Chapter 2.8

Dynamics and Challenges of Innovation in Germany

Alexander Ebner, Johann Wolfgang Goethe-University, Frankfurt, Germany
Florian A. Taube, European Business School, Oestrich-Winkel, Germany

Introduction

The economy of the Federal Republic of Germany, labeled a 'growth miracle' in the 1950s, emerged as the growth engine of Europe throughout the 1960s and 1970s. Despite the slowdown of growth rates during the 1980s, it remained Europe's strongest and most innovative economy (Hartshoff, 2008), making its unique brand of a 'social market economy' a role model, combining technological innovativeness, international openness, and industrial competitiveness with an extensive welfare system. Since the 1990s and 2000s, however, the various challenges posed by economic globalization, technological change, locational competition, demographic pressures, persistent mass unemployment, and the fiscal burden of reunification with East Germany have exercised a pressure for institutional reform. Indeed, current German policy discourse is preoccupied with the need for inducing more entrepreneurial drive into the economy at large, in line with the formation of a knowledge-based economy. This reform orientation also affects the debate on innovation: the primary task is the restructuring of Germany's innovation system in the direction of an entrepreneurial approach that combines institutional flexibility in the research and educational systems with promotion of entrepreneurship in both start-ups and established firms, while providing adequate risk capital and manpower. Thus, innovation in Germany is a reflection of more extensive institutional changes which are transforming Germany's post-war coordinated 'social market economy' into an institutional hybrid whose shape is not yet clear—apart from becoming decidedly more entrepreneurial.

In this chapter, we outline existing conceptual frameworks for assessing innovation dynamism in a country, combining the neo-Schumpeterian notion of a national innovation system with Michael Porter's concept of 'national innovative capacity' (Furman, Porter, and Stern, 2002) and David Audretsch's approach to the 'entrepreneurial society' (2007). Next, we survey the relevant institutional determinants of the German economy, addressing such issues as the trade regime, competition law, labor relations, the financial system, and entrepreneurship policies. We then highlight the basic features of the German innovation system, in particular pointing to factors such as education and training, R&D, and university-industry relations. We emphasize two salient developments in financial markets, namely the advent of venture capital and of...
high-growth stock markets. Finally, we investigate patenting and the role of regulatory conditions for new ventures and provide an outlook on the future challenges to German innovation performance in the context of globalization.

Assessing innovation: Knowledge, institutions, and entrepreneurship

Innovation may be perceived as an interactive process requiring complex institutional arrangements, specifically, the coordination of the interplay between entrepreneurship and organization in the commercialization of knowledge by introducing novelty into the domains of markets and industries. In other words, technological innovation may be perceived as an outcome of embedded entrepreneurship; that is, a collective process shaped by formal and informal institutional frameworks and knowledge infrastructures (Ehren, 2009).

The systems innovation approach offers a useful Schumpeterian perspective for addressing these topics and emphasizes the innovation-driven character of capitalist development. It examines the impact of institutional networks on the generation and assimilation of innovations within a given territorial setting, and highlights the conditions for organizational learning in stimulating innovative capability. Businesses comprise the principal terrain for innovation, but other institutional elements, such as R&D facilities, education and training programs, and financial, legal, and patent systems are taken into consideration as components of those public and private networks which contribute to the introduction of new technologies (Freeman, 2002). Thus, knowledge is viewed as a fundamental resource for innovation, whereas organizational learning is assessed as the most important underlying process. Industrial structures and the institutional set-up of an economy then determine the shape and performance of a national or regional innovation system, whose structural constellations yield a specific entrepreneurial potential. Thus, innovation systems include those structures of governance which handle the innovative contributions of public and private goods in a manner supportive of economic growth (Lundvall et al., 2002).

Institutional configurations indicate the specifics of an innovation system in a given territory or country. Accordingly, as the nation-state provides the most relevant indicator of economic order, innovation-related interactions and related market activity, the systems concept has been most extensively applied to compare national innovation systems, augmented by analyses at the regional and sectoral level. Indeed, it makes common sense that the systems approach considers how decisively the policies of particular governments, national laws and a shared culture in an institutional arena affect the intensity and direction of technological innovation (Lundvall, 1992; Nelson and Rosenberg, 1994). Corresponding efforts in comparative institutional analysis have taken a general interest in the diversity of national models of capitalist development and the institutional basis of advantages in their respective innovation patterns (Hall and Soskice, 2001). The description of institutional characteristics even allows for characterizing distinct types of national innovation systems, such as "myopic" or "dynamic". Myopic systems are typical in the United States and the UK with short-term modes of technology investment, as compared with dynamic systems of innovation in late-industrializing countries such as Germany and Japan, which tend to recognize the long-range character of technological investment and complement market processes with specific policies for technological learning (Patel and Pavitt, 1994).

