The "gender gap" in the scientific labour market

The case of science, engineering and technology-based SMEs in the UK

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Abstract

Purpose – This paper seeks to address a key issue, yet a neglected area of local policy and research i.e. the "gender gap" in the labour market in the scientific-based SMEs in the UK. The paper seeks to compare and contrast the employment and management structure, as well as participation in research and development (R&D) between female and male. It further aims to explore the educational background and the personal and professional barriers that prevent women from progression in scientific management and R&D related occupations.

Design/methodology/approach – The empirical investigation is based on a sample of 45 female employees working in science, engineering and technology (SET)-related positions and 48 SET-related companies. Data were collected through the empirical survey of SMEs and semi structured "face-to-face" interviews with female employees.

Findings – The study concluded that there was no evidence of specific SET-related barriers preventing career progression amongst women. The major barriers to progression were related to work-life balance issues such as dependent children as well as non-gender-related issues such as insufficient resources for training, lack of opportunities for career advancement and lack of encouragement from management, which are more likely to be SME-related issues.

Practical implications – The paper suggests that current programmes and initiatives to encourage people to enter SET occupations may eventually increase participation in that workforce but will not necessarily increase numbers of women in managerial and highly technical positions because of the continuing conflict over work-life balance decisions such as having a family, or because of management and SME-related issues such as insufficient resources.

Originality/value – The findings are based on original and unique databases, assembled over the past two years, funded by the ESRC Science in Society Programme and the Higher Education European Social Fund National. The "gender gap" in the labour market in scientific-based SMEs in the UK, combing data of companies and employees, has not, empirically, been investigated before.

Keywords Gender, Sciences, Research and development, Work study

Paper type Research paper

Introduction

Women in the UK are generally under-represented in senior positions within business, public and political spheres and earn significantly less than men, particularly in the science, engineering and technology (SET) sectors. They may also encounter the additional barrier of intimidation or stereotyping when entering the environment of male-dominated sectors such as SET. Although female participation in the UK workforce has been increasing since the 1960s, participation by women in scientific fields in general are significantly lower than national levels, particularly in less favoured regions (ONS, 2004).

It is widely believed that SMEs play a well-documented role in scientific discoveries and production of innovation, crucial to the growth of output, productivity, competitive advantage, high quality employment and overall success of the economy (Shiekh and Oberhoizner, 2001). However, the level of participation and contribution of women in

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this highly important segment of the economy appears to be largely a neglected area of research and policy in the UK.

The scientific labour market

Within the scientific labour market, there are marked differences between the participation of men and women (Table I).

Since the introduction of the sex discrimination act 30 years ago, concerns about the under-representation of women in SET have been increasingly raised and expressed by the government and various other organisations. Numerous areas of concern have been highlighted in governmental and academic reports, including education, training, employment and positions of influence. Rising awareness of the issue has resulted in the development of numerous initiatives, reports and consultation, particularly at national levels.

However, even with the slight improvement in female participation in the scientific labour market in recent years, the number of women reaching high positions in science is still much lower in the UK compared to the USA and many other European countries and only a small proportion of women eventually emerge to make successful careers in science. Despite greater activity in the labour markets in general, the gender gap in pay persists. In the 1970s Schultz identified that although progress had been made in reducing the earnings gap according to ethnicity, "white women have apparently not closed the relative gap between their fully employed earnings and those of the white males, holding age and schooling constant" (Schultz, 1972, p. 2). More recently, this gender gap was again widely publicised following the European Court of Justice's 2006 ruling in the Bernadette Cadman case, concerning the link between earnings and length of service, which highlighted issues surrounding the decision to take a career break in order to have a family.

In most European countries, the numbers of female graduates is proportionately higher than those of male graduates. In the UK, in 2004, women accounted for 36 per cent of SET graduates (Marriot, 2006). The number of female SET graduates in SET occupations ran at just over 80,000 in 2003, compared with around 400,000 men. Women account for less than 25 per cent of the workforce in some SET related industry sectors compared to 80 per cent in health and social work, and 45 per cent for all sectors (ONS, 2004).

