

## Home Offices



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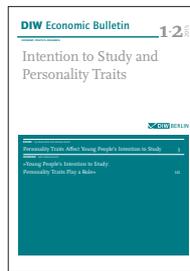
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**NEXT ISSUE OF DIW ECONOMIC BULLETIN**

## Behaviour of Small Companies in the European Emissions Trading System

# Home Offices: Plenty of Untapped Potential

By Karl Brenke

As far as the share of individuals with a home office is concerned, Germany is below the EU average and lags considerably behind other countries such as France, the UK, or the Scandinavian countries. Only 12 percent of all employees in Germany work primarily or occasionally from home, although this would theoretically be possible in 40 percent of jobs. In most cases, an employee's desire to work from home is not recognized by employers. If these employers were to reconsider their position, however, the share of people working from home could rise to over 30 percent. The disparity between employees wanting to telecommute and the options offered by employers is greatest in the financial sector and in public administration. Well-qualified full-time employees in particular are interested in working from home. The main motive would appear to be more autonomy in managing their own time, not only reconciling work and family life, since there are just as many singles who would like to work from home as there are single parents. Telecommuters often end up working much longer hours than average, and it is not at all uncommon for them to do unpaid overtime. Nevertheless, their job satisfaction is higher than that of other employees—particularly those who would like to work from home but are not given the option.

Since mid-2015, employees in the Netherlands have been legally entitled to perform their existing jobs from home.<sup>1</sup> The onus is on the employer to prove that there are compelling business reasons preventing an employee from working from home. This legislation has given additional impetus to the debate about home offices in Germany. For instance, the Green Party has called for a similar reform,<sup>2</sup> whereas the German Federal Ministry of Labour and Social Affairs (BMAS) is appealing to employers to provide their employees with more opportunities to work from home.<sup>3</sup>

The following sections will outline how many employees in Germany work from home, their social characteristics, and features of their jobs. A similar study by DIW Berlin two years ago had to rely solely on data from the German Federal Statistical Office's microcensus.<sup>4</sup> However, since 2014, data on working from home have also been collected as part of the Socio-Economic Panel (SOEP) study<sup>5</sup> conducted by the survey institute *TNS Infratest Sozialforschung* on behalf of DIW Berlin, which means that another generally accessible data source is now available to the research community for analyses on the subject. Although the microcensus and the SOEP vary with regard to the questions that members of the households surveyed are asked (see box), there are only slight differences in the results and, consequently, the conclusions drawn from both are robust.

<sup>1</sup> Niederlande schaffen Recht auf Heimarbeit. Frankfurter Allgemeine Zeitung, April 16, 2015.

<sup>2</sup> Arbeitszeitgesetz: Grüne wollen Recht auf Homeoffice durchsetzen. Spiegel-Online, September 12, 2015. [www.spiegel.de/wirtschaft/soziales/die-gruenen-wollen-recht-auf-homeoffice-durchsetzen-a-1052491.html](http://www.spiegel.de/wirtschaft/soziales/die-gruenen-wollen-recht-auf-homeoffice-durchsetzen-a-1052491.html).

<sup>3</sup> Interview with Andrea Nahles in Bildzeitung, December 18, 2013.

<sup>4</sup> Brenke, K. (2014): Immer weniger Menschen in Deutschland gehen ihrem Beruf von zu Hause aus nach. DIW Wochenbericht, no. 8/2014.

<sup>5</sup> On the SOEP see, inter alia, Wagner, G. G., Göbel, J., Krause, P., Pischner, R. and Sieber, I. (2008): Das Sozio-oekonomische Panel (SOEP): Multidisziplinäres Haushaltspanel und Kohortenstudie für Deutschland – Eine Einführung (für neue Datennutzer) mit einem Ausblick (für erfahrene Anwender). ASTA Wirtschafts- und Sozialstatistisches Archiv 2.

Box

### Identification of the home workers: comparison between Mikrozensus and German Socio-Economic Panel

Household and individual surveys such as the microcensus or the Socio-Economic Panel (SOEP) study at DIW Berlin are normally conducted using questionnaires which are presented to household members for them to fill in themselves or have read to them by an interviewer who then notes the responses. The questions are usually in multiple-choice format, with respondents expected to select the answers that best describe their personal social circumstances (for instance: occupational status) or their opinions (for example: preference for a particular political party). The advantage of this extensive standardization is that the data obtained can be collected and processed easily and therefore cost-effectively. If the questions were not multiple-choice (but, instead, respondents are required to give answers to open questions), their freely

formulated statements would have to be captured somehow; these responses would then have to be categorized by qualified personnel. This involves a great deal of work and is barely feasible timewise or financially for surveys with large sample sizes; there is also a risk that respondents' answers may be interpreted and categorized differently by the personnel processing the data.

Of course, the formulation of the possible answers for a multiple-choice questionnaire can often be a source of tension: on the one hand, these responses need to be clearly worded and comprehensible, so that respondents can easily categorize their information. On the other hand, it must be possible to accurately record the relevant facts using the answers provided. These can sometimes be conflicting requirements.

Working from home is recorded in the German microcensus and the SOEP using various multiple-choice questions. In the microcensus, respondents are asked: "Have you carried out your work from home in the last three months?," while the question in the SOEP is worded as follows: "Do you ever carry out your work activity at home?" (see table). Apart from the fact that a time reference is included in the microcensus survey ("last three months"), the two questions are virtually identical. In both cases, the aim is to record respondents' most recent habits.

However, there are considerable differences between the two surveys as far as the possible answers are concerned. There are only two options provided in the microcensus: respondents are asked whether they work from home on the majority of their working days or on less than half of them. Conversely, there are four possible answers to choose from in the SOEP: respondents are expected to distinguish between working from home every day, several times a week, once every two to four weeks, or more rarely, only when needed. In both surveys, the focus is on the

Table

#### Comparison of Mikrozensus and German Socio-Economic Panel: Work from home in the questionnaires

In percentage of all employees

Question	Mikrozensus 2014	German Socio-Economic Panel 2014		
	Do you work from home in the last three months?	Do you ever carry out your work activity at home?		
Answers	In the majority of working days	1.5	Daily	3.9
			Several days a week	4.6
	In less than the majority of working days	5.9	Once every 2 to 4 weeks	2.8
			Rarely, only when needed	6.6

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### Germany lagging behind other European countries

According to data from the official microcensus, in recent years, there has been a decrease in the number of individuals in gainful employment working primarily or occasionally from home as a share of the total working population. Here, it is important to make a distinction between the self-employed and employees. There has been a continuous sharp decline in the share of self-employed working from home since 2008 (see Figure 1). Among

employees, this share fell between 2008 and 2011, and then stagnated. However, a different trend was seen in the EU as a whole:<sup>6</sup> the percentage of self-employed individuals who telecommute rose up until 2013—but has stagnated since. As far as employees are concerned, the

<sup>6</sup> The microcensus is part of the European Union Labour Force Survey (EU-LFS). This entails the statistical offices of the participating states collecting a specified set of information using household surveys with identical questions. Consequently, the information obtained is comparable internationally.

frequency of working from home—but not on how many of the total hours worked were from home.

In both the SOEP and the microcensus, the possible answers relating to questions about working from home lack precision. If—as in the SOEP survey—someone works from home “once every two to four weeks,” in most cases, this is still likely to mean working from home more or less regularly. If, however, someone works from home even “more rarely” and “only when needed,” this does not count as working from home in the strictest sense but rather it is work occasionally carried out from home because, for example, it happened that household members had to be cared for temporarily. Accordingly, all individuals who gave this response in the present study were not counted as telecommuters.

In the case of the microcensus, it is possible that individuals who occasionally work from home due to the exceptional circumstances of having to care for household members (or because of being ill themselves) are also counted as homeworkers. Here, it is not possible to distinguish them from actual homeworkers, however.

The analytical part of the present study focuses on employees only. It excludes groups who do not have the option of working from home due to their occupational status: trainees, individuals on job creation schemes (in particular: one-euro jobs), individuals taking a gap year to do voluntary work in the social or environmental sector, or disabled people working in specially designed workshops. Because these individuals are excluded, the share of employees working from home is slightly higher—also in comparison to the microcensus data used here, which were taken from the Eurostat database and includes the above-mentioned groups of employees so they cannot be excluded from the study.

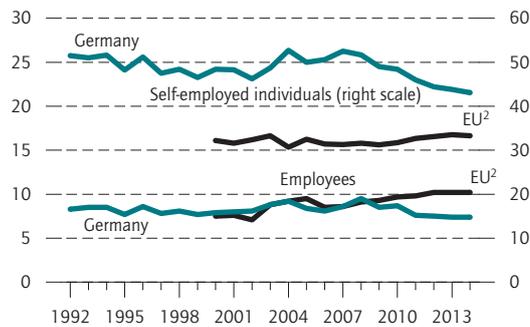
stagnation began one year earlier, following an increase prior to this.

