pettengill, 1993) but Pettengill's (2003) review of the empirical literature suggests there a number of potential explanations for the phenomenon. More recently Chandra's (2006) investigation of returns in Asia-Pacific markets finds no consistent day-of-the-week effects across the range of countries studied.

Direct evidence of temporal variation in productivity other than by days of the week

Vernon (1917a, 1917b, 1921) drew attention to the role of 'spell fatigue', that is, the effect of continuous strain until relieved by a meal-break, in reducing output over the course of the spell. He found that the output of women covering chocolates rose during the morning with practice-efficiency but that output began to fall before the lunch break as fatigue and monotony set in. Goldmark and Hopkins (1920) found a similar pattern.

Kent (1917), on the other hand, tracked how output over the course of the day was affected by fatigue. He pointed to "unsatisfactory output of the early morning period (before breakfast) [which] is due partly to loss of co-ordination. It appears to depend also upon lack of rest, lack of food, and general discomfort. These things arise indirectly from excessive hours of labour." He went on to argue that "the unsatisfactory output of the overtime period is due to fatigue".

Baldamus (1961) offers a different explanation for the patterning of output over the course of the day with the concept of 'traction', which is the sense of achievement a worker gets once she has got into the rhythm of repetitive work. This creates a sense of satisfaction that permits effort to be maintained in tasks that are inherently unpleasant. From this one might infer that the early stage of any work-period will have lower traction and so lower effort.

Some studies show productivity varies over the course of a week as a result of changes in the composition of workers and the amount of overtime they undertake. Recognition of this fact has inspired studies in industrial engineering seeking to optimise the mix of labour inputs in terms of contract-types and amounts of overtime. For instance, Hancock et al. (1987) show how the greater use of part-time workers and increased use of overtime increase labour productivity in hospital units, where productivity is defined in terms of the time workers take to perform their work load relative to a standard of expected hours set by the hospital management. The authors, noting that "there is rarely a technical basis for determining what productivity levels could be achieved, how one should staff, and the resulting budget" (1987: 321) advocate the use of computer programmes to

allow management to schedule staffing across days of the week to meet predicted demand, taking account of contextual factors such as the degree of team production and technological constraints.

Indirect evidence of temporal variation in productivity other than by days of the week

Injuries and accidents

There is a substantial empirical literature estimating the probabilities of accidents and injuries as a function of time spent at work but most of this relates to time variance other than day effects. Folkard and Lombardi's (2006) meta-analysis of the risks of injury/accidents and features of work schedules establishes that risk depends on the length and type of shift as well as frequency of breaks. Risk of 'incidents' rises with successive workdays, the relative risk rising more on night shifts. Accordingly, one would expect the risk of incidents to rise through the work week. But the relative risk of injuries and accidents also rises with longer shifts and with time since the last work break. The type and length of shifts affects risk probabilities far more than total weekly hours, a finding that has clear policy implications (see below).[13]

Using data on workers' compensation claims in Texas between 1998 and 2002 Fortson (2004) finds injury rates are higher on late night shifts than during regular nine-to-five shifts. Having discounted fatigue and compositional differences in workers across shifts he suggests that workers are not optimally alert during night shifts, citing the psychological and neuroscience literature on circadian rhythms in support of the proposition.[14]

Task Performance

Kirby and Kirby (2006) assess the effects of pro-activity and time-of-day preference on student classroom performance. They find that a preference for morning activity over activity later in the day ('morningness'), which is related to individual differences in circadian rhythms, accounts for a significant portion of variance in student classroom performance, ceteris paribus. The authors suggest the findings have implications for the timing of tests and training during the course of the day.

[13] The review notes a number of methodological problems that affect many studies linking accidents to work schedules. These include the self-selection of the fittest workers into longer work hours, seniority rosters which allocate the least attractive shifts to low tenured workers, variance in the number of individuals at work over a 24-hour period and thus the numbers at risk, and lower likelihoods of reporting incidents at night. Wilkins' (2005) paper also points to the value of methodological advances in tackling unobservable factors that may confound the relationship between working time and injuries. By using industry-level panel data he is able to tackle this problem. As a consequence, he finds no effect of variation in working hours on full-time workers' injury rates in Australia – a finding that runs counter to the earlier studies using cross-sectional data. However, increasing working time of part-time workers is found to increase injury rates per hour worked.

[14] Circadian rhythms are "biochemically regulated processes that generate a diurnal variation in the body's level of alertness" (Fortson, 2004: 24).

Compressed Working Week

The compression of work schedules through nine-day fortnights and four-day weeks offers employees leisure benefits, though the longer working day can induce fatigue and affect domestic life according to Dawkins and Tulsi's (1990) review of the empirical literature. However, whereas there is potential for employers to reap productivity gains through morale improvements and reduced absenteeism, detrimental productivity effects may arise through fatigue and "because of work coordination and communication problems and reduced service to customers (p. 125).

