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Gendered Geographies of High-Tech Regional Economies

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Abstract

Over the last two decades, as part of a 'cultural turn', an expansive research agenda has developed in economic geography around the sociocultural dynamics of regional learning and innovation processes underpinning high-tech regional development. At the same time within the subdiscipline, there has also emerged a substantial research agenda around cultural economies of gender. For the most part, these two research streams have proceeded separately from one another. Recently, however, a number of scholars have begun to challenge this intellectual divide. In parallel with similarly motivated research literatures in organizational psychology, management studies and human relations, scholars have explored how different dimensions of high-tech regional economic development are fundamentally and unavoidably gendered. This article offers a summary introduction to this nascent research agenda, focused on three phenomena widely documented in the regional literature as supporting intra- and interfirm learning and innovation processes, but whose attendant gendered social relations and gender divisions have yet to be fully analysed and understood, namely, (i) processes of worker mobility, labour 'churning' and their brokering by different labour market intermediaries; (ii) venture capital financing, entrepreneurship and firm start-up; and (iii) the origins and implications of (masculinist) corporate cultures for firms' absorptive capacities. By way of conclusion, the article outlines some interesting directions in which future research in this area might usefully develop in order to contribute to a broader project around holistic regional (socio)economic development.

1 Introduction

> The full complexity of modern economies only becomes apparent when we move outside what are often still considered to be the 'normal' territories of economic inquiry. Then a whole new world hoves into view. (Thrift and Olds 1996, 311)

The rise of cultural economic geography over the last two decades is one of the most significant, exciting and contentious developments in the subdiscipline's recent history. Received wisdom has long held 'culture' and 'economy' as self-determining entities; each with its own discrete set of institutions, rationalities and conditions of existence; indeed, each defined

by what the other is not: 'economy' as irreducibly instrumental, materialistic; 'hard', vulgar and tangible; 'culture' as non-instrumental, intrinsic; 'soft', aesthetic and intangible (see Jackson 2002). However, since the early 1990s, economic geographers increasingly have embraced a range of more fluid and hybrid conceptions of 'the economic' that emphasize its mutual constitution by, and hence fundamental inseparability from, 'the cultural', 'the social' and 'the relational' (see, for example, Barnett 1998; Crang 1997; Lee 1989; Lee and Wills 1997; Massey 1997; Peet 1997; Sayer 1997; Thrift and Olds 1996). Under the broad banner of 'cultural economy', geographers have broadened their analyses to examine how 'traditional' economic concerns of capital, production, exchange, valuation and consumption, operate within, and impact on, the spatially variable sets of sociocultural conventions, norms, attitudes, values and beliefs of the societies within which economic decisions and practices take place.[1] In so doing, economic geographers have drawn attention to new subject matter and scales of analysis; accorded roles to previously ignored and subordinated players; encouraged a wider diversity of analytical frameworks; and connected economic geography to significant debates in other social sciences. Fundamentally, scholars have also called into question the very nature of 'the economic' itself.

Arguably, nowhere has this 'cultural turn' been more apparent within the subdiscipline than within the regional industrial systems literature, as economic geographers have sought to identify the spatial foundations of economic success in the context of a globalized knowledge economy. Building on an earlier interest in 'hard' agglomeration economies and 'traded' input–output linkages (e.g. Scott 1986, 1988; Storper and Walker 1989), scholars have broadened their analyses to examine how 'untraded' cultural, institutional and relational characteristics of regional industrial agglomerations foster and support conditions conducive to knowledge creation, inventiveness, information dissemination, learning and, hence, sustained economic competitiveness (see, for example, Amin and Thrift 2004; Camagni 1991; Gertler 1995; James 2005, 2006a; Lazaric and Lorenz 1997; Saxenian 1994). The regional innovation and learning literature is now extensive (see MacKinnon et al. 2002 and Cumbers et al. 2003 for useful recent reviews), but at the broadest level the advantages of agglomeration are argued to emerge from intra- and extraregional information flows, technological spillovers and collective learning (see, for example, Amin and Cohendet 1999; Bathelt et al. 2004; Capello 1999; Malmberg and Maskell 1997, 2002). Key mechanisms that have been identified as underpinning the circulation of knowledge and expertise within (and between) high-tech regional economies include worker mobility (or 'churning'), collaborative networks of interaction between firms and their employees, venture capital networks, and firm start-up. Scholars have also focused on the cultural conventions and norms on which actors routinely draw to combine varied skills, competencies and ideas to create new

knowledge and apply it in the pursuit of improved economic performance (e.g. by developing new products or services, new technological capabilities, and/or new ways or organizing production processes and service delivery; see Benner 2003). The point is that innovation and learning are fundamentally interactive, and hence unavoidably *sociocultural*, processes (Asheim 2001; Lundvall 1992; Malecki and Oinas 1999; Morgan 1997).