Despite the downward trend in recent years, the percentage of self-employed individuals who work from home in Germany is still higher than the European average. Conversely, this phenomenon has become a relatively rare occurrence among German employees. Particularly in Scandinavian and Western European countries, a much higher proportion of employees work from home primarily or occasionally (see Figure 2). The share

Figure 1

### Employees and self-employed individuals working from home<sup>1</sup>

Share of all employees and self-employed individuals, in percent



<sup>1</sup> Usually or sometimes.

<sup>2</sup> Excluding Croatia.

Source: Eurostat (Labour Force Survey); calculations by DIW Berlin.

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In the EU, the share of workers from home rose temporarily and in Germany the share decreased.

of telecommuters in countries with weaker economies (in Southern and Eastern Europe) is even lower than in Germany.

### Two out of five employees could work from home ...

The SOEP data allows us to determine for the first time how many employees could realistically work from home—according to their own assessment—given the requirements of their job. Due to the specific tasks to be performed, many jobs cannot be carried out from home. For instance, a roofer needs to be on site and a sales assistant has to stand behind the shop counter.

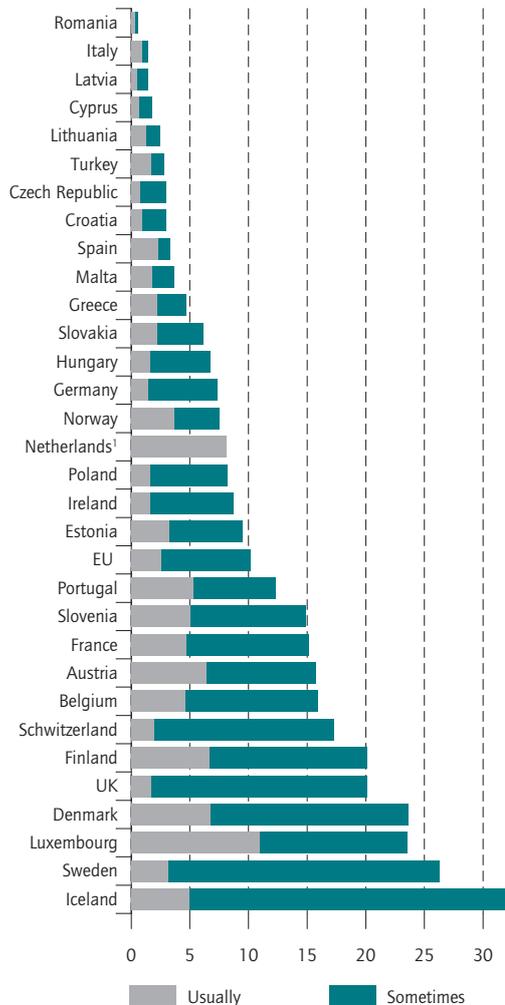
The information in Table 1 is based on data provided by respondents, so this might not necessarily correspond with the actual facts in all cases. Nevertheless, it can be assumed that, as a rule, employees are certainly able to assess whether or not and to what extent their professional activities can be performed from home. For the sake of simplicity, the present study will make no additional distinction according to the extent of work done from home. Furthermore, the self-employed are excluded from the analysis.

In 2014, just under 60 percent of all employees stated that working from home would be inconceivable in their occupation, while around 40 percent felt it would be fea-

Figure 2

**Employees working from home, 2014**

Share of all employees, in percent



<sup>1</sup> No information available on the share of employees who "sometimes" work from home.

Source: Eurostat (Labour Force Survey).

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Germany's proportion of home workers is below the European average.

sible. In general, the higher the qualifications a position requires, the more likely that job could also be performed from home. For professions requiring a college degree, it would be possible to work from home in three-quarters of all cases. For jobs demanding an apprenticeship certificate or technical college qualification, working from home would still be an option for one-third, but only for one-sixth of unskilled occupations where no vocational training is needed.

The options for working from home also vary considerably from one economic sector to another. There tend to be more opportunities to work from home in occupations in the service sector—in particular, financial services (banks, insurance companies, etc.), business services or in public administration—and far fewer opportunities in trade, in the transportation industry, and in the provision of consumer services (including the hospitality industry and healthcare). In the construction industry and agriculture, too, due to the type of activities in these sectors, there are relatively few jobs where employees can work from home.

All this is evidenced by the occupational status of employees: working from home is an option mainly for well-qualified and highly skilled salaried employees, for managers, and for senior civil servants—but not so much for those with jobs lower down the hierarchy (see Table 2). Nevertheless, among skilled workers, salaried employees with an average level of education, and qualified employees performing relatively simple tasks, there were also a number of people who indicated that they could carry out at least some of their work from home. Many employees with a low-level job also share this opinion.

Moreover, it was shown that a larger proportion of the staff in medium-sized and, in particular, in large companies could make use of the opportunity to work from home than in smaller ones. This may be partly related to the relevant branch of industry—but a more important factor may be that there are often a relatively large number of service functions to be performed in larger companies (for instance, office and administrative tasks) and some of the work involved could also be carried out from home. However, virtually no differences were observed between western and eastern Germany with regard to the possibilities of working from home.

### ... but in fact only one in eight employees works from home

The number of people who actually work from home is much lower than the number of jobs where this would theoretically be possible: according to responses recorded by the SOEP, only just under one in eight employees sometimes works at home, and only one in 25 does so on a daily basis.

As is to be expected, a relatively high proportion of telecommuters are to be found precisely in sectors where it is also frequently possible to work outside the company premises—in some service sectors and in large corporations. As far as the branch of industry is concerned, there is no clear trend, however. In some sectors, it would be possible to work from home very frequently but this is in fact not the case. A particularly strong discrepan-

Table 1

**Home workers and non-home workers<sup>1</sup> and workplace factors**

In percentage of employees in the respective group

	Nature of activity does not allow working from home	Nature of activity allows working from home, and the employee ...		
		... has already worked from home	... has not yet worked from home	
			Total	... would like to work from home
<b>Industrial sector</b>				
Agriculture, forestry	71	14	15	*
Manufacturing (excluding construction)	58	9	33	65
Construction	72	4	24	59
Trade	76	3	20	61
Communications	65	8	27	74
Financial services	29	11	60	73
Business services, real estate	31	21	48	77
Public administration	40	8	51	65
Consumer services, other services	62	17	21	60
<b>Company size</b>				
Fewer than 4 employees	62	14	24	50
5 to 9 employees	71	6	23	68
10 to 19 employees	64	8	28	71
20 to 99 employees	62	13	25	65
100 to 199 employees	60	10	30	66
200 to 1,999 employees	54	9	37	68
Over 2,000 employees	49	17	33	67
<b>Job qualification requirements</b>				
No professional training needed	82	3	15	57
Apprenticeship, technical college	64	6	30	66
College, higher education	23	32	45	69
<b>Location of offices</b>				
West Germany	57	13	30	66
East Germany	61	9	30	69
<b>Total Employees</b>	<b>58</b>	<b>12</b>	<b>30</b>	<b>66</b>

<sup>1</sup> Excluding trainees, individuals in special labor-market-assigned jobs, individuals in sheltered workshops, volunteers for social or ecological causes, and not active persons in partial retirement measures.

Source: Socio-Economic Panel (v31); calculations by DIW Berlin.

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In 58 percent of all jobs, working from home is not possible; it is possible in 42 percent of jobs, but only 12 percent of all employees actually work from home.

cy is evident here in financial services and in public administration.

Among employees whose occupation requires a college degree, one-third work from home, which is a particularly high share. Here, those in the upper echelons of the civil service stand out in particular. Teachers play a prominent role here since they normally carry out their class preparations and grading at their desk at home. However, there is an extremely low proportion of homeworkers among employees whose job requires an apprentice-

ship certificate or technical college qualification. Virtually none of the employees with no qualifications perform their work from home.

### Many more employees would work from home if their employers allowed them to

If it is possible to work from home in a good 40 percent of all jobs, but only 12 percent of all employees practice their profession from home (primarily or occasionally), this raises the question as to why this is the case. Only

Table 2

**Home workers and non-home workers<sup>1</sup> by selected social characteristics**

In percentage of employees in the respective group

	Nature of activity does not allow working from home	Nature of activity allows working from home, and the employee ...		
		... has already worked from home	... has not yet worked from home	
			Total	... would like to work from home
<b>Professional status</b>				
Unskilled, semi-skilled worker	86	2	12	58
Salaried employee engaged in unskilled activities	72	3	25	60
Skilled worker, master craftsperson	81	1	17	53
Civil servant, lower level	52	13	35	73
Salaried employee engaged in skilled activities	52	8	40	69
Civil servant, middle level	28	38	35	71
Civil servant, upper level	12	71	17	62
Salaried employee engaged in highly skilled activities	24	28	48	70
Salaried employee with extensive managerial duties	32	40	28	57
<b>Working time</b>				
Full-time	53	14	34	68
Parttime	62	10	29	61
Minor employment	78	7	15	59
<b>Sex</b>				
Male	58	13	29	66
Female	58	11	31	66
<b>Household type</b>				
Single	57	13	31	66
Single parent	56	13	30	67
Couple with children	69	8	22	66
Couples without children	61	14	25	63
Other households	68	4	28	66
<b>Children at home</b>				
No	58	11	30	66
Yes	56	14	30	68
<b>Likelihood of finding a new job in the event of job loss</b>				
Easy to find a new job	57	13	30	68
Difficult or impossible to find a new job	58	11	31	65
<b>Total employees</b>	<b>58</b>	<b>12</b>	<b>30</b>	<b>66</b>

<sup>1</sup> Excluding trainees, individuals in special labor-market-assigned jobs, individuals in sheltered workshops, volunteers for social or ecological causes, and not active persons in partial retirement measures.