"In many ways, women are unable to choose to do science: society has already chosen who will do science through its construction of gender roles." (Etzkowitz *et al.*,

SET occupation	Male		Female		Total[a]
	Actual[a]	%	Actual[a]	%	
Engineering professionals	367	95.0	20	5.0	387
ICT professionals	327	87.1	49	12.9	376
Science and engineering technicians	163	78.1	46	21.9	209
IT service delivery occupations	128	24.2	44	25.8	172
Science professionals	67	57.7	49	42.3	116
Draughtspersons and building inspectors	45	89.0	6	11.0	51
Science research professionals	31	53.6	27	46.4	58

Note: [a]Values are in '000s
Source: UKRC (2006)

Table I.
SET occupations by gender in the UK, 2005

2000, p. 47) and from an early age "boys and girls develop different gendered images of scientists and what they do." (Etzkowitz *et al.*, 2000, p. 26).

The environment at home and in education influences girls" vision of their role in society but also their degree of assertiveness, experimentation, self-motivated exploration and risk taking – important features in the lives of successful scientists. Such factors influence their choice of subjects at school such as maths and science and their subsequent ability to engage in SET-related activities upon entering the workforce, well before factors such as family-related responsibilities become an issue. However, existing theory and academic research pointing to an inherent male-bias in scientific enquiry that has been built up over the centuries, "does not provide an explanation for the skewed representation of women within SET education, i.e. their under-representation in engineering and physical science and their over-representation in the biological and medical sciences" (Siann and Callaghan, 2001, p. 89).

Women experience direct and indirect, personal and professional barriers, which hinder free choice of occupation and progression. On average, as women tend to possess lower levels of human capital than men they will therefore trail behind in the supply and demand for their labour. Due to family and domestic commitments, women also find it more difficult to increase their human capital through education and training and therefore remain in a secondary position in the labour force. Presumably if the labour market tightens then more women would be drawn into the labour markets as the human capital opportunities for employers are met at a dynamic margin (see for example Darity and Mason, 1998; Elias and Scarbrough, 2004; Figart and Mutari, 2005; Loury and Glenn, 1998; Mincer, 1997). When women do raise their human capital through SET education, they often continue to leak out of the SET pipeline as stated by Meg Munn, MP, UK Deputy Minister for Women and Equality, in the forward to a report by Pilch (2006): "Around 70% of women who have science, engineering and technology qualifications are not working in sectors that use these skills. This is a significant loss to the economy; the country paid for the training that is not being used, business lose out by not having qualified women working for them, and many of the women lose out by not having a well-paid, interesting career in the sector" (Pilch, 2006, p. 6).

Women may have difficulty in entering male-dominated networks of information exchange, departmental and other research teams and group grant applications in the workplace, or engaging with male colleagues in social activities outside of the office. Whilst many women choose to combine a family and a career, some leave the SET sectors altogether and face additional barriers if and when they wish to return, to the extent that many may never come back (Wynarczyk and Renner, 2006).

Existing research has identified "family commitment" as one of the main barriers preventing women from entering and progressing in the labour market and employment rates for women are closely linked to the presence and age of dependent children in the family. In the UK, the employment rates for women with dependent children under the age of five were 52 per cent, while rates for those with children of primary school age and those with children aged 11-15 rose to 71 per cent and to 77 per cent respectively. The employment rate for women without dependents was 67 per cent. In comparison the employment rate for men with dependents is 90 per cent and 74 per cent for men without dependents (EOC, 2005, p. 15). Existing research suggests that women engaged in scientific fields tend to be younger and relatively fewer of them have children compared with other female employees. Research has also demonstrated that highly educated women are more likely to postpone maternity than other female

employees (EC, 2003). Presently there is no gender breakdown of patentees, research and development (R&D) and other IPR (design, trademark and licensing), spin-out and innovation activities in the UK, particularly at regional levels. The limited evidence available suggests that women may not play, or may be currently prevented from playing, their full role in technological advancement in the UK.

On the surface, there does not appear to be any fundamental reason why women should not participate equally with men in scientific discoveries and the innovation process, indicating a possible neglect of a rich and largely untapped pool of inventive and innovative talent in the UK. We know that women's recorded participation in science, technology and innovation is lower than their overall participation in the workforce, particularly in the most uncompetitive regions, but we do not know the details of why this is the case. As a result, the country may be missing a fundamental means of increasing its competitive strengths. Systematic research is therefore required on gender contribution (or lack of contribution) relating to the generation, development and uptake of technological change in the UK and the characteristics and causes of it.