At the same time within the subdiscipline, there has also emerged a substantial research agenda around cultural economies of gender. As female labour participation rates have steadily increased in the context of massive industrial restructuring, so geographers have engaged with feminist scholarship to examine the role of gendered social relations in constituting and affecting newly emergent geographies of work, employment practices, local labour markets, new styles of management, corporate cultures and shifting work/home boundaries between production and social *re*production (see, for example, Bagguley et al. 1990; Hanson and Pratt 1995; McDowell 1997, 2000; Pratt 1997; Walby 1986, 1997). Additionally, the very nature of contemporary service work based on feminized 'emotional labour' and a 'commercialization of intimacy' (Hochschild 1983, 2003; see also Leidner 1993) has forced scholars to question previous 'culture'/'economy' binaries – fundamentally, because the production and consumption of the service occur simultaneously, the cultural identity, personality, appearance, embodied personality and social characteristics of the worker become part of the product consumed. Geographers have also paid particular attention to emergent social structures of constraint within the firm (glass ceilings) that militate against female employees progressing as quickly as their male colleagues (see, for example, McDowell and Court 1994; McDowell 1997; Jones 1998). In summary, gender analyses of new geographies of work and employment have broadened the boundaries of economic geography, indeed helping to force a reconceptualization of the very notion of 'the economic' itself.

It is therefore striking that these two epistemic lynchpins of cultural economic geography have, for the most part, largely proceeded independently of one another. Despite its expansive nature, the regional learning and innovation literature has for the most part failed to offer any engagement with the gendered nature of the social relations by which firms are linked together beyond mere traded input–output links. At the same time, many feminist geographers steer well clear of what they perceive to be an increasingly abstract, self-referential and somewhat myopic regional learning and innovation literature narrowly focused on the minutiae of firms' productive processes at the expense of broader societal concerns of gender inequality and female empowerment. Encouragingly, however, a number of scholars have begun recently to challenge this intellectual divide, making links between these two expansive research literatures to explore how the socioeconomic dynamics of high-tech regional development are always and everywhere unavoidably gendered.

At the root of their analyses, geographers are responding primarily to the ever-increasing numbers (both absolute and relative) of women within the various industrial sectors and occupations that are conventionally grouped together under the banner of 'high technology'[2] and their unevenness at different geographical scales (nation-state, region, industry, occupation and firm). Tables 1 and 2 illustrate the uneven gendering of high-tech industries in terms of firm ownership and occupation in the US context (the USA is widely regarded as furthest down the route to the

Table 1. Selected 'high-tech' industries and their uneven gendering.

High-tech subsector (see US Bureau of Labor Statistics and Hecker 2005)	NAICS code (North American Industrial Classification System)	Women-owned companies as percentage of US national total by high-tech subsector* (US Census Bureau 2006)
Chemical manufacturing	325	20.9
Pharmaceutical and medicine manufacturing	3254	–
Computer and electronic product manufacturing	334	14.1
Computer and peripheral equipment manufacturing	3341	–
Communications equipment manufacturing	3342	–
Semiconductor and other electronic component manufacturing	3344	–
Navigational, measuring, electromedical and control instruments manufacturing	3345	–
Transportation equipment manufacturing	336	11.0
Aerospace product and parts manufacturing	3364	–
Internet publishing and broadcasting	516	29.7
Telecommunications	517	22.7
Internet service providers, web search portals and data processing services	518	37.1
Architectural engineering and related services	5413	13.3
Computer systems design and related services	5415	20.4
Scientific research and development services	5417	26.5

*Figures refer only to privately held companies in which women hold a 51% or greater share of the company.

Table 2. Selected 'high-tech occupations' and their uneven gendering.

High-tech-orientated occupation (US Bureau of Labor Statistics; see Kilcoyne 2001)	Standard occupational code	Percentage of workforce female (US Bureau of Labor Statistics 2005)
Medical scientists	19-1042	53.2
Database administrators	15-1061	33.6
Chemists	19-2031	32.5
Computer and information systems managers	11-3021	31.0
Computer support specialists	15-1041	29.7
Computer systems analysts	15-1051	29.4
Computer programmers	15-1021	26.7
Computer software engineers	15-1032	25.0
Network systems and data communications analysts	15-1081	21.9
Network and computer systems administrators	15-1071	20.3
Chemical engineers	17-2041	15.8
Computer hardware engineers	17-2061	12.7
Aerospace engineers	17-2011	11.3
Aerospace engineering and operations technicians	17-3021	11.3
Electrical and electronics engineers	17-2071	7.9
Mechanical engineers	17-2141	5.8

New Economy). Indeed, similar figures and patterns are evident in other national economies. For example, women comprise on average 28% of science, engineering and technology (SET) workers in the European Union, ranging from figures of 32.5% (Bulgaria) and 28.9% (Ireland), down to a less encouraging figure of 18.6% in the Netherlands and Italy (Eurostat/European Union 2005). And, at the scale of the firm, scholars continue to find that women are concentrated in a narrow subset of (appropriately 'feminine') occupations within high-tech firms (see Panteli et al. 1999), particularly human resources and marketing (see, for example, James 2007). More encouragingly, however, female high-tech labour force participation rates continue to increase, not least as a result of ongoing institutional efforts to promote and support female graduates in SET disciplines, and to encourage women into SET industrial sectors [interesting examples include the Athena SWAN (Scientific Women's Academic Network) initiative in the UK; and in the USA, the Women in Technology Project funded through the US Department of Labor, Agriculture and Education].