Source: Socio-Economic Panel (v31); calculations by DIW Berlin.

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It is not only employees in households with children who work at home or wish to work at home: many others do as well.

to a lesser extent is the decision made by the employees themselves: of those whose job would permit them to work from home but who have not done so to date, only one-third would turn down an offer from their employer to telecommute. The vast majority—in other words, around one in five employees in Germany—would take up the

opportunity to work from home if this were authorized by the company or public authority they work for. Here, no major differences can be seen based on the individual branches of industry, company size, the qualifications needed for the job, or between western and eastern Germany. Where working from home would be possible as

Table 3

**Home workers and non-home workers<sup>1</sup> and working hours**

In percentage of employees in the respective group

	Nature of activity does not allow working from home	Nature of activity allows working from home, and the employee ...		
		... has already worked from home	... has not yet worked from home	
			Total	... would like to work from home
<b>Working hours</b>				
Full-time	53	14	34	68
Part-time	62	10	29	61
Minor employment	78	7	15	59
<b>Extent of flexibility in working hours</b>				
Fixed beginning and end of work hours	73	5	22	66
Working hours fixed by employer, which may vary from day to day	74	10	16	62
Flexitime within a working hours account	30	12	58	67
No formally fixed working hours	33	37	30	68
<b>Overtime</b>				
No overtime	69	9	21	56
Overtime with time or wage compensation	54	8	38	67
Overtime not or only partially compensated	51	21	28	73
<b>Total employees</b>	<b>58</b>	<b>12</b>	<b>30</b>	<b>66</b>

<sup>1</sup> Excluding trainees, individuals in special labor-market-assigned jobs, individuals in sheltered workshops, volunteers for social or ecological causes, and not active persons in partial retirement measures.

Source: Socio-Economic Panel (v31); calculations by DIW Berlin.

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Working from home is most common among those with full-time jobs or with working hours that are not strictly regulated.

far as the type of professional requirements are concerned and if this option were available to them, employees would also make use of this opportunity in the majority of cases.

There are still some anomalies, however. In microenterprises, a relatively high proportion of employees would forgo working from home—a special affinity with the company or a friendly working environment may play a role here, or perhaps even a particular degree of social expectation and control. In financial services, where the disparity between opportunities to work from home and the actual take-up of telecommuting is particularly great, an above-average share of employees would like to be able to work from home. The same applies to corporate services.

### Telecommuters work long hours—and overtime is often not remunerated

Employees who are already telecommuting work relatively long hours. In 2014, they clocked up 40.6 hours a week on average (compared to 36.2 hours a week for

employees overall). This can be partly explained by the fact that a relatively high number of people working from home (over three-quarters) have a full-time job—whereas this only applies to two-thirds of all employees (see Table 3). While one in seven full-time employees works from home, the corresponding figure for part-time employees is only one in ten; among those in marginal employment, working from home is even less widespread. Due to the nature of the tasks to be carried out by those working reduced hours, it is also more frequently unfeasible for them to work from home than for full-time employees.

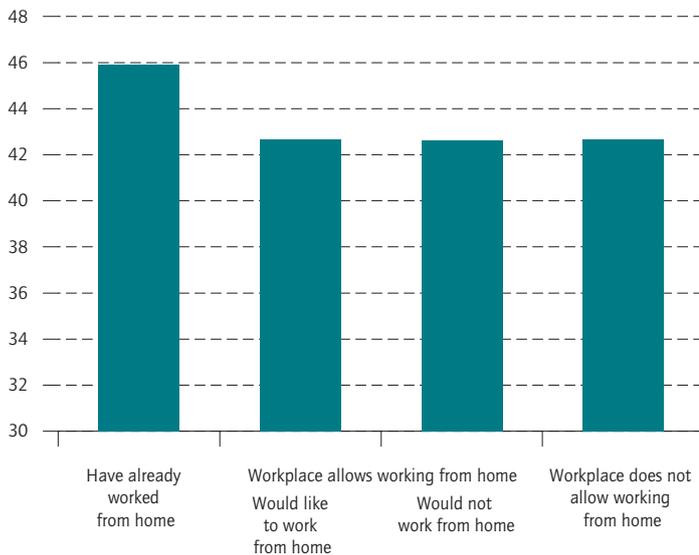
Another factor is that telecommuters work relatively long hours in general, irrespective of the number agreed. For instance, those in full-time employment clock up just under 46 hours a week on average—a good three hours more than the norm for a full-time job (see Figure 3).

Regardless of whether they are working full-time or reduced hours, the share of telecommuters who do any overtime at all is not much higher (77 percent) than for

Figure 3

**Average weekly working hours of full-time employees,<sup>1</sup> 2014**

In hours



<sup>1</sup> Excluding trainees, individuals in special labor-market-assigned jobs, individuals in sheltered workshops, volunteers for social or ecological causes, and semi-retired individuals without paid working hours.

Source: Socio-Economic Panel (v31); calculations by DIW Berlin.

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Full-time home workers work much more hours per week than the average.

other employees (71 percent). If they do work overtime, telecommuters log a lot of hours, however—and most of these are only partially recompensed through time off in lieu or extra pay—or sometimes not at all (see Figure 4).

Full-time employees who do not yet work from home but who would be able to in principle, given the nature of their work, and would also be happy to do so, do not clock up more hours a week than the average for all employees. It is striking, however, that a disproportionately high number of employees work overtime in this group. In most cases, however—unlike with telecommuters—their additional work is compensated by time off in lieu or extra pay, and the amount of overtime is generally quite low. These employees who are also eligible to work from home are therefore relatively flexible in that they are prepared to work overtime—so far, they have not been used to doing unpaid overtime, however.

As is to be expected, telecommuting is mainly observed when company hours are virtually unregulated. Accord-

ingly, it seldom occurs when work is rigorously scheduled—and strictly regulated working hours also often reflect the fact that employees' constant presence in the company is essential, or at least considered to be. It would theoretically be possible for more people to work from home, particularly in jobs where working hours are regulated by a flexitime system—here, more than half of employees believe that at least some of their work could be done from home, and the vast majority would also take up this opportunity. Although there are already a relatively high number of telecommuters in jobs where the start and finish of the working day are not regulated at all, working from home would also be a viable option for considerably more employees.

### Working from home not linked to household composition

The family environment does not play a decisive role in determining whether someone already works from home or would like to. For instance, there are just as many telecommuters among people living alone as among single parents. And working from home is even a somewhat rarer occurrence for families with children than for couples with no children in their household. Moreover, if employees have not worked from home to date, but the nature of their job would allow it, no differences are evident in terms of their desire to telecommute: two-thirds would accept an offer to work from home—irrespective of their household composition. There are no significant gender differences here, either.

### Lower job satisfaction among employees wanting to work from home but unable to do so

The majority of employees in Germany are satisfied with their job. There are very few differences in the levels of satisfaction measured according to the usual systems when employees are compared using relevant socio-economic characteristics; even the level of pay has virtually no impact on job satisfaction.<sup>7</sup> A different picture emerges when we look at working from home: employees who work from home are on average not substantially but still somewhat more satisfied than those who do not (see Figure 5). The difference between these employees and those whose job requirements would allow them to work from home and who would also like to do so but are unable to because their employer does not provide them with this option is statistically significant.<sup>8</sup> This group is also

<sup>7</sup> Brenke, K. (2015): The Vast Majority Of Employees in Germany Are Satisfied with Their Jobs. DIW Economic Bulletin, no. 32-33/2015.

<sup>8</sup> Since the measured values of job satisfaction are not normally distributed, only non-parametric tests can be used. The Mann-Whitney test was utilized here.

significantly<sup>9</sup> less satisfied with their job than those who have no desire to work from home whatsoever.

Moreover, telecommuters are not only particularly satisfied with their job but also with their life in general and with their income. Whether or not and to what extent these aspects are linked is beyond the scope of the present paper. The high level of satisfaction with income can probably also be partly explained by the fact that most employees who work from home have demanding and well-paid jobs. This is also likely to have an impact on life satisfaction.