The R&D labour market

R&D is a high priority on the governments' agenda, as it is seen as a key driver for economic growth and as a way to increase productivity (Bloom and Griffith, 2001). Many authors have highlighted the potential financial and social gains to be had from R&D investment (see for example Porter, 1990; 1998; Griffith, 2000; Hall, 1991; Grilliches, 1992; Cameron, 2000; DTI, 2005; Rodgers, 2006). In the governmental ten year framework for investment in science and innovation the ambitious target of raising R&D from 1.9 per cent of GDP to 2.5 per cent of GDP between 2004 and 2014 was set (DTI, 2005; Rodgers, 2006). Between 1996 and 2004, expenditure on R&D performed in the UK businesses experienced a steady increase, from £9,297 million in 1996 to £13,504 million in 2004 (MA14, 2005). However growth in other countries such as the USA, China, Japan and India have experienced higher levels of growth than the UK (DTI, 2005; Rodgers, 2006).

There is very little data on female participation in industrial R&D, which appears to result largely from the issue not being addressed by national or regional policies and a general lack of research from elsewhere, notably academia. As stated in *Women in Industrial Research, A Wake Up Call for European Industry*, "understanding the positions of women and men in industrial research in Europe is hampered by the lack of reliable, harmonised sex-disaggregated statistics" (EC, 2003, p. 29). Limited information available suggests that there is a European wide shortage of individuals in R&D, females provide an obvious source of untapped pool of expertise (Gago, 2004).

The empirical investigation

Based on a survey of 48, SET-based SMEs operating in the UK and 45 female employees, the empirical findings presented below explores factors such as participation in R&D, management structure, educational background, as well as the personal and professional barriers that prevent women from progressing in scientific management and R&D related occupations.

Survey of enterprises

Total employment by gender is presented in Table II. As the table shows, 60 per cent of the firms surveyed had less than ten employees and 29 per cent had more than 20 employees, while 15 per cent had more than 50 employees. There are some significant

Size	Total number of employees	Male total	Male full time	Male part time	Female total	Female full time	Female part time
0 (%)	4	6	4	79	31	42	67
1 to 9 (%)	56	54	63	21	56	50	31
10 to 19 (%)	10	15	8	0	10		2
20 to 49 (%)	13	13	13	0	2	2	0
50 to 99 (%)	13	10	10	0	0	0	0
100+ (%)	4	2	2	0	0	0	0
Total (%)	100	100	100	100	100	100	100
Average	22.90	19.52	18.46	0.38	3.38	2.54	0.79
Median	7	6.5	4	0	1	1	0
Range	217	187	187	6	30	22	11
Percentage	100		85		15		

Table II.
Employment structure by gender

Source: SERU SME database

gender imbalances in the employment structure of the firms. For example, some 31 per cent had no female employees compared with only 4 per cent with no male employees. Furthermore, as demonstrated by the averages and medians, women generally tended to hold a smaller share of the workforce compared with their male counterparts. The average firm had 20 male employees compared to only three female employees. Only 2 per cent of the firms had more than 20 female employees but 29 per cent had more than 20 male employees. The range of female employees was 30 compared to 187 for male employees. It is interesting to note that one of the surveyed firms had no male employees and only one female member of staff – the proprietor, who was also behind the development of new saucepan design.

In short, only 15 per cent of all jobs were held by women compared with 85 per cent of total jobs held by male staff (Figure 1).