With the onset of globalization, however, these national characteristics are being transformed, depending on country-specific decisions and path dependencies. In particular, the extent to which firms, research centers, and government agencies institutionalize their innovation-oriented activities and interactions have become highly relevant, indicating the way in which national innovation systems are moving towards greater international openness and market competition (Galil and Teubal, 1997). However, despite this tendency, the most crucial modes of interaction remain at the national level. There may be supranational parallels, but these do not yet substitute for the institutional competence of nation-states. Besides, even though tendencies toward structural convergence persist, they have the effect of promoting even greater institutional specialization and divergence among national innovation systems (Freeman and Soete, 1997).

In this context, national innovative capacity, as outlined by Porter and others, implies those very institutional and structural features of a national innovation system, which promote the international competitiveness of firms and industries, and thus reflect the competitive advantages of nations in an increasingly globalized economy. National innovative capacity is defined as the capability of a country to produce and commercialize new technologies over the long term. In so doing, a country can reflect institutional and structural features, such as variation in economic geography, firm-level spillovers, and cross-country differences in industry and technology policy, as indicated by public R&D expenditures and the enforcement of intellectual property rights. In the systems framework, the linkages between innovation infrastructures and industrial clusters are critical for maintaining dynamic growth, augmented by appropriate skilled human resources, well-structured research endowments, and adequate venture capital (Furman, Porter, and Stern, 2002).

Entrepreneurship parallels these concerns. The systems framework somewhat neglects certain aspects in the microfoundations of innovation, namely, the role of new business ventures in the ongoing structural change towards a knowledge-based entrepreneurial economy. Indeed, since 2000, major impulses for employment creation and income growth in the OECD have been generated by start-up enterprises of diverse scale and scope well beyond the operations of large corporations operating in global production and service networks. According to Audretsch's "knowledge spillover theory of entrepreneurship", cross-national differences in entrepreneurial performance may be explained by institutional contexts. Those which are rich in knowledge and new ideas will tend to generate more entrepreneurial opportunities (Audretsch, 2007). Accordingly, a new policy approach is emerging which focuses on enabling the creation and commercialization of knowledge by promoting the startup and viability of new firms involved in knowledge-based entrepreneurship. This policy approach encompasses multiple levels of activity in a pattern of systemic linkages, ranging from the individual to the enterprise, and to the cluster or network, which might involve an Industry or sectoral dimension, or a spatial dimension, such as a district, city, region, or even an entire country.

Related policy instruments include distinct policies for taxation, immigration, or education, as well as more direct instruments, such as the public provision of resources for finance or training (Audretsch, Grillo, and Thurik, 2007).

However, given the empirical complexity of entrepreneurship, innovation and economic growth, we must not consider the perspectives and approaches described above as being mutually exclusive. It is more appropriate to view the economic performance of a nation or region as the outcome of a particular system of innovation. It is the system which constitutes the backbone of an institutional infrastructure that promotes specific innovation capacity in an evolving entrepreneurial society. Next, in this integrative perspective, we examine the institutional determinants of the German economy, in particular its trade regime, competition regime, labor and welfare state issues, and entrepreneurship policies. This will prepare the reader for a critical discussion of the German innovation system, highlighting the key areas of technological advantages, education and training, R&D, and university-industry relations.