Overall, therefore, against this varied industrial, occupational and institutional backdrop, the limited amount of work to date that explores

the gendering of high-tech regional economies suggests a very fruitful – yet highly underdeveloped – economic geographical research agenda in this vein. So motivated, this article offers a summary introduction to this nascent economic geographical literature and its parallels with other research streams being developed in management studies, feminist economics and human relations. The article focuses on three phenomena widely documented in the high-tech regional literature as supporting intra- and interfirm learning and innovation processes (see, for example, Keeble et al. 1999; Lawson et al. 1998), but whose attendant gendered social relations and divisions have yet to be fully analysed by geographers. Section 2 explores processes of female versus male worker mobility and churning and the brokering of the former by various female-dedicated 'labour market intermediaries' (LMIs). Section 3 explores processes of female high-tech entrepreneurship, venture capital (equity) financing and firm start-up, arguing that the vast majority of insights around entrepreneurship in the regional learning literature to date have come from an almost exclusive focus on male entrepreneurs. Section 4 explores some of the origins and implications of masculinist corporate cultures for firms' abilities to absorb and apply new information and insights once they enter the firm (firms' 'absorptive capacities'). Finally, in recognition of some of the shortcomings of recent studies, the article outlines some significant directions in which future work in this area might usefully develop, as part of a broader holistic regional economic competitiveness agenda that moves beyond the standard 'dessicated' indicators of development also to include issues of social justice, gender equality and well-being.

2 Female Worker Mobility, Knowledge Spillovers and Labour Market Intermediaries

In the context of the shift to a knowledge-driven economy, the capacities of regions to foster and support interactive processes of learning, innovation and knowledge spillovers have been identified as key sources of sustainable competitive advantage (e.g. Cooke and Morgan 1998; MacKinnon et al. 2002; Storper 1997). The point is that as cheaper and more extensive communications technologies have made some forms of codifiable or formalized knowledge readily accessible to all, the economic competitiveness of firms is increasingly dependent on their ability to access less ubiquitous embodied forms of tacit knowledge (Polanyi 1967, 4),[3] which are difficult to formalize, highly personal and context-specific (Maskell and Malmberg 1999). One major mechanism for the interfirm transfer of tacit knowledge in regional industrial systems is through worker mobility, or labour churning. When employees move to a different firm and work with new colleagues with partially overlapping knowledges (e.g. technical, organizational, commercial or intellectual), comparisons of evolving ideas are made with other practices in the firm that are not internally generated. Thus, there

is an increased potential for new unexpected ideas, interpretations and synergies to develop, that is, for increased learning and innovation (Grabher 1993; Malecki and Oinas 1999). Employees may also maintain advantageous ongoing links between their new firm and their previous firm via personal relationships. Thus, in contrast to rather esoteric notions of knowledge and innovation residing 'in the air' (Marshall 1890) or in the 'buzz of urban life' (Storper and Venables 2002), interfirm tacit knowledge transfer is not some disembodied process. Rather, it is always and everywhere peopled.

Problematically, however, major insights in the regional learning and innovation literature to date have come predominantly from explorations of male worker mobility (albeit in an international range of locations!). This is illustrated by a number of well-known and oft-cited studies. For instance, in the UK, Henry and Pinch (2000) provide a convincing empirical demonstration of the concrete mechanisms through which knowledge dissemination occurs in Oxford's Motorsport Valley,[4] based on the 'churning' of key personnel between firms (principally designers, managers and engineers), tracked through 100 leading employees' career biographies. This mapping revealed a move on average of once every 3.7 years, and a total eight moves in an average career in the industry. Strikingly, however, all of the career history case studies showcased in this study are male. In the USA, Almeida and Kogut (1999) have also tracked regional variations in knowledge spillovers in the semiconductor industry through the interfirm mobility paths of patent holder engineers in 12 US regions. Only 10 of the star engineers in their database of 483 patent holders are female! And, in Scandinavia, based on an impressive time-series dataset of 1.1 million workers, Power and Lundmark (2004) explore intensities of intra- and interfirm mobility of professional workers in a prominent Information and Communications Technology (ICT) cluster in Stockholm, Sweden (centred on Kista Science Park), and find them to be higher in this cluster than in the rest of Stockholm's urban economy. However, while acknowledging that women comprise 29.3% of ICT workers in Stockholm's ICT cluster, Power and Lundmark fall short of comparing male and female labour mobility patterns, instead lumping both groups of workers together in an apparently genderless mass.[5]