Emotions

In addition to the literature on day-to-day variance in satisfaction and happiness there is a growing literature on variance in emotions within days. The literature distinguishes different dimensions of happiness such as life satisfaction, 'moment-to-moment' happiness and time doing enjoyable activities. These may have different implications for productivity. Furthermore, the ways in which they are collected – either retrospectively or using 'real-time' day reconstruction methods – together with the order in which survey questions are asked may elicit quite different responses from individuals (Kahneman et al., 2006). Kahneman and his colleagues place particular emphasis on what they term 'focusing illusion' which is the phenomenon whereby individuals give too much weight to a particular factor if asked to evaluate its impact on a particular outcome. Findings from this methodological research raise questions about the value of direct questions regarding evaluations of productivity and productivity-related outcomes on different days of the week.

Using the Day Reconstruction Method (DRM) Stone et al. (2006) map diurnal rhythms in the emotions of a random sample of American working women taken from a drivers' licence list. Positive emotions peaked at noon and evenings; negative emotions peaked at mid-morning and mid-afternoon. Tiredness was V-shaped whereas competence was an inverted-U shape. These patterns are discernible even when accounting for the effect of activities undertaken, though these also had an independent effect on positive and negative affect. It is conceivable that these emotional states are related directly or indirectly to labour productivity and, as such, may induce substantial variance in individuals' productivity during the course of a day.

Summary and Policy Implications

It is widely accepted that flexible working arrangements may benefit workers seeking to balance work and family commitments whilst helping employers match labour supply to demand for their goods and services. Working patterns may also have implications for labour productivity, measured in terms of workers' output or value-added per hour. This paper focuses specifically on labour productivity across days of the week. We suggest that labour productivity may vary over days of the week for a variety of physical, physiological and compositional reasons relating to lapsed time since the start of a working period, the timing and duration of rest periods, and worker preferences. However, our review of the empirical literature uncovers scant direct evidence on day-of-week productivity effects. Those studies that do exist often rely on relatively unsophisticated methods of identifying day effects. Those offering more reliable evidence are either dated or are confined to particular firms or sectors thus making generalisations difficult.

There is more reliable evidence of temporal variance in outcomes that are indirectly linked to productivity. This evidence suggests that the timing of labour inputs across and within days affects outcomes such as error rates, absence and accidents through fatigue, habituation to work patterns, and emotions. However, even this evidence is partial and only provides possible insights into how productivity might vary by day of the week. For example, there is clear evidence of how individuals' task performance varies with their emotional patterns throughout the day. But without evidence on how biological rhythms vary over the week (as opposed to the day) it is difficult to see what the precise implications might be for variations in productivity across the week.

Obtaining the data needed to identify productivity variances by day of the week is not straightforward. First, one needs measures of worker productivity each day: that is, the marginal product per unit of worker effort. In practice, it is more likely that firms will hold data on sales or value-added per employee over various time periods. However, sales values do not always provide an accurate indication of the amount of output and working time is not a perfect measure of worker effort. Furthermore, the analyst must account for the effects of variations in demand for products and services which may affect sales.

Second, to obtain the causal effect of days of the week on productivity the analyst must seek random variation in working time. Where workers are not randomly allocated to working time patterns, sorting effects may confound estimates of day effects on productivity. This may occur where workers choose working patterns – or have them chosen for them by employers – for reasons which also affect productivity. If the analyst is unable to control for the factors simultaneously affecting productivity and working patterns then any estimates of day effects on productivity may be biased. The analyst is most likely to observe random variance in

hours worked when an exogenous change in working hours, such as that induced by a change in government policy, affects one set of workers but not another. Under these circumstances the analyst can conduct a 'before-after' study comparing the relationship between hours worked and productivity for the affected and unaffected group. Differences between their pre- and post-change productivity can, under certain assumptions, be attributed to the change in policy. From this it may be possible to recover the effects of working hours on productivity. Of course, such situations are difficult to come by and so one is likely to have to rely on data on sets of individuals with different working patterns, with attendant efforts to counter selection effects. Some working environments are better set-up than others to deliver such data. Some examples may be supermarkets or call centres where shift-work and electronic monitoring of worker output are commonplace. But the identification of day effects in these environments remains by no means straightforward.

If a study could be devised with the design features outlined above, it would clearly provide a much better indication than is currently available of how productivity might vary across the week, and of the reasons for any such variation. It might then point towards particular configurations of working time that are more productive, on average, than those currently in vogue: findings that could be of some importance in policy terms. Suppose, for instance, that a well-designed study indicated that productivity rose during the very early part of the week and then gradually declined towards a low point at the end of the week (a pattern suggested by the discussion at the beginning of Section 3 and by some of the evidence presented in Section 4). In this case, there would be three obvious implications for policy.