Furthermore, it should be noted that there are no differences between employees who would also like to do their job from home but are unable to do so and those who have no desire to telecommute in terms of general life satisfaction or satisfaction with their personal income, only in terms of job satisfaction. This suggests that the unfulfilled desire to work from home has a dampening effect on job satisfaction.

**Conclusion**

With regard to opportunities for employees to carry out at least some of their work from home, Germany has been overtaken by other European countries. In terms of the share of telecommuters among all employees, Germany is now below the EU average and lagging considerably behind other economically strong countries. Around 40 percent of all jobs do not require constant presence in the company premises, but the opportunity to work from home is taken up in fewer than one-third of these. This is only to a lesser extent because employees do not want to work from home but in the vast majority of cases it is because employers do not provide the option of working from home. If employers were to reconsider their position, the number of telecommuters could be more than doubled.

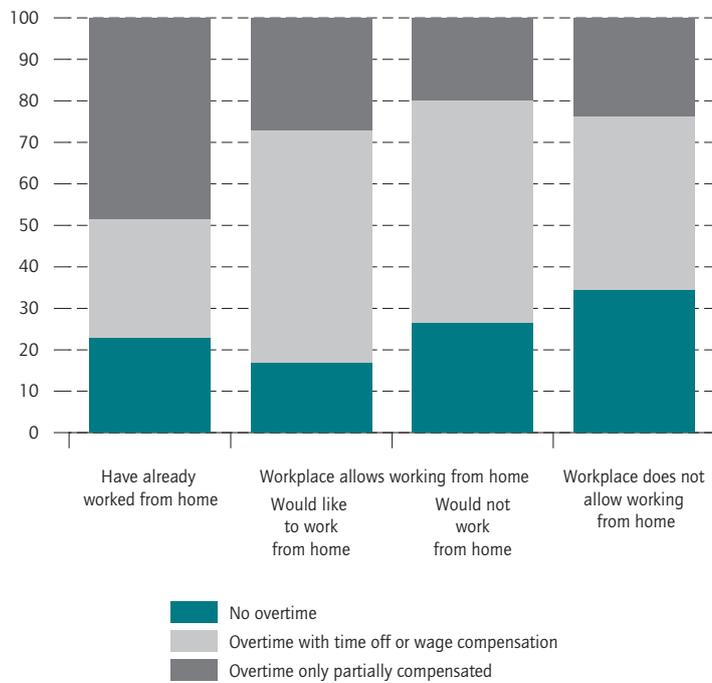
Many employers have apparently still not realized that employees who are also able to work from home tend to show higher levels of job satisfaction and dissatisfied staff tend to change jobs relatively frequently.<sup>10</sup> The study also shows that working from home is primarily the domain of qualified and—at least with a view to working hours—rather flexible employees. The motives for working from home are not—or not only—to better reconcile work and family life. There must therefore be another reason for this which can only be a desire for more autonomy in organizing the working day.

<sup>9</sup> See Footnote 8.

<sup>10</sup> See Brenke, The vast majority of employees.

Figure 4

**Home workers and non-home workers' and overtime work, 2014**  
In percent



<sup>1</sup> Excluding trainees, individuals in special labor-market-assigned jobs, individuals in sheltered workshops, volunteers for social or ecological causes, and semi-retired individuals without paid working hours.

Source: Socio-Economic Panel (v31); calculations by DIW Berlin.

More home workers work unpaid overtime than do non-home workers.

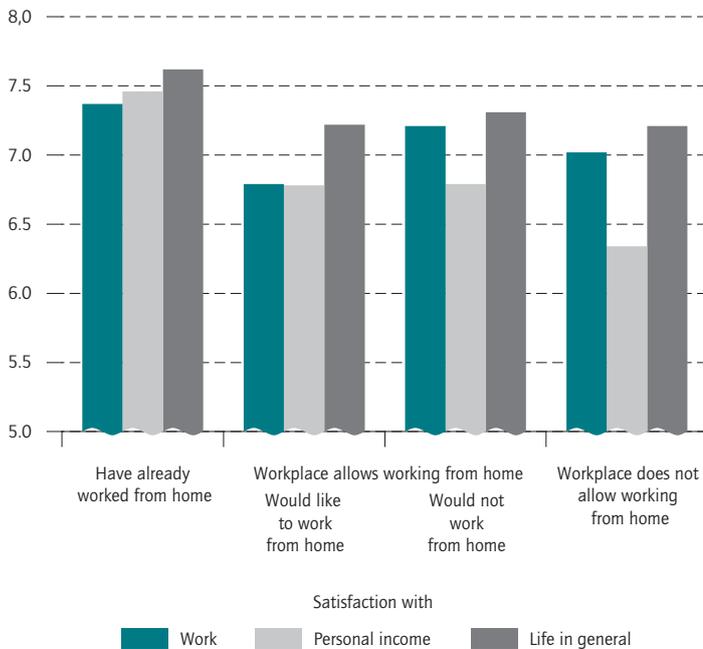
It may still be entrenched in the mindset of some HR managers that the performance of employees can only be monitored if they are actually present. Performance is not always synonymous with presence, however. When working from home, it is down to employees to prove themselves by producing results. It may be more difficult to monitor productivity then but it is certainly more effective than simply having employees clocking on and off.

As complex job activities are set to gain ground and consequently the structure of employees will continue to shift toward those who are highly qualified, even more employees might also want to be able to work from home—particularly since modern communication technology of ten already makes this option possible. With a potential workforce that will probably shrink in the future, employers who do not take enough account of their employees' wishes and rigidly insist on their presence at work will

Figure 5

### Home workers and non-home workers' and job satisfaction, income satisfaction, and life satisfaction, 2014

Mean (from 0 = "very unsatisfied" to 10 = "very satisfied")



<sup>1</sup> Excluding trainees, individuals in special labor-market-assigned jobs, individuals in sheltered workshops, volunteers for social or ecological causes, and semi-retired individuals without paid working hours.

Source: Socio-Economic Panel (v31); calculations by DIW Berlin.

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On average, home workers are more satisfied than are other employees.

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JEL: J81, J28, J83

Keywords: Home office work, job satisfaction

be left behind. Some of these employers could then really have cause to complain about a shortage of skilled workers. Here, the onus is on market forces to bring unreasonable employers to their senses and compel them to keep up to speed with modern human resource management. If this is effective, there would be no need for any special legislation to be introduced. One exception is the civil service, where there is a major disparity between what employees want and the reality in terms of working from home—and market forces are powerless to change this situation.

Working from home also brings risks for employees, however. Those who already do their job from home put in relatively long hours, and their overtime is frequently not remunerated. Company agreements and perhaps even collective agreements might be helpful to counter such developments. There are also certain demands placed on the employees themselves: they have to be disciplined with time management and ensure that their job is kept strictly separate from housework or leisure time.



Karl Brenke, Researcher in the Department of Forecasting and Economic Policy of DIW Berlin

## SIX QUESTIONS TO KARL BRENKE

# »Working from home: Germany lagging behind other European countries«

1. Mr. Brenke, you've been conducting research on working from home in Germany. DIW Berlin produced a similar study two years ago. What distinguishes the recent study from the previous one? The main difference is that we now have data on how many people would actually be able to work from home, given their employment conditions. We didn't have this information last time. Of course, someone who sits behind a cash register in a store or has to carry out their job on a construction site can't work from home, but now we can distinguish whether an individual's employment conditions allow them to work from home and whether the person in question would actually want to do so.
2. Who can work from home then? According to what respondents themselves reported, it would be possible for approximately 40 percent of all employees to perform all or at least part of their job from home. Of course, the study showed that working from home is more of an option for those in certain branches, primarily in the service industry, banks, insurance companies, and in public administration. Highly qualified salaried employees are more likely to be able to work from home but it is much less likely for unskilled or even skilled workers.
3. Would more people work from home if their employers allowed them to? Yes, they would. Of those who have not worked from home so far but whose job would permit them to, two-thirds would work from home if their boss gave them this option. This equates to one in five employees in Germany. Only one-third prefer to work in the company premises. Often the only problem is that it doesn't occur to employers to give their staff the chance to work from home. This gap between the desire and opportunity to work from home is particularly wide in banks and insurance companies, as well as in public administration. Here, apparently, human resource policy is still stuck in the Stone Age.
4. How high is the share of people who work from home in Germany compared to other European countries? If we take a figure that can be compared with other countries in Europe, only around eight percent mainly or occasionally work from home. This is a low proportion compared to other European countries. This is also partly because, in Germany, the number of employees working from home has declined over the past few years. In the last two years, this decrease has ground to a halt while in Europe as a whole, the number of people working from home has actually increased. Germany has been left behind here.
5. What are the advantages or disadvantages for employers whose staff work from home? In fact, there are no disadvantages for employers. We see that employees already working from home put in longer hours than average and sometimes even take on extra work without being paid or taking time off in lieu. People working from home have to prove they have accomplished something. The same will often also apply to someone who works in the company premises but in many cases, just being present is what counts most. So employers have to reconsider their position and use other criteria to assess performance, not just presence, which may be difficult for some. Perhaps another factor is that some bosses think it reinforces their legitimacy if they're surrounded by their employees.
6. Is working from home compatible with regulated company hours? An employer cannot monitor the hours an employee works at home. As a result, the employer and employees are expected to be able to produce a particular product or prove a certain level of performance. Of course, this has to be predefined by the employer. It's possible to work out what needs to be done in a particular time frame, for instance, writing a report or making some specific calculations. It's all feasible.