As such, there exists a relative dearth of explicit analyses of female labour mobility and churning in high-tech *regional* industrial systems, let alone how patterns of female labour churning vary between different high-tech *sectors* (e.g. computer software compared with biotech or semiconductors), and within that between different high-tech *occupations* (e.g. test engineers compared to project managers). However, a number of recent studies have begun to take issue with this strange state of affairs. Focusing specifically on female and male professionals in the ICT sector in Cambridge's high-tech regional economy,[6] Gray and James (2007) found significant gender differences in the qualitative nature of job churning,

underpinned by processes of 'trailing spouse syndrome' (see Hardhill 2002). Specifically, while female ICT workers change jobs almost as often as their male counterparts, this is often not for their own personal career advancement, but to accommodate their partner's career moves (also see Dex 1987). One outcome of this is that these professional women often make suboptimal career choices in order to increase their male partner's career mobility, meaning that their own career trajectories tend to be more erratic, unplanned, with more time spent underemployed. In terms of the impact of trailing spouse syndrome on firms' absorptive capacities, these kinds of female worker mobility trajectories are a double-edged sword. On the one hand, it potentially undermines female workers' abilities to act as conduits through which firms can access external sources of information and tacit knowledge outside of their existing competencies. Specifically, because 'new product development in high-tech sectors is favoured by cooperation between individuals with partially overlapping tacit knowledge of a technical sort' (Lawson and Lorenz 1999, 310), beneficial information transfer between firms through labour mobility (self-motivated or not) only functions when employees remain in the *same* sector or move into similar sectors where those same types of information, skill and competencies are equally valued. In contrast,

> Frequent transfers *between* occupations and sectors not only serves to devalue these embodied skills at the level of the individual female worker, but also the social networks of relationships between employees in different firms which take time to develop; a key form of corporate social capital which non-self-motivated labour mobility devalues and undermines. (Gray and James 2007, 426)

On the other hand, however, when individuals take insights learned in one sector (concerning, for example, materials, processes or products) and apply them in a different industrial or corporate context, it can also be argued that women with a greater likelihood of moving between sectors are in fact better placed to stimulate cross-firm and cross-industry spillover effects and more radical innovations.[7] Clearly, therefore, more work is needed on how the balance between these two effects falls in different high-tech subsectors and occupations.

Extending this theme, scholars have also found significant differences in the levels of job hopping between the majority of female workers with minor or no home and childcare responsibilities, compared to the majority of their female colleagues who have children (see also Dumelow et al. 2000). Females with children invariably demonstrate lower levels of occupational mobility in attempts to minimize the disruptive effect that changing jobs can have on the entire family unit (see Folbre 1994).[8] Again, while limiting individual female employees' abilities to further their own careers relative to their male colleagues, constrained levels of job hopping identified among female ICT workers also constrain those workers' abilities

to acts as conduits through which tacit embodied knowledge is transferred between firms in the region. Indeed, Gray and James (2007) suggest that these problems are reinforced by many female ICT workers foregoing attendance at masculinized afterwork social events where they might otherwise become aware of suitable job openings at other firms, and share in informal information exchange (cf. Saxenian 1994).

It is therefore encouraging that within this context, other scholars have documented the activities of a range of LMIs (Abraham 1990; Benner 2002; Capelli 1999; Osterman 1999) external to the firm that seek to remove barriers to the occupational mobility of female high-tech workers. Traditionally, the role of LMIs refers to job brokering or matching activities in which employers and workers are brought together in the labour market. Traditional LMIs, therefore, include temporary staffing agencies, employment agencies, recruiters and labour unions. However, in the context of the new economy, new forms of LMIs have emerged including professional associations, high-tech craft guilds and online organizations (see, for example, Benner 1998, 2004; Benner and Dean 2000) whose expanded activities include skills training, workforce development, restructuring hiring practices, social network building and sharing of expertise, skills and knowledge in support of regional, occupationally based, cross-firm learning communities. Examples of female-focused LMIs in this genre are given in Table 3, some of the more well-known of these organizations including the online and face-to-face activities of the Association for Women in Computing (www.awc-hq.org), Women in Technology (www.womenintechnology.co.uk) and Webgrrls (www.webgrrls.com). Particularly successful, Webgrrls has a membership of 30,000 women spread across over 100 chapters worldwide and is comprised of female IT workers in a range of professions and semiprofessions at different levels of the employment hierarchy (Webgrrls User Survey 2007; see also Benner 2003). While not explicitly excluding men from their membership and activities, the common raison d'être of these female-orientated LMIs stems from concerns that women in high-tech occupations continue to face greater barriers to personal networking than do their male colleagues when:

> Ultimately the ability of workers in information technology industries to attain and retain their high status in the labour market requires . . . the ability to stay on top of industry trends and changing skills demands, to find access to multiple employment opportunities when needed, and to build career mobility over time across multiple organizational contexts. (Benner 2003, 1819)

In short, therefore, female-orientated LMIs provide their members with a soft infrastructure to learn and maintain the skills and expertise needed to compete in volatile high-tech regional labour markets, also providing female IT workers with mentoring programmes, peer support, online job listings, technical discussion boards and advice around issues of combining childcare and paid work (persistent gender inequalities in the burden of

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Table 3. Female-orientated high-tech labour market intermediaries.