First, one might consider encouraging a greater concentration of working hours in the middle of the week. There would seem to be some scope for this form of redistribution of working time because, as we have shown in Section 2, there are a substantial proportion of employees who are not at work in the middle of the week and, among those who are at work, a substantial proportion work less than a full day. At one extreme, it may mean curtailing the traditional working week to four days if, as some have argued, the subsequent increase in output would more than offset the reduction in working time (Lajeunesse, 1999). A more likely scenario is that one would seek to effect further inequality in the distribution of hours across the traditional five days.

A second possible policy initiative would be to consider the timing of bank holidays. Three of the four non-religious bank holidays in England and Wales fall on a Monday but might reasonably be moved to a Friday if that were deemed to be the least productive day in the traditional working week. This would, of course, bring about only a negligible increase in national output across the year, but would to some small degree represent a more efficient allocation of labour.

A third possible policy initiative, and the one which is inherently most appealing, is to permit even greater flexibility than is currently on offer in the scheduling of working time. Whilst there may be certain times in the week that are most productive for the average worker, this optimal time point is certain to vary across individuals depending upon their personal and job characteristics. Economic theories would suggest that workers are already likely to be supplying labour at the most productive times of the week, since higher productivity should attract higher wages. In practice, workers may not always make choices that are optimal from a productivity perspective and therefore maximise earnings, especially if they tend to be paid roughly the same in their job regardless of temporal variance in their productivity, and if they value working particular hours or days irrespective of the productivity consequences. This implies that any reallocation decisions need to be taken jointly by employees and employers. Productivity gains may therefore be attainable if both employers and employees are encouraged to take a more creative approach to the question of work scheduling over the week and to engage in more active discussion about how work can be scheduled in ways that maximise output. Similar initiatives could also bring benefits in allowing a more productive allocation of work across the working day or other temporal dimensions, if the current distribution of effort across these dimensions is sub-optimal in productivity terms.

In determining the policy initiatives that might be pursued, it is also important to recognise that hard choices may need to be made in trading off worker well-being against higher output if worker and consumer preferences over the distribution of working time are not optimal for productivity. Employers must also be able to accommodate shifts in working time and will be concerned to ensure that the costs of doing so not outweigh the productivity benefits. This recognises that there are a number of important constraints to reorganising the timing of work. We end this report with a short discussion of some of these constraints.

First, it seems likely that, unless the total length of the working week is to be altered or the overall size of the labour force is to be expanded, any reorganisation of working time is likely to lead to an increasing proportion of working time falling in what are usually perceived as 'unsocial hours': early mornings, evenings or weekends. These unsocial hours affect social and family life, because they reduce the opportunities for interaction and affect established patterns of social and domestic activity. For example, in a recent study of atypical working patterns, one third of mothers with frequent atypical hours said that their work limited the time they could spend every week reading, playing and helping their children with their homework (compared with around ten per cent of other employed mothers) (La Valle et al, 2002) . Parents who worked on Sundays were particularly likely to say that their work limited their engagement in family activities (*ibid.*).[15] Accordingly,

[15] Further research conducted in Australia suggests that, under current circumstances, those who work on Sundays generally do not seem able to compensate during their day off for the social interaction that is lost as a result of Sunday working (Bitman, 2005).

departures from traditional patterns of working may bring social costs unless complementary adjustments can be made in the work or school patterns of family members and other social contacts.

To the extent that any reorganisation of work does entail a greater proportion of what are deemed to be 'unsocial' (or otherwise less desirable) hours, any attendant productivity gains may also be accompanied by increased wage costs. Unsocial hours typically attract a wage premium as a means of compensating employees for the loss of opportunities for social interaction. Figures from Incomes Data Services indicate that a 50 per cent premium is not uncommon for Sunday working in the retail sector (Incomes Data Services, 2006). Increased wage costs will, of course, offset the value of any productivity gains to some degree, and thus have the potential to reduce the extent of any economic benefits.

A further constraint arises from the need to synchronise work schedules both within and across firms (or between firms and consumers). The time at which workers supply their labour matters, especially if demand for the product or service must be contemporaneous with labour supply, as with so many customer-facing services. Any change in working patterns that deviates from established patterns of work, leisure and consumer demand raises the possibility of interfering with the current synchronisation of such activities. Firms must continue to be able to synchronise the efforts of their workers with the requirements of supply chains and the demands of customers. Technological advances may make this easier in some circumstances, but the 'on-demand' nature of the 27/7 society may equally present significant constraints.

Clearly, the importance of such constraints will depend critically upon the extent to which any reorganisation of work is adopted universally across families, social groups, work groups and supply chains. With the increasingly inter-connected nature of society along both national and international dimensions, it seems implausible to expect anything other than localised adjustments. The challenge of identifying the most productive patterns of work are therefore likely to be no greater than the challenges of effecting a more productive pattern of working, should one be found.

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