Interview by Erich Wittenberg

# Support for Private Research and Development in OECD Countries on the Rise but Increasingly Inefficient

By Heike Belitz

The majority of OECD member states promote companies' research and development (R&D) activities by providing project funding. Recently, in many countries, tax incentives have also begun to play an increasingly important role. The present study examines the level of R&D support in 18 OECD countries and explores how efficient the system of funding actually is. The main findings show that in the majority of the countries studied, the share of research and development expenditures funded by the government is on the increase. The system has become less efficient, however. Increasingly frequently, one euro of public funding fails to result in a corresponding increase in private R&D spending. In countries with high funding rates and substantial tax incentives (such as France and the UK), companies' spending relative to economic output has not increased any faster than in countries with considerably lower funding rates and no tax incentives at all (such as Germany).

In developed economies, research and development (R&D) is one of the key determinants of productivity performance, international competitiveness, and economic growth. For the most part, R&D is conducted by private companies—in Germany, as in many other countries, the private sector accounts for around two-thirds of total R&D investment. The government supports these companies' R&D activities by, for example, providing a research infrastructure comprising public education and research institutions as well as institutions for knowledge transfer, and by passing legislation to protect intellectual property rights. However, it also provides financial assistance for private R&D activities: on the one hand, directly, through grants and subsidies for selected R&D projects and through R&D contracts and, on the other hand, indirectly through tax breaks for R&D investment which is a mechanism that many countries have expanded considerably in recent years. The primary objective of incentives in this context is to reduce barriers to investment: for example, various forms of market failure can result in a situation where R&D development has a positive impact on innovation and growth from a macroeconomic perspective but where the companies actually conducting the research and development profit less.

Although, for purposes of international comparison, the OECD has already been providing national data on the level of direct R&D support, i.e., funding provided to subsidize R&D project costs and R&D contracts<sup>1</sup> for each OECD country for some time now, it has only just started to collate additional data on the level of tax incentives relative to GDP, most recently for 2013.<sup>2</sup> The resulting loss of tax revenue across all OECD countries is estimated at approx-

<sup>1</sup> OECD Frascati Manual. See [www.oecd.org/sti/inno/frascaticmanualproposedstandardpracticeforsurveysonresearchandexperimentaldevelopment6thedition.htm](http://www.oecd.org/sti/inno/frascaticmanualproposedstandardpracticeforsurveysonresearchandexperimentaldevelopment6thedition.htm).

<sup>2</sup> OECD (2015): Science, Technology and Industry Scoreboard 2015. Paris. Even the OECD itself has described these data as still "experimental." One of the difficulties is that countries may estimate and present past tax revenue in different ways. See OECD (2011): Science, Technology and Industry Scoreboard 2011. Paris.

Table

**Corporate R&D and its funding in selected OECD countries**

	End year	Starting year	Share of funding in R&D	Share of tax incentives in total funding	Private R&D intensity (without funding)	Annual growth rate of R&D without funding (constant PPP)	Difference in funding rate of R&D	Difference in private R&D intensity	Change in the proportion of tax incentives					
										End year			Period of time in total	End year compared to starting year
										In percent			In percentage points	
Canada	2013	2006	26.1	84	0.63	-3.5	6.5	-0.26	-3					
France	2013	2004	26.1	69	1.07	0.3	12.4	-0.06	52					
Belgium	2012	2007	25.0	52	1.26	3.8	8.4	0.19	-14					
Austria	2013	2006	18.4	32	1.71	3.5	4.6	0.27	2					
Czech Republic	2013	2006	17.3	33	0.85	6.2	-3.1	0.27	13					
UK	2013	2006	16.6	46	0.89	0.6	4.1	-0.00	7					
Spain	2012	2006	15.6	19	0.57	1.0	-3.4	0.05	-5					
Netherlands	2013	2007	15.6	87	0.92	1.9	4.7	0.12	8					
USA	2012	2006	13.9	27	1.61	1.3	1.3	0.05	5					
South Korea	2013	2007	12.9	57	2.84	8.9	0.6	0.83	7					
Australia	2011	2006	12.4	85	1.08	2.8	4.5	0.01	33					
Denmark	2013	2007	6.5	46	1.83	1.0	1.2	0.17	-7					
Italy	2013	2006	6.5	1	0.67	3.4	-1.6	0.18	1					
Sweden	2013	2005	6.1	0	2.14	0.2	1.6	-0.21	0					
Japan	2013	2006	6.0	82	2.49	0.4	0.4	0.00	0					
Germany	2013	2006	3.4	0	1.84	2.6	-1.2	0.19	0					
Finland	2013	2006	3.2	14	2.20	-0.6	-0.5	-0.09	14					
Schweiz/land	2012	2004	0.8	0	2.04	2.7	-0.7	0.09	0					

Sources: OECD; calculations and estimates by DIW Berlin.

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### Germany's funding rate is one of the lowest in the OECD.

imately 50 billion US dollars for 2016<sup>3</sup>—around 6.5 percent of total business enterprise expenditure on R&D. Approximately the same sum was spent on direct support for R&D in 2013. Whereas the share of companies' R&D spending accounted for by direct support has remained approximately constant for the last ten years, in many countries, indirect support through tax policy has either been considerably expanded or, in some cases, only just introduced. Of the 34 OECD countries, 28 now have relevant legislation on this (see Box 1). Germany and Switzerland are among the few countries which do not provide tax incentives to promote research and development.

### In an international comparison, countries with high funding rates ...

Among the OECD countries where data for both direct and indirect R&D support are available, France, Canada,

and Belgium have the highest funding rates: in each case, the government funds around one-quarter of companies' R&D costs (see Table). In France, tax incentives account for a good two-thirds of all R&D funding, in Canada, the equivalent figure is as high as almost 84 percent, and in Belgium, it is still over half. In these three countries, the overall funding rate has increased dramatically in the last few years and the same applies to Austria, the Netherlands, Australia, and the UK. With the exception of Belgium and Canada where tax incentive levels were already very high, this form of support has been expanded particularly in countries where the overall funding rate increased most sharply. Along with Sweden, Switzerland, Finland, and Italy, Germany is one of the few countries which, up until 2013, either did not use tax incentives at all to promote R&D or only made marginal use of this mechanism. In these countries, the overall government funding rate is under seven percent and, with the exception of Sweden, this figure has even declined slightly in recent years.

<sup>3</sup> OECD (2015): The generosity of R&D tax incentives. [www.oecd.org/sti/rd-tax-incentive-indicators.htm](http://www.oecd.org/sti/rd-tax-incentive-indicators.htm).

## Box 1

**Tax incentives for R&D in different European countries**

Tax incentives for research and development (R&D) are provided through income tax for natural persons and/or corporation tax.<sup>1</sup> They primarily consist of tax allowances that reduce the tax base, or tax credits that directly decrease the amount of tax payable. The tax credit may be offset against corporate taxes, or R&D personnel costs (income tax or social security payments). The subsidy is either based on volume, thus on the relevant R&D expenditure, or incremental, that is, related only to the growth of R&D expenditure compared to the previous period.

Tax incentives are not always granted to all companies but, for instance, restricted to companies of a particular size, specific age groups, regions, or fields of technology. The tax credit can be designed so that it would also be reimbursed in the event of companies operating at a loss ("negative tax"), in which case these companies would receive payments from the tax authorities.<sup>2</sup>

The attractiveness of R&D tax incentives for companies is heavily dependent on the specific tax system of that particular country, tax rates, and tax bases. Finally, how attractive the tax breaks are depends on how difficult it is to make use of them from an administrative perspective.

**France**

France switched from incremental to completely volume-based tax incentives in 2008. As part of the *Crédit d'Impôt Recherche* (CIR) program, the government reimburses 30 percent of R&D

expenditure by means of an input tax deduction up to a total of 100 million euros and five percent of expenditure exceeding that amount.<sup>3</sup> In 2008, total government spending on R&D more than doubled compared to the previous year, increasing to 4.45 billion euros. Since 2010, annual expenditure has been over 5.2 billion euros and recently reached 5.5 billion euros. Young companies also receive support through a further tax measure called *Le régime de la jeune entreprise innovante* (J.E.I.).<sup>4</sup>

**Netherlands**

Since 1994, companies in the Netherlands have been able to reduce their R&D costs through the tax measure known as *Wet Bevordering Speur- en Ontwikkelingswerk* (WBSO). At present, 35 percent of the R&D personnel costs up to a total of 250,000 euros and 14 percent of any personnel costs over this amount are reimbursed. Another program, RDA, was introduced in 2012 to foster additional investment in R&D equipment. The Dutch government spent just over a billion euros on the two measures combined in 2013.