The proportion of R&D employees as a percentage of total employment is one indication of level of R&D effort and intensity. Technological capability and innovativeness has been linked to the percentage of qualified scientists employed in R&D related positions in a number of studies. R&D employment by gender is presented in Table III. As the table shows, half of the firms had no employees specifically responsible for R&D activities. The table clearly demonstrates that women are particularly under-represented in R&D positions within SET related SMEs. As the table shows, 83 per cent of the surveyed firms had no female R&D employees,

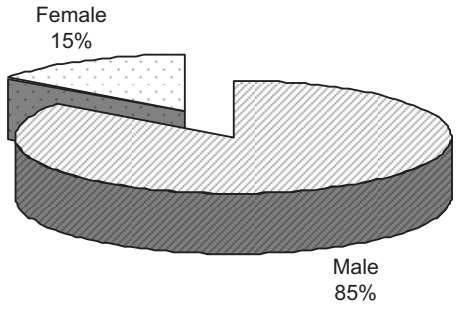


Figure 1.
Percentage of total jobs held by males and female

Source: SERU SME database

	Total employees	R&D male total	R&D male full time	R&D male part time	R&D female total	R&D female full time	R&D female part time
0 (%)	50	52	56	85	83	85	96
1 to 4 (%)	31	31	35	13	17	15	4
5 to 9 (%)	8	6	0	2	0	0	0
10+ (%)	10	10	8	0	0	0	0
Total (%)	100	100	100	100	100	100	100
Mean	3.29	3.00	2.25	0.38	0.29	0.23	0.06
Median	0.5	0	0	0	0	0	0
Range	27	24	24	6	3	3	2
Percentage	100		91		9		

Source: SERU SME database

Table III.
R&D employment by gender

(compared to 52 per cent without male R&D employees). The remaining 17 per cent of firms with female R&D employees recruited less than five female R&D employees. In contrast, over 16per cent of the firms recruited more than five male R&D employees.

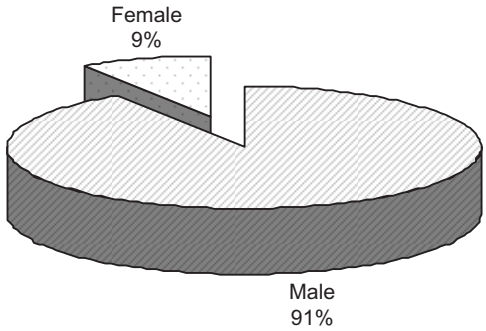
Further examination of the results show that male employees held the remaining vast majority of R&D jobs, at 91 per cent, (Figure 2).

The results show 14 per cent of the total workforce were engaged in industrial R&D. However, only 1 per cent were female (Figure 3).

Management structure

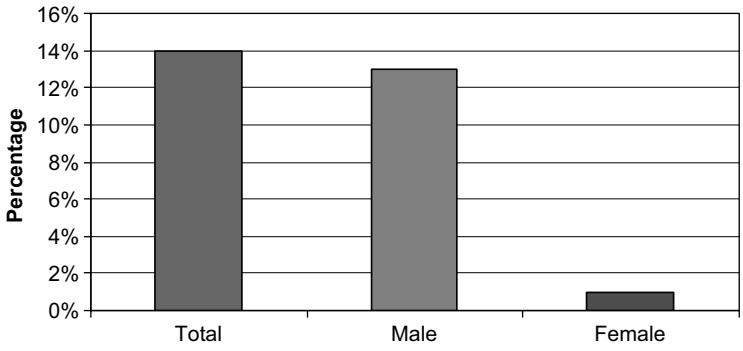
With regard to specific roles at senior and managerial levels, the results summarised in Table IV and Figures 4 and 5 show women are far more likely to hold managerial positions in non-scientific areas such as human resources (HR), finance, purchasing and data processing than in R&D and other scientific and technical posts. In contrast, only 2 per cent of women held R&D and other scientific positions compared with some 43 per cent of men.

The results generally suggest that women are not participating in the scientific managerial labour market at equal levels to their male counterparts. However, the results imply they are making a relatively higher contribution to the managerial labour



Source: SERU SME database

Figure 2.
Percentage of total R&D jobs held by males and female



Source: SERU SME database

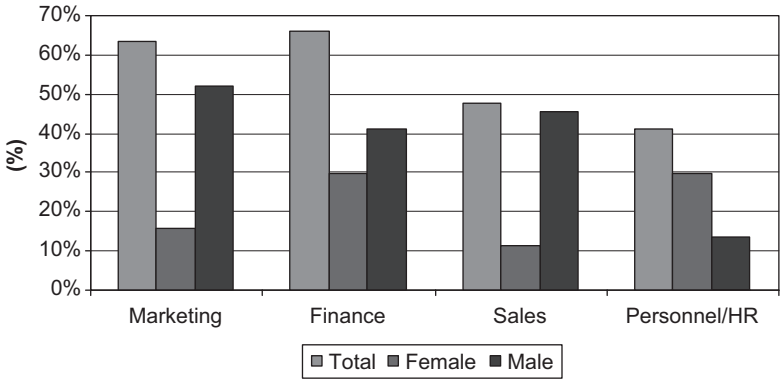
Figure 3.
Percentage of total R&D employment to total employed