Organization	URL	Description/aim
Association for Women in Computing	www.awc-hq.org	Provides opportunities for professional development of women in computing through networking and programs on technical and career-oriented topics
BlackGeeks	www.blackgeeks.com	'Online community and gathering place for African American Techno Savvy women'
GirlGeeks	www.girlgeeks.org	Online community: seeks to ensure that women and other often-overlooked groups have the freedom, motivation and resources to participate in the new world of technology (founded out of the Bay Area)
MentorNet	www.mentornet.net	US online mentoring network for women in engineering and science: connects senior women in technology to female university students pursuing technology careers
SF WOW – San Francisco Women on the Web	www.sfwow.org/	San Francisco/Silicon Valley based group committed to serve, educate and empower women in technology through professional development, support and diverse networking opportunities.
Systers	http://anitaborg.org/initiatives/systers	Global online community of technical women in computing and technology fields: provides a private space for women to seek advice from their peers, and discuss the challenges they share as women technologists
TECHDIVAS	www.techdivas.com	Virtual community for technical women in computing
Webgrrls International	www.webgrrls.com	International online news network and resource for information on women and technology
Women In Technology	www.womenintechnology.co.uk	Seeks to help women succeed in an increasingly technical workplace and world through networking, exchanging job and business leads, and teaching new skills (UK based)
WorldWIT	www.worldwit.org	Global online discussion community for women in business and technology

childcare continue to be reinforced by powerful policy and workplace discourses that position work-life 'balance' as a 'women only issue'). In empowering female workers in pursuit of increased labour mobility, these LMIs also shape regional cross-firm dynamics of learning and information exchange in ways yet to be comprehensively analysed by geographers.

3 Female Entrepreneurship, Equity Financing and Firm Start-up

Over the last two decades, scholars have also shown that the existence of well-developed venture capital networks significantly accelerates the pace of technological innovation and regional economic development (see, for example, Florida and Kenney 1988; Florida and Smith 1990; Rausch 1998; Zook 2002). Venture capital refers to the provision by specialized financial companies or by individuals (business angels) of, usually, equity capital for new and existing enterprises, which are unable to finance growth from internally generated sources of finance and debt finance, and are too small or unwilling to access public equity markets (Martin 1999; Mason and Harrison 1999). For companies seeking to exploit significant growth opportunities, the financial requirements of the business may rapidly exceed its capability of generating funds internally and of attracting additional debt finance on account of the limited availability of business collateral (Binks and Ennew 1996). However, at the start-up stage, firms have neither the track record nor the collateral to support bank-lending on the scale required. In these circumstances, firms' abilities to obtain equity finance[9] will determine their ability to grow and survive. In addition, venture capitalists bring technical skill, operating experience, accumulated learning and networks of industry contacts as well as cash to the ventures they fund, helping to further the long-term viability of newly created firms (Castilla et al. 2000). As such, venture capital networks are an integral component of the learning and innovation infrastructure within high-tech regional industrial systems (Florida and Samber 1999), empowering entrepreneurs to form new companies by providing finance, contacts and expertise to facilitate the commercialization of new ideas and innovations.

However, while venture capital networks are recognized as a fundamental elements of the 'soft' infrastructure supporting innovation and learning in high-tech regional economies, data suggest that less than 5% of all equity investments made in the USA are made to women-led firms (Greene et al. 2001), likewise in Canada (Jennings and Cash 2006), compared to only 3.4% in Europe (VentureOne 2005). In other words, the vast majority of our current understanding of venture capital dynamics in high-tech regional economies has come from analyses of the successful activities of male entrepreneurs. Economic geographers have, in the main, yet to engage fully with processes of female entrepreneurship, and the sources and consequences of gendered constraints to female access to venture capital.[10] In contrast, there exists a sizeable literature on female entrepreneurship by industrial

relations scholars and economists. Emerging research shows that female entrepreneurs continue to face significant cultural-economic obstacles relative to male entrepreneurs in accessing venture capital networks. These obstacles include: a lesser confidence in their own entrepreneurial capabilities relative to males on the basis of internalized gender-specific images and discourses that position women in a subordinate role (Hofstede 1991); less time spent developing and maintaining professional networks of contacts than male entrepreneurs as a function of the double burden of combining paid work with a disproportionate share of household and caring responsibilities (Verheul and Thurik 2001); and stereotypical assumptions invoked by investors regarding the relative abilities of female and male entrepreneurs that construct female-led ventures as 'riskier investments' (see Bygrave and Timmons 1992; Greene et al. 2001).