**UK**

Tax incentives for R&D have been gradually expanded in the UK since 2000, first for small and medium-sized enterprises (SMEs) and then, in 2002, for large companies, too. At present, the increased deductions amount to 230 percent for SMEs and 130 per-

<sup>1</sup> See also Belitz, H., "Steuerliche Förderung von Forschung und Entwicklung – Erfahrungen aus dem Ausland," *DIW Roundup. Politik im Fokus*, no. 85 (Berlin: November 23, 2015).

<sup>2</sup> OECD, "Tax Incentives for R&D and Innovation," *STI Outlook* (Paris: 2014): 161-173.

<sup>3</sup> OECD, *Compendium of R&D Tax Incentives Schemes: OECD Countries and Selected Economies* (December 17, 2015), <http://www.oecd.org/sti/rd-taxstats.htm>.

<sup>4</sup> OECD, *Compendium*.

**... do not necessarily have high private R&D intensity**

The primary aim of government support for research and development is to increase business investment in this area—both in absolute terms and relative to GDP (private R&D intensity<sup>4</sup>). In 2013, private R&D intensity was even comparatively high in countries with relatively

low funding rates—these included Switzerland, Finland, Germany, and Sweden (see Figure 1). Yet, in countries such as France, Canada, and Belgium which already had a high funding rate and at the same time attached particular significance to tax incentives, private R&D intensity was considerably lower. In the group of countries with moderate levels of R&D funding, South Korea stands out as having the highest private R&D intensity overall. In this group, the US and Austria also have relatively high R&D intensity but it is very low in countries such as the UK, the Netherlands, and Spain. When these countries are compared internationally, therefore, there is no dis-

<sup>4</sup> Measured here as business enterprise expenditure on R&D minus government funding relative to GDP.

cent for large companies. In other words, the company's tax base is reduced by 230 pounds for 100 pounds sterling of allowable R&D expenditure for SMEs and by 130 pounds for large companies. In addition, the definition of SMEs has been changed so as to also include companies with up to 499 employees in this category.<sup>5</sup> Since 2013, large companies have been able to opt for an alternative tax reduction mechanism through which a new "above the line" R&D tax credit is granted, which is based directly on admissible R&D expenditure. This has improved the situation for companies operating at a loss. The tax credit amounts to ten percent of allowable R&D expenditure and is itself subject to taxation. The new system will become mandatory for large companies as of April 2016. Tax credits amounting to 1.37 billion pounds sterling were claimed in the 2012/2013 financial year.

Austria

The "research premium" was introduced in Austria in 2002 and initially amounted to only three percent of total research expenditure in a given financial year. It was gradually increased and has been 12 percent for large companies and SMEs since the beginning of 2016. The research premium is credited by the tax office and also benefits companies that have not reported any profits. It can also be claimed by companies commissioning external research worth a maximum of one million euros. The total amount paid out in research premiums in 2013 was 377 million euros (following just over 570 million in the previous year).

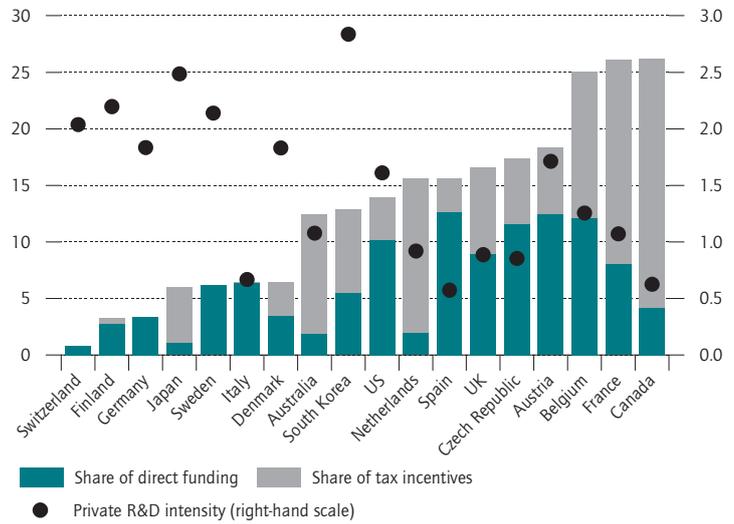
<sup>5</sup> Gucer, I. (2015): Tax incentives and R&D: an evaluation of the 2002 UK reform using micro data. Working paper series (WP)15/11. Oxford University Centre for Business Taxation, August 2015.

cernible robust correlation between funding rate and private R&D intensity. Even increases in funding rates between 2006 and 2013 were not always accompanied by an increase in R&D intensity (see Figure 2).<sup>5</sup> Relatively large increases in funding rates in France, Belgium, and Canada coincided with levels of self-financed business R&D spending which, relative to GDP, had either stagnated or were even declining. Finally, the average annu-

<sup>5</sup> The observation period differs slightly among the selected countries since data are not available for every year.

Figure 1

Funding rates and private R&D intensities of selected countries in 2013<sup>1</sup>  
In percent



<sup>1</sup> The relevant end year from the Table is shown.

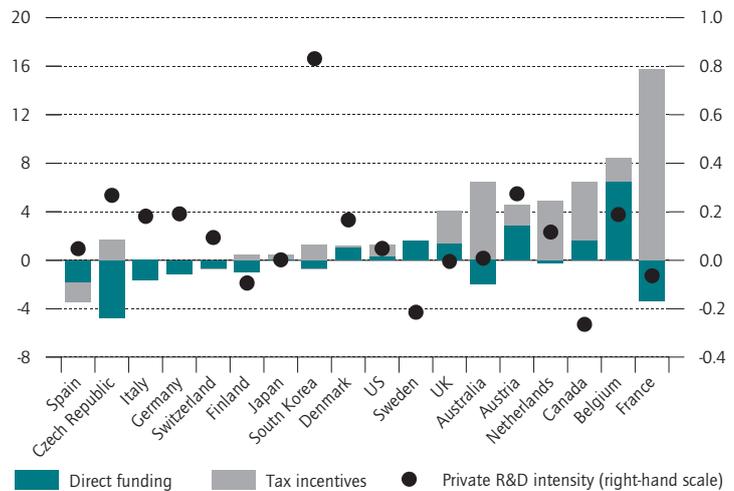
Sources: OECD; calculations and estimates by DIW Berlin.

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Private R&D intensity is relatively low in countries with high funding rates.

Figure 2

Changes in funding rates and in private R&D intensity in selected countries between 2006 and 2013<sup>1</sup>  
In percentage points



<sup>1</sup> Changes in the relevant period from the Table are shown.

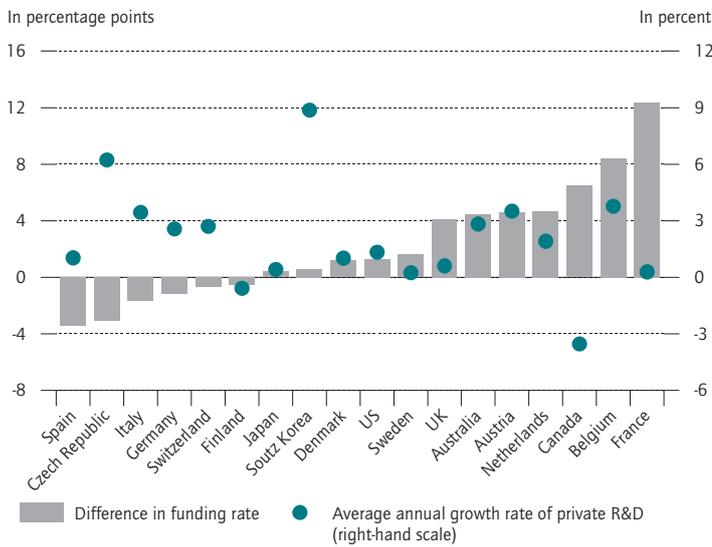
Sources: OECD; calculations and estimates by DIW Berlin.

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Increases in funding rates were not always accompanied by an increase in R&D intensity.

Figure 3

**Changes in funding rates and annual growth in companies' self-financed R&D expenditure between 2006 and 2013<sup>1</sup>**



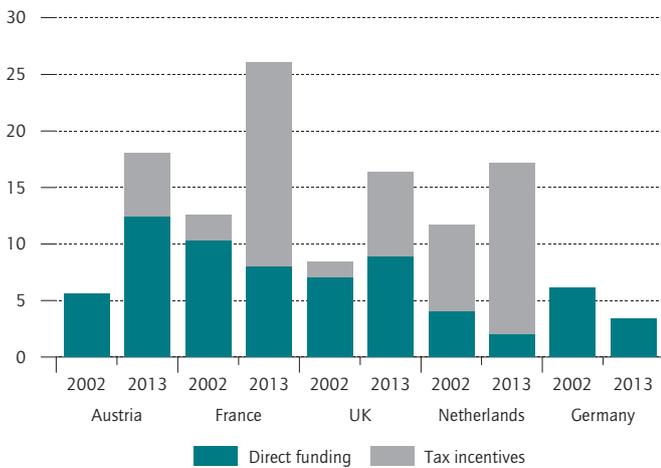
<sup>1</sup> Changes in the relevant period from the Table are shown. Sources: OECD; calculations and estimates by DIW Berlin.