market in, for example, finance and HR and hold a stronger position in HR than their male counterparts. Studies of innovative and high growth SMEs have demonstrated the importance of a well-structured, formal management teams with complementary expertise, both scientific and non-scientific. Directors with scientific and technical expertise generally setup scientific enterprises. As the company grows, unless "professional" management supplements the owner's expertise, performance is likely to stagnate or decline (Wynarczyk and Thwaites, 2000). For a rapidly growing scientific small firm, the largely informal management style of the typical owner-manger will need to be supplemented by the recruitment of new managers with complementary skills, particularly in the areas of sales and marketing to develop a more formal managerial structure in order for growth to be successfully achieved (Wynarczyk *et al.*, 1993).

Specific role for	Total (%)	Female (%)	Male (%)	Paired sample *T*-test
Production	43	11	39	3.09*
Marketing	64	16	52	3.52*
Finance	66	30	41	0.96
Purchasing	43	16	30	1.43
Exports	16	0	16	2.85*
Sales	48	11	45	4.3*
Legal	32	5	30	3.11*
Operations	48	14	41	3.09*
IT	48	14	43	3.3*
R&D	48	2	43	5.01*
Technical/scientific	41	0	41	5.46*
Data processing	23	5	18	1.96[a]
/UPPersonnel/HR	41	30	14	1.74
Design	39	7	34	3.32*

Table IV.
Management structure/ roles

Notes: [a]*T*-test = Paired mean *T*-test of differences between female and male managers; *significant at 5 per cent level
Source: SERU SME database



Source: SERU SME database

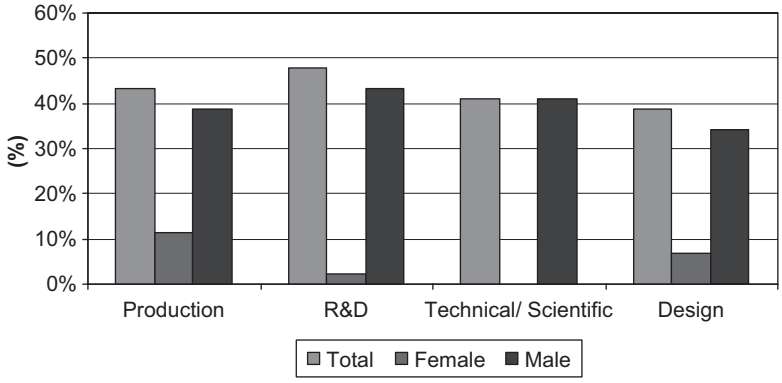
Figure 4.
Percentage of non-scientific managerial positions by gender

Qualifications and positions

A high proportion of the women who participated in the research held SET related qualifications (84 per cent), 9 per cent had no SET qualifications and 7 per cent of responses are unknown (Figure 6).

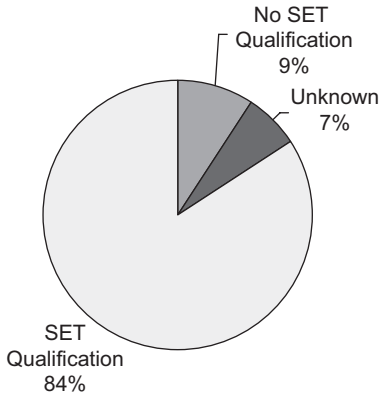
Below illustrates all of the SET qualifications stated by respondents, it illustrates that engineering (35 per cent) related qualifications are most frequent, followed by IT (29 per cent) and chemistry (21 per cent), interestingly, despite the nationally higher proportions of females in biology and health related areas, there were few women with qualifications in these areas (10 per cent) (Figure 7).