Other studies have examined the specific creative practices that women entrepreneurs use to overcome these obstacles. On the one hand, female entrepreneurs leverage alternative sources of finance to increase their legitimacy in the eyes of potential investors by demonstrating product feasibility, cash management capability and customer acceptance, and therefore increase the chances of obtaining equity capital for later stages of growth. These so-called 'bootstrapping' activities involve creatively acquiring resources without raising equity or borrowing money, or else minimizing the need for financing in the first place by securing resources at little or no cost (Bhidé 2000; Freear et al. 1995). Thus, for example, based on an analysis of 88 female-led high-tech firm start-ups seeking equity financing in the high-tech regional economies of Silicon Valley, Boston, Chicago, Washington, DC and New York, Brush et al. (2006) showed that women practise a variety of inventive bootstrapping activities including: using pre-paid expenses, royalties and special deals from customers and suppliers to finance R&D; using personal savings, personal credit cards, and working from home to sustain business development; limiting cash flow and expenses by borrowing equipment, buying second-hand equipment and through trade credit; by meeting short-term cash needs through the withholding of founders' salaries, delaying payments to suppliers, or through loans from friends and families; or else trading services with other women in exchange for help or participation in Local Exchange Trading Systems (see Harrison et al. 2004; Williams et al. 2001).

In addition, these individual efforts by female entrepreneurs find institutional support in a number of regionally focused female networking, mentoring and financing initiatives. The sample of female high-tech entrepreneurs in Brush et al.'s (2006) study was drawn from applicants to Springboard (www.springboardenterprises.org), a US-based non-profit organization explicitly developed to educate, showcase and support female high-tech entrepreneurs seeking to equity investment. To date, Springboard companies have raised over US$3 billion from over 4000 investors, financiers and service providers. Other interesting examples of organizations

established to foster and support female high-tech entrepreneurship include the Women's Technology Cluster (now Astia) in San Francisco (www.astia.org), a mentoring network of over 220 professionals has helped 110 women-led high-tech start-ups raise over US$230 million; the Forum for Women Entrepreneurs and Executives in the Bay Area (www.fwe.org); and Fund Isabella, a venture capital firm catering explicitly for female only entrepreneurs (www.fundisabella.com). These various initiatives accelerate the success of women entrepreneurs in high-tech sectors by providing unique opportunities for them to meet, learn, exchange knowledge and expertise, and to collaborate through peer-to-peer networking, in pursuit of overcoming gendered barriers to leveraging equity growth finance. Nevertheless, much remains to be done, not least in exploring how the networking needs of women in different high-tech sectors and occupations differ; likewise the feasibility of spatially transferring successful female networking initiatives to other legislative, institutional and cultural contexts.

4 Masculinist Corporate Cultures and Firms' (Reduced) Absorptive Capacities

For high-tech firms, competitiveness is sustained by becoming a moving target through continuous technological learning and the rapid development and commercialization of new ideas (Block 1990; Storper 1995). Crucially, however, this is dependent not only on firms' employees' abilities to access external sources of information as outlined above, but also on their abilities to assimilate, reconfigure, transform and apply new information to commercial ends; or in other words, on their 'absorptive capacities' (Cohen and Levinthal 1990, 1994; Feldman and Klofsten 2000; Howells 2000; Hotz-Hart 2000). Different absorption rates are not random but depend on both the social and cultural structures within firms (Farrands 1997), because the ability to absorb new knowledge within a firm will always depend on sociocultural constructions of what is acceptable and desirable (Schoenberger 1997). The innovation literature has thus consistently highlighted a set of cultural norms that, if widely shared by the members of a firm, actively promote the generation of new ideas and facilitate the implementation of new approaches. These norms are argued to include a climate of openness in which debate is encouraged; a willingness to listen to other people's ideas; creative dissent or the right of employees at all levels to challenge the status quo; and multiple advocacy that learning requires more than one 'champion' if it is to succeed (Deal and Kennedy 2000; DiBella et al. 1996; O'Reilly 1989). The point is that the open exchange of ideas among members of a project team or a firm functions to stimulate thought and generate a level of creative thinking that solitary reflection rarely stimulates (Lawson and Lorenz 1999). It is, therefore, a precondition for learning and innovation that firms' employees should be able to communicate with one another (Amin and Wilkinson 1999; Spender 1996).