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The growth rates of private business R&D are independent of the changes in funding rates.

Figure 4

**Shares of direct funding and tax incentives of total business enterprise expenditure on R&D in selected countries in 2002 and 2013**  
In percent



Sources: Statistik Austria; Verhoeven, van Stel, and Timmermans (2012), OECD Reviews of Innovation Policy Netherlands (2014); Ministère de l'Education nationale, de l'Enseignement supérieur et de la Recherche; HM Revenue and Customs; OECD; calculations by DIW Berlin.

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France, the Netherlands, and Great Britain saw increases primarily in tax incentives for R&D.

al growth rates for business enterprise expenditure on R&D in countries experiencing strong growth in funding rates are actually no higher than in countries with stable or virtually unchanged funding rates (see Figure 3). Consequently, neither the rate of direct or indirect funding nor increases in this rate in the OECD countries studied has had a strong impact on the development of business research and development spending since the mid-2000s. Only in Austria did a relatively strong increase in the funding rate coincide with comparatively high growth in self-financed business R&D since 2006 and a substantial rise in private R&D intensity.<sup>6</sup>

**Germany sees fall in share of private R&D investment funded by government ...**

The following section will examine the efficiency of direct and indirect R&D support in Germany and in four other research-intensive European countries, France, the UK, the Netherlands, and Austria, in more detail. Unlike the data used above which were based on two points in time and a large group of countries, this part of the study uses annual data for the period from 2002 to 2013 for a small number of countries. The data on R&D tax incentives were taken from national data sources.<sup>7</sup> The annual data on the level of business enterprise expenditure on R&D and direct government support, i.e., grants or procurement, are provided by the OECD.<sup>8</sup> These data show the different trends in funding and R&D spending in the individual countries since 2002.

If we add up the shares of overall business R&D expenditure accounted for by direct and indirect funding, in 2002, France and the Netherlands had the highest funding rates, each with around 12 percent, followed by the UK with eight percent, and Germany and Austria with around six percent (see Figure 4). Whereas in the Netherlands, tax incentives already played a central role in 2002, the share accounted for by these incentives in France and the UK was still very low and Germany and Austria only provided direct support at this time.

<sup>6</sup> The evaluation of the "research premium" and also the entire funding system for companies in Austria, which was called for by the government, may explain why this is the case. This evaluation is still pending however. See, inter alia, Response from the Austrian Minister of Finance, Dr. Hans Jörg Schelling, to written parliamentary question no. 5063/J regarding the increase in the "research premium" of May 20, 2015 by the member of parliament Dipl.-Ing. Gerhard Deimek and colleagues (Vienna: July 16, 2015).

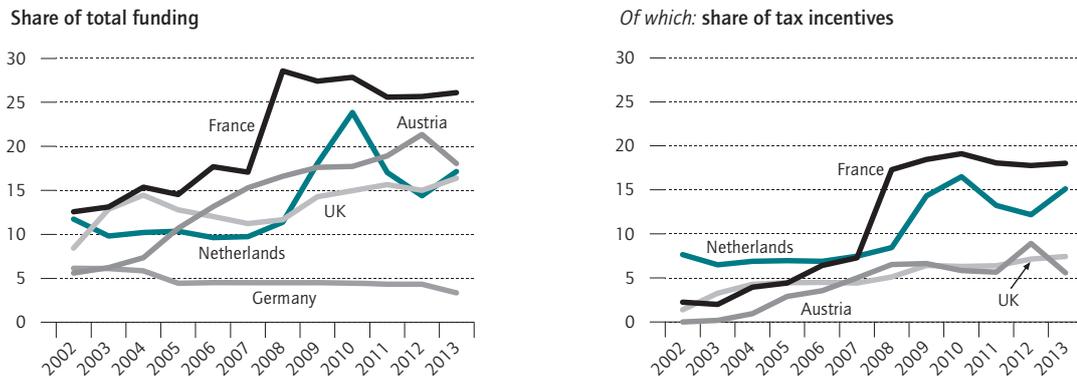
<sup>7</sup> See Verhoeven, W.H.J. et al. (2014): Evaluatie WBSO 2006-2010. Zoetermeer, February; OECD (2014): Reviews of Innovation Policy Netherlands. Statistik Austria; HM Revenue and Customs, Ministère de l'Education nationale, de l'Enseignement supérieur et de la Recherche. In France, only expenditure for central tax measures for all companies, the CIR, was taken into consideration (see Box 1).

<sup>8</sup> In Austria and the Netherlands, during the study period, data on R&D expenditure was not collected every year. For years with no original data on R&D expenditure and direct R&D support, the data were estimated based on linear interpolation.

Figure 5

**Shares of direct funding and tax incentives of total business enterprise expenditure on R&D in selected countries between 2002 and 2013**

In percent



Sources: Statistik Austria; Verhoeven, van Stel, Timmermans (2012), OECD Reviews of Innovation Policy Netherlands (2014); Ministère de l'Education nationale, de l'Enseignement supérieur et de la Recherche; HM Revenue and Customs; OECD; calculations by DIW Berlin.

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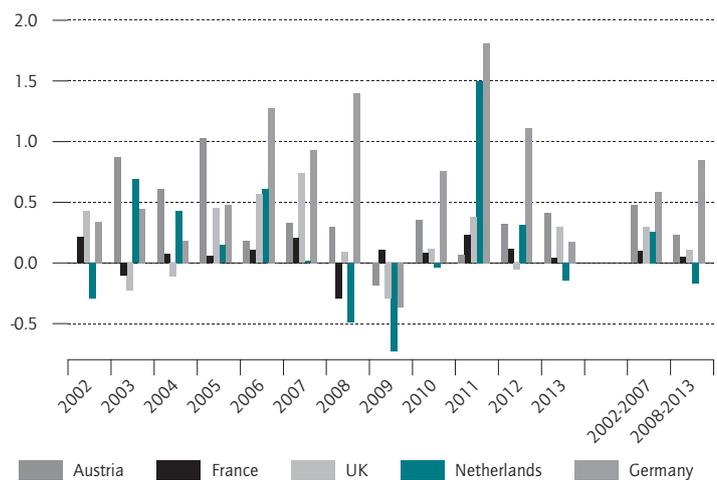
To address the consequences of the global economic crisis, France and the Netherlands relied primarily on the use of tax incentives for R&D.

Up until 2013, the share of business R&D expenditure which was funded by governments directly and indirectly increased in all the countries studied, with one exception. Germany was the only country where public subsidies fell to under four percent. France had the highest level of government funding with over 26 percent, followed by Austria with 18 percent, the Netherlands with 17 percent, and the UK with a good 16 percent. The discrepancy between government funding rates in Germany and in the other countries studied has therefore grown considerably since 2002 (see Figure 4). The expansion of tax incentives in France, Austria, and the UK (a mechanism which has not even been introduced in Germany) made a major contribution to this. In France, for example, as far back as 2013, 18 percent of business R&D expenditure was already funded through tax subsidies (see Box 1). However, the gap between Germany and Austria in terms of public funding did not only grow as a result of Austria introducing tax subsidies which already made up almost six percent of business R&D expenditure in 2013. An increase in direct funding that accounted for 12.5 percent of business R&D expenditure also contributed to the situation.

Whereas the share of R&D support contributed by public funding in Austria steadily increased from 2002 to 2013, the equivalent figure in France and the Netherlands rose sharply as both countries chose to address the consequences of the global financial and economic

Figure 6

**Efficiency of R&D funding in selected countries between 2001 and 2013<sup>1</sup>**



<sup>1</sup> Austria excluding 2002, Netherlands excluding 2011.

Sources: Statistik Austria; Verhoeven, van Stel, Timmermans (2012), OECD Reviews of Innovation Policy Netherlands (2014); Ministère de l'Education nationale, de l'Enseignement supérieur et de la Recherche; HM Revenue and Customs; OECD; calculations by DIW Berlin.

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In Germany, the efficiency of R&D funding is high.

## Box 2

**Firm-level studies on the efficiency of public funding**

Numerous studies based on company data come to the conclusion that direct funding has a positive impact on companies' R&D expenditure. The possibility that private funds might be completely replaced by government funding can generally be ruled out.<sup>1</sup> However, only very few of the recent studies on companies in major EU countries conclude that R&D expenditure in companies (including public funding) grew more than the amount of the government subsidies received.<sup>2</sup> In other words, the government funding mostly replaced some of the funds for R&D provided by the companies themselves (partial crowding out), but the total amount of private and government funding for R&D is ultimately higher than it would have been without the direct funding.