When previous positions are analysed, 62 per cent of participants previously worked in SET, 20 per cent had no previous position, but 100 per cent of those went into a SET position and had a SET related qualification, therefore 18 per cent of respondents did not have a SET related previous position. With reference to current positions 22 per cent do not have SET related roles, however, a high proportion are managers or directors (44 per cent), 4 per cent are business owners and 52 per cent are in non-managerial positions, of this 52 per cent all of the respondents are working in SET related fields (Figure 8).



Source: SERU SME database

Figure 5.
Percentage of scientific managerial positions by gender 2003/2004



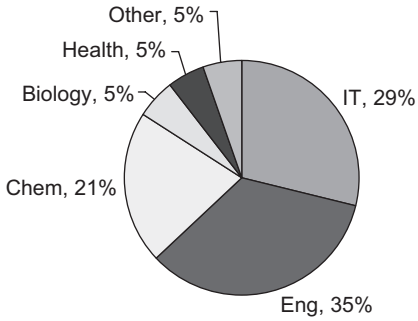
Source: SERU SME database

Figure 6.
SET and
non-set qualifications

A high proportion of female managers in SET organisations hold SET related qualifications (64 per cent), 23 per cent do not have SET related qualification and 13 per cent are unknown. This suggests that women who are entering the SET pipeline are following their chosen career path therefore, the problem of low female SET participation is due to the lack of women engaged in scientific disciplines within SET related SMEs in Europe as whole (EU, 2006), this has been attributed to the fact that fewer women study science related subjects at university. In contrast to the evidence provided by AWISE, the results presented here demonstrate that women with scientific qualifications in the UK are more likely to hold scientific positions.

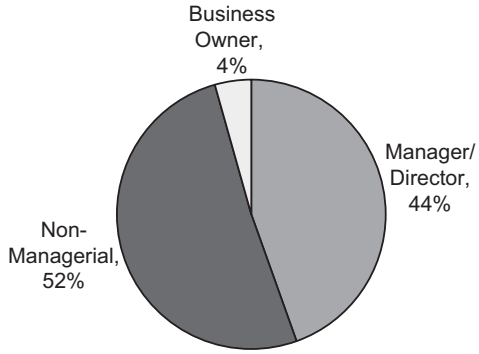
Personal barriers

The majority of female SET employees in the survey (56 per cent) stated that they had experienced barriers in their personal lives that were likely to hinder professional development. In addition, only 38 per cent of the women employed in the scientific companies had dependent children, which touches upon the frequently raised issue of work-life balance and raising a family whilst working. One participant said they did not wish to start a family, as this would prevent them from progressing further in their



Source: SERU SME database

Figure 7.
SET qualifications by
subject area



Source: SERU SME database

Figure 8.
Positions of respondents

careers, stating, "I have decided not to have children, partly due to my concerns regarding the work/life balance".

A large number of those with dependent children and other family commitments faced problems relating to their families (27 per cent of respondents) (see Table V). Many stated the desire to be in the same geographical location as their partner and family, which often lead to problems in career development. Indeed 18 per cent of respondents specifically mentioned dependent children as a personal barrier. The following comments came from a number of participants:

> It can be difficult if you are both professionals and need a position which is quite specific, but you are limited to a city/region.
>
> I have a young son which makes it difficult to attend conferences/training outside this area.
>
> I started a family and took a full year maternity leave. I only wanted to return part time, but this completely changed the level of work I can do.
>
> General difficulties being a full time parent and coping with full time work and being a lone parent in terms of time and energy, especially when the child is small.

Personal barriers	%
Lack of self-confidence	1
Lack of encouragement/expectation from teachers, family or friends	4
Lack of financial support/resources	7
Family commitments	27
Employment must be in the same geographical region as partner's	7
Dependent children	18
Other dependant	4
Other family ties	2
Career break	4
Unwilling/unable to travel	9
Lone parent	4
Lack of role models	2
Work life-balance	7
Commitment to work/workload	4
Other	18

Source: SERU SME database

Table V.
A summary of the personal barriers faced by female participants

Professional barriers	%
Barriers at entry level	4
Gender stereotypes	9
Institutionalised sexism	11
Lack of career opportunities for women	2
Lack of confidence/self esteem	4
Lack of qualifications	4
Lack of resources/funding	22
Lack of support/encouragement from management	18
Lack of training	11
Male dominated field	7
Nature of short-term contract	4

Source: SERU SME database

Table VI.
A summary of the professional barriers faced by female participants

Personal barriers commonly shared amongst a high proportion of participants included; lack of financial resources, unable/unwilling to travel, work-life balance, lack of encouragement and support, lack of female role models, being a lone parent and lack of confidence. One participant stated;

> I was working class and brought up by my mum, therefore there was never any mention of going to university – we thought you needed to have money in order to pursue an education.