Within this context, it is significant that, in contrast, geographers have documented 'masculinist' corporate cultures in high-tech firms that either fail to evidence these traits, or else contradict them, significantly undermining firms' capacities to make full use of female employees' embodied competencies, skill-sets and knowledge. Notably, Doreen Massey has investigated the gendering of organizational cultures in high-tech firms – or what she terms masculinized 'high-tech monasteries' – in Cambridge, England (Massey 1995). On one level, the social construction of high-tech jobs as 'male' can be understood in terms of the time-based nature of post-Fordist competition between knowledge-intensive firms, coupled with an individualized knowledge-based labour market that, in combination, (re)produce corporate cultures based on presenteeism, the glorification of working evenings and weekends, and 'not letting the team down'. Or in other words, 'the ideal scientific worker is, once again, that elusive rational individual without dependents' (McDowell 2000, 499) – long live the Silicon cowboy! However, Massey argues, the origins of these masculinist organizational cultures must also be understood not so much in terms of overt discrimination or sexism around the perceived unsuitability of women for high-tech jobs, but ultimately in terms of a set of deeply internalized broader societal dualisms that structure workplace social relations based on the logical and scientific nature of high-tech work:

> These jobs represent an apex of the domination of reason and science. It is this which lends them much of their status . . . What they demand is the ability to think logically. They are in a sector of the economy whose prime characteristics are, for these employees, structured around one of the oldest dualisms in Western thought – that between reason and non-reason; it is a sector identified with that pole – reason – which has been socially constructed, and validated, as *masculine*. (Massey 1995, 489 emphasis added)

Building on Massey's earlier research, Gray and James (2007) also identified masculinist corporate cultures in their sample of ICT firms in Cambridge, UK, manifest in terms of significant gender inequalities in the abilities of female employees to make their voices and ideas heard relative to their male colleagues. Specifically, female research participants outlined how they had articulated important insights and ideas that were either not incorporated into final product designs, or else were subsequently accredited to male colleagues. Gray and James have argued that, in turn, this significantly limits the processes of creative dissent, constant questioning and multidirectional knowledge flows that are widely theorized to underpin positively firms' capacities for innovation and learning. However, this study falls short of offering an empirical demonstration of whether or not these self-identified constraints at the level of individual workers give rise *collectively* to a discernible impact on firms' observed 'bottom line' performance, as manifest in metrics such as revenue, share value, frequency of product roll-out, etc. Or, in other words, is it possible to frame arguments

for improved gender equality in high-tech firms in a language that business owners appreciate and understand? There remains much to be done.

As geographers seek to explore these mechanisms in more depth, they might usefully draw on empirical studies on heterogeneous work teams from management studies, organizational psychology and human relations that suggest that, in work environments characterized by high levels of uncertainty (such as high-tech) gender diversity within firms' workforces is positively correlated with superior corporate performance along a number of dimensions. First, empirical studies suggest that workforce diversity stimulates creativity and innovation (see, for example, Eisenberger et al. 1990; Filley et al. 1976) because:

> Attitudes, cognitive functioning, and beliefs are not randomly distributed in the population, but tend to vary systematically with demographic variables such as age, race and gender. Therefore, an expected consequence of increased cultural diversity in organizations is the presence of different perspectives for the performance of creative tasks. In addition, employees who feel valued and supported by their organizations tend to be more innovative. (Robinson and Dechant 1997, 27)

Second, research has also shown that heterogeneous work teams outperform homogenous work teams on the basis that diversity allows team members to see problems from a variety of perspectives based on a range of experiences: the natural conflict that emerges from the interaction of these different perspectives ensures that a wider range of possible solutions and alternatives are entertained (e.g. Jackson et al. 1995; Fenwick and Neal 2001). Nevertheless, these competitive advantages do not automatically flow forth from the simple presence of women in a firm's workforce or management team *per se*. Rather, they are also dependent on a corporate culture in which everyone's opinions are valued, and in which male colleagues are actually willing to listen to the inputs of female colleagues.

5 Concluding Comments

Over the last two decades, as part of a 'cultural turn' within the discipline, expansive research agendas have developed in economic geography around the sociocultural dynamics of high-tech regional development and around cultural economies of gender. While for the most part, these two research streams have proceeded separately from one another, scholars have begun to bridge this intellectual divide, variously drawing on parallel research literatures in organizational psychology, management studies and human relations to explore how different dimensions of high-tech regional economic development are fundamentally and unavoidably gendered. This short article has introduced three phenomena widely documented in the regional literature as supporting intra- and interfirm learning and innovation processes and whose attendant gender relations are now, at last, beginning

to be investigated, namely, (i) processes of worker mobility, labour 'churning' and their brokering by different labour market intermediaries; (ii) equity financing, entrepreneurship and firm start-up; and (iii) the origins and implications of (masculinist) corporate cultures for firms' absorptive capacities and hence economic competitiveness. The wider importance of this nascent hybrid literature is that it begins to make visible subtle gender inequalities in the very high-tech workplaces and regional economies that policy-makers worldwide continue to look to as positive exemplars of the new work and employment conditions accompanying the transition to the so-called 'New Economy'.