For tax incentives, too, there are a number of empirical analyses from different countries that use corporate data. Although findings on the input additionality vary, most studies show

that companies tend to respond to tax incentives by increasing their research expenditure. Studies using more sophisticated econometrics show that a loss in tax revenue amounting to one euro results in growth in R&D spending of less than one euro,<sup>3</sup> i.e., here, too, partial crowding out is normally observed. Recent meta-analyses attempt to verify and sum up the abundance of findings from econometric studies using statistical methods.<sup>4</sup> Although they establish a bias in the publications towards positive effects (publication bias), they ultimately confirm robust, albeit moderate, effects of R&D tax incentives on increasing private R&D spending. However, there are variations in the effects for different groups of companies, for instance, in low- and high-tech sectors, or for SMEs. Additionality is higher in countries with incremental public funding.<sup>5</sup> Moreover, recently published studies identify lower efficiency coefficients than older publications.<sup>6</sup>

**1** See, for example, Aristei, D., Sterlacchini, A. and Venturini, F. (2015): The effects of public supports on business R&D: firm-level evidence across EU countries. MPRA Paper 64611, Munich; Correa, P., Andrés, L., and Borja-Vega, C. (2013): The Impact of Government Support on Firm R&D Investments. A Meta-Analysis. The World Bank, Entrepreneurship and Innovation Unit, July; Alonso-Borrego, C. et al. (2014): Assessing the Effect of Public Subsidies on Firm R&D Investment: A Survey. *Journal of Economic Surveys*, 28 (1), February, 36–67.

**2** Aristei, Sterlacchini, and Venturini, Effects of public supports.

**3** Straathof, B. et al. (2014): A study on R&D tax incentives. Working Paper no. 52-2014, a study conducted by a consortium led by Netherlands Bureau for Economic Policy Analysis CPB. The Hague: November 28.

**4** Castellacci, F. and Lie, C. M. (2015): Do the effects of R&D tax credits vary across industries? A meta-regression analysis. *Research Policy*, 44 (4), 819–832; Gaillard-Ladinska, E., Non, M. and Straathof, S. (2015): More R&D with tax incentives? A meta-analysis. CPB Discussion Paper. CPB Netherlands Bureau for Economic Policy Analysis.

**5** Castellacci and Lie, Effects of R&D.

**6** Gaillard-Ladinska et al., R&D with tax incentives.

crisis by promoting R&D activities more proactively (see Figure 5).<sup>9</sup> Also in the UK, after a slight decline, the financial contribution of overall support increased again in 2008. Only in Germany has the funding rate been on a continuous downward trend since 2002, reaching 3.4 percent in 2013.

**... but increase in efficiency of funding from macroeconomic perspective**

From 2002 to 2013, private R&D intensity, i.e., the R&D expenditure funded by companies themselves, relative to GDP, experienced the strongest growth in Austria (0.41

percentage points). In Germany, private R&D intensity grew by 0.27 percentage points. The Netherlands recorded a smaller increase of 0.09 percentage points.<sup>10</sup> In the UK and France, private R&D intensity even declined slightly (by 0.13 percentage points in each case). If we examine the growth of business-funded R&D spending, a similar picture emerges: in Austria, this increased by 54 percent between 2002 and 2013, in Germany the increase was 31 percent during the same period, and in the Netherlands, the corresponding figure was 23 percent. In the UK and France, however, business-funded R&D expenditure remained at its 2002 level. Consequently, growth in companies' self-financed R&D spending was particularly low, both in absolute terms and relative to GDP, in countries where R&D tax incentives play a major and increasing role (see Figure 4).

**9** In the Netherlands, the decline in the publicly funded share of overall funding in 2011 was largely the result of the break in the time series caused by the transition from a sample survey to a complete survey of companies' R&D expenditure. See OECD (2016): Main Science and Technology Indicators. <http://stats.oecd.org/index.aspx?r=85052>.

**10** Here, the increase in the Netherlands is slightly overestimated due to the break in the time series in 2011.

## Box 3

**Measuring the efficiency of government funding from a macroeconomic perspective**

Funding efficiency on the macroeconomic level can be measured by looking at the annual growth or decrease in the self-financed R&D expenditure of companies in a country (excluding public funding) relative to total government funding in a given year.<sup>1</sup> The funding efficiency ( $E$ ) in year  $t$  is measured using the ratio between the change in R&D self-financed by companies ( $RS$ ) compared to the previous year and the volume of the total direct ( $DF$ ) and indirect ( $IF$ ) funding in year  $t$ .

$$E_t = \frac{(RS_t - RS_{t-1})}{(DF_t + IF_t)}$$

**1** A considerably more challenging approach is an estimation of the model to explain the annual changes in the self-financed R&D expenditure in companies where other factors are also taken into account in addition to public funding. This type of analysis was conducted for 17 OECD countries in the period between 1983 and 1996. See Guellec, D. and Van Pottelsberghe, B. (2003): The impact of public R&D expenditure on business R&D. *Economics of Innovation and New Technologies*, 12 (3), 225–244.

In the above formula, the companies' self-financed R&D spending ( $RS$ ) for a given year is calculated by subtracting the direct ( $DF$ ) and indirect ( $IF$ ) funding from their total internal R&D expenditure. An efficiency score of one or higher means that funding amounting to one euro results in an additional self-financed R&D expenditure of one or more than one euro in the same year. An efficiency factor between zero and one indicates that for each euro of funding provided, there is less than one euro of additional private R&D expenditure. A funding efficiency score of zero or below zero means that, despite public funding, the self-financed R&D expenditure has not increased or has even decreased (crowding out).<sup>2</sup>

**2** In the above-mentioned study by Guellec and Van Pottelsberghe, an additionality or, here, funding efficiency score of 0.7 for direct funding and 0.32 for indirect funding is estimated. Another finding is that an increase in one type of funding may have a negative impact on the other.

The efficiency of public spending on private R&D should primarily be measured on the basis of the direct effects of higher investment in business R&D (input additionality). Numerous studies have examined this at company level (see Box 2).

The following section examines the efficiency of funding at a macroeconomic level (see Box 3). For Germany, and the other four research-intensive countries, we were able to calculate funding efficiency, taking into account both direct and indirect funding for the period from 2002 to 2013.<sup>11</sup> In terms of how efficient the funding was, strong fluctuations can be observed both between the countries and over time (see Figure 6). Over three-quarters of the annual funding efficiency scores are higher than zero but of these, a good half are lower than 0.5. Generally, this means that for every “euro of funding,” there is an increase in business-funded R&D spending of less than 50 euro cents. Only 22 percent of the efficiency scores are less than zero and these occur more frequently during the global financial crisis. The mean funding efficiency scores in the period preceding this crisis (2002 to 2007) are mainly higher than after it (2008 to 2013).

**11** Due to data availability, the first funding efficiency score for Austria was calculated for 2003. The efficiency score for the Netherlands for 2011 was excluded since the increase in R&D expenditure against the previous year was probably, for the most part, the result of the expansion of the R&D survey to include all companies conducting research from 2011 onward.

This indicates declining funding efficiency coinciding with increased funding rates in the European countries compared in the present study. Germany is the exception since not only did this country achieve the highest funding efficiency from a macroeconomic perspective but also no decline was observed during the period following the crisis.

## Conclusion

Using the most recent data available, the present study has not only examined the level of direct government support for research and development—for instance, in the form of project funding—but also indirect tax incentives. It was found that the overall funding rate in some OECD countries has increased dramatically in recent years and is now over ten percent in 11 out of 18 research-intensive countries studied. At the same time, tax incentives have become increasingly important in many places. There has been a decline in the efficiency of funding, however: in countries with high funding rates and a strong emphasis on tax incentives, private R&D intensity has not increased any faster than in countries with considerably lower funding rates and limited tax incentives—or no tax breaks at all. An increase in the funding rate, on the one hand, and changes in private R&D intensity and growth in business R&D expenditure in real terms, on the other hand, are not positively correlated in the OECD countries included in the study. Ger-

many is one of those countries with quite a low funding rate, which has even fallen recently, and yet, at the same time, a relatively high private R&D intensity, which has risen sharply over time.

The findings presented here raise doubts that high and, in some countries, sharply rising funding rates that are frequently accompanied by an expansion of broad tax incentives have made an effective contribution to the increase in business R&D. Proposals to also use tax incen-

tives to promote R&D investment in Germany, too, in the future, should therefore be very critically reviewed and account taken of the diverse international experiences. In the event that companies conducting R&D—or at least individual groups of companies—in Germany also receive tax incentives, this would certainly have to be linked to an evaluation that might give some indication of any necessary adjustments to be made. This is particularly relevant bearing in mind the interaction between tax incentives and direct funding.

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