Professional barriers

A high proportion (67 per cent) of respondents stated they faced barriers in their professional life. There were a wide range of barriers faced by the participants (see Table VI), including institutional sexism, gender stereotypes, lack of support and encouragement from senior management, male dominated fields, male biased incentives and career development opportunities such as training, were commonly mentioned. A high proportion of women blame their colleagues and bosses for lack of confidence or progression. A number of participants shared the following comments:

> Sometimes I have not been taken seriously enough because I am female. For example, in the pharmaceutical profession when talking to professors/surgeons, they did not expect me to have sufficient knowledge and looked down at me on occasion.

> An older male manager who did not believe that part-time or flexitime was acceptable.

> Initially I was employed at an administrative grade in the company, despite having an Engineering degree, I therefore had to work my way through more grades than most.

> Working in a male dominated environment (90 per cent men), it may be that my ideas have had less kudos than those suggested by male colleagues.

In addition, 22 per cent of respondents stated that resources and funding were a significant barrier, however it is likely that this is a company wide issue rather than a gender or personal issue. Some participants offered the following responses;

> Lack of specific training and resources to aid development in work environment, although not gender specific.

> The company I work for is a small one and money available for courses is limited although I think this is a company wide issue with regards to money for training courses and not gender specific.

Summary and conclusions

The results, based on a survey of 48 SET firms and 45 employee questionnaires based throughout the UK, confirm that the participation of women in scientific activities within the private sector is very low. Some 31 per cent of the firms surveyed had no female employees compared with only 4 per cent with no male employees. The average firm had 20 male employees compared to only three female employees. This gender gap is particularly strong in highly technical and R&D related occupations and managerial positions. Only 2 per cent of women held R&D and other scientific positions compared with some 43 per cent of men, whilst 83 per cent of the surveyed firms had no female R&D employees. The results do suggest they are making a relatively higher contribution to the managerial labour market in areas such as finance and HR and indeed hold a stronger position in HR than men.

A large majority of the women who participated in the research held SET-related qualifications (84 per cent), with engineering-related qualifications are most frequent (35 per cent), followed by IT (29 per cent) and chemistry (21 per cent). Interestingly, despite the higher national proportions of females in biology and health related areas, there were few women with qualifications in these areas (10 per cent).

The majority of female SET employees in the survey (56 per cent) stated that they had experienced barriers in their personal lives that were likely to hinder professional development, the most notable of which related to family commitments such as having dependent children. In their professional lives, the most notable barrier to progression was a lack of resources and funding (22 per cent), a common problem throughout the SME sector and not only in the SET sectors, as well as a lack of support from management (18 per cent).

The lack of women involved in R&D and technical positions provides further evidence of the difficulty women have in pursuing highly specialised careers in the most high profile positions in a company, largely due to time constraints caused by family responsibilities and, particularly, dependent children. The problem of career progression in SMEs is further exacerbated by the (non-gender specific) problem of insufficient resources for training and career progression, with insufficient resources and training and lack of support from management mentioned by over 50 per cent of respondents. The fact that these issues were stated by such a high proportion of females illustrates that these are the main areas of concern, however they are problems that the majority of SMEs in the UK are likely to face and will be largely unaffected by gender related initiatives, policies and legislation alone. The results of this paper reveal that there are relatively few SET-specific barriers faced by women in those sectors, despite the general perception of SET as male dominated areas. Whist this may be influenced by the participants in this survey, namely those who continue to work in SET as opposed to those who have dropped out of the industry, issues surrounding family responsibilities and dependent children would clearly remain a major factor in career progression.

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