There remain a series of interesting research questions with which future research within this vein might engage. First, given that many of the gender inequalities outlined in this article are rooted in an ongoing unequal domestic division of labour in which women continue to bear a disproportionate share of household and childcare responsibilities, what kinds of work-life 'balance' policies and workplace practices do different cohorts of female knowledge workers find most useful in mitigating negative work-to-home spillovers and constraints on their career progression? Indeed, in the context of widespread ongoing scepticism on the part of many employers regarding the so-called 'business case' for work-life balance, under what conditions and through what mechanisms does worker uptake of different work-life balance (WLB) provisions enhance the kinds of intra- and interfirm learning and innovation processes discussed in the main body of this article as positively underpinning the economic competitiveness of knowledge-intensive firms in dynamic regional economies?[11] These issues are only just beginning to be researched in economic geography (see, for example, James 2006b, 2007). Second, our understanding of the regional cultural economy of high-tech female entrepreneurship remains at best partial. In particular, there is considerable scope for incorporating a more explicit geographical imagination into the extant female entrepreneurship literature through spatial comparative analyses of how female high-tech entrepreneurs seek, acquire and manage equity finance in different regional institutional settings, as well as in different national legislative contexts. And third, while more recent accounts of inter-regional 'global knowledge pipelines' based on international networks of migrant workers begin to rectify the problems of earlier over-territorialized conceptions of regional economies (see, for example, Saxenian 2005), there remains considerable scope for exploring the causes and consequences of gender divisions within these global migrant networks. Or, in other words, what of the new Argonettes?

In tackling these various issues, economic geographers might contribute to an emerging holistic regional development project that, while not excluding economic concerns of competitiveness, growth and productivity, attempts to move beyond narrow economism and 'dessicated indicators of development' (Morgan 2004) to develop a broader and more progressive

conception of regional 'development' that also integrates normative questions of quality of life, gender equality, well-being and social reproduction (see also Blake and Hanson 2005; Bristow 2005; Perrons 2001, 2004; Rees 2000). That is, the traditional priority of first 'fixing the economy' as a prelude to and platform for securing social well-being is challenged (Pike et al. 2006, 256). Herein, lies the broader relevance of the crucially important research agenda presented in this article.

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Short Biography

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Notes

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[1] Indeed, geographers have also explored how these economic categories are themselves discursively as well as materially constructed, practised and performed at different spatial scales.
[2] The term 'high-tech' is used widely to describe an heterogeneous group of industries. Different studies use a diverse range of input measures (e.g. percentage of total employment in science, engineering and technology occupations; or R&D spending as a percentage of sales) and/or more qualitative judgements of firms' outputs (e.g. industries producing products deemed as 'embodying new or leading-edge technologies') (see Hecker 2005). Likewise, different studies define competing occupations as 'high-tech' dependent on different measures of educational inputs to production, and workplace application of specialist knowledge (see Kilcoyne 2001). Based on their continual review of competing methods, the US Department of Labor Statistics

maintains an authoritative and considered list of high-tech sectors and high-tech occupations that are also consistent with popular conceptions of 'high-tech'. These lists have informed Tables 1 and 2.

[3] Notions of tacit knowledge draw on the work of Michael Polanyi, and refer to the knowledge or insights that individuals acquire which is ill-defined or uncodified and which they themselves cannot fully articulate, in contrast to explicit (or codified) knowledge is knowledge that is transmittable in formal, systematic language. However, the distinction between 'tacit' and 'explicit' knowledge is not fixed.

[4] 'Motorsport Valley' refers to the regional agglomeration of the British motorsport industry that employs 'well in excess of 30,000 people and consists of scores of small-and-medium sized firms clustered in a 50 mile radius around Oxfordshire in southern England. Approximately three quarters of the world's single-seater racing cars are developed and assembled in the region' (Henry and Pinch 2000, 192).

[5] Similar problems beset other studies including Keeble et al. (1999).

[6] The qualitative dataset for Gray and James's (2007) Cambridge ICT study was derived from 88 semi-structured interviews with female and male human resource managers, CEOs, engineers, scientists and technologists in 11 of Cambridge's leading computer software and telecommunications firms (defined by employee size and establishment revenues in 2002). This was supplemented with 10 group interviews (each with between three and seven participants) in three of the initial 10 firms segregated by gender to facilitate freer exploration of the role of gendered social relations and divisions in workers' respective workplaces.

[7] I am grateful to an anonymous referee this key point.

[8] This disruption includes changing complex commuting patterns that incorporate nursery, school and a partner's commute; possible redistribution of domestic duties; and even possible relocation of home, school and social networks.

[9] Venture capital involves the exchange of capital for an ownership stake in the firm (Florida and Smith 1990).

[10] However, the work of Heike Mayer and her colleagues offers an important exception to this pattern (see Mayer forthcoming; Mayer et al. forthcoming).

[11] Work-life 'balance' policies and practices can be divided into three main groups: those designed to give workers greater 'flexibility' in the temporal scheduling and spatial location of work; those that reduce workers' total hours worked; and those designed to provide workplace social support for working parents.

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