Institutional determinants of the German economy

The German economy illustrates outstanding growth over a very long period, beginning with the successful recuperation of the German Empire in the last quarter of the 19th century, accomplished through major efforts in education, training, and innovation. Indeed, both modern university- and science-based research firms originated in the late 19th century as examples of institutional innovation in Germany (Keil, 1993; Buenstorf and Marmann, 2005). In combination, these formed the backbone of an industrial system of professional engineers that enabled Germany (and the United States) to overtake British technological leadership, in industries such as synthetic dyes (Marmann, 2003; Jones, Wuchty, and Uzzi 2008). This was followed by the German "economic miracle" of the 1950s which turned Western Germany into an export-oriented economic power in the world economy, the home of major multinational enterprises, and the home market of globalizing industries such as electronics, pharmaceuticals, and automobiles. Nonetheless, the various challenges posed by globalization, technological change, intensified geographic competition, demographic pressures, persistent mass unemployment, and the fiscal burdens of reunification have hampered German economic performance since the 1990s. These have made it difficult for Germany to put in place those institutional reforms which are necessary to establish a more vibrant growth trajectory in line with the demands of a knowledge-based economy. The underlying drive to maintain international competitiveness—despite all the internal rigidities and frictions that hamper Germany's political and
is the "world champion of exports" (Wu, 2008), with around 10 percent of world exports. Figure 1a illustrates total exports and Figure 1b the even higher share of exports of manufactured goods. The latter reflects the relevance of the manufacturing sector in Germany and its competitive advantage in terms of innovation, not cost. In Germany, manufacturing as a share of GDP has been stable since 1995, relative to the UK, U.S., France, and Japan, in all of which it has been declining.

In terms of exports, China is catching up, and, having already overtaken Japan in 2004 and the U.S. in 2007, is now a close second behind Germany (Wu, 2008).

Structurally, the German trade regime is subject to the various rules and regulations of the European Union, which has exercised an impact on trade issues ever since the Rome Treaties of 1957 installed the Customs Union in Western Europe. However, this relatively high degree of openness to foreign trade and investment is subject to restriction when it comes to areas such as agriculture and some industries, in which non-tariff protectionism is bolstered by subsidies and related instruments of selective industrial policy, in particular those having strategic significance. Moreover, the German economy displays institutional peculiarities - viz. the historic and only very recently changing role of the banking sector and labor unions in non-market decision making - which may be responsible for the relative underperformance in capital inflow (Siebert, 2005).

The openness of the German economy is also promoted by a distinct competition regime, governed by European Union regulations. Yet post-war efforts to boost Germany's competitiveness to reflect market principles have persistently influenced the European policy agenda, resulting in adoption of policy approaches to antitrust legislation, mergers, cartels, and to liberalization, internationalization, and state aid which parallel the concepts found in traditional German competition policy.

Institutional reform to activate entrepreneurial initiative is characteristic of labor and welfare state policy. Some one-third of German GDP is allocated to social policy issues, financing an extensive welfare state which provides budgets for unemployment benefits, health care, and old-age pensions. The linking of social and labor market policy has been a fundamental concern since the 1990s, confronting the pressures of reunification, globali- zation, and demographic change. Following the failure of neo-corporatist labor market initiatives, the Schröder government implemented the so-called 'Hartz Commission' proposals for reform of administration and the social security system. One key focus of these reforms, as bundled in the Agenda 2010 program, is the drive to motivate the unemployed to undertake entrepreneurial initiatives, using material incentives that would lower the reservation wage and facilitate an earlier re-entry into the labor market (Crada, 2005).

Corresponding efforts to promote greater flexibility in wage setting and labor regulations indicate that the heyday of German neo-corporatism is definitely over. The role of both unions and employer associations in labor relations is decreasing. As a result, not only are firm-level wages more easily adapted to potentially more volatile local conditions, but there is greater fragmentation of organized interest groups. This latter consequence may lead to intense distributional conflicts. Still, the concept of 'co-determination,' which gives the unions a strong standing in the supervisory boards and worker's councils of large firms, is still in place, even though its abolition had been repeatedly predicted.

This pattern of change also applies to entrepreneurship policy, which combines basic concerns for competition and labor market policy with a drive for innovation. While traditional types of industrial policy have been largely focused on large firms in both sunrise and sunset sectors of the German economy, the most pressing task is the promotion of entrepreneurship on all organizational levels, regardless of the scale and scope of the firms involved. Indeed, traditional industrial policy has basically neglected the dense networks of small and medium-sized enterprises (SMEs) that are the foundation for employment, training, and income generation in Germany's industrial system of flexible specialization, with its regional focus in south-west Germany. During the 1990s, however, the special role of business start-ups in promising new industries was recognized, leading to initiatives such as the BioRegio contest, aimed at the formation of innovative networks in biotechnology among public and private sector in 17 regions all over Germany, which competed for public funding. In this manner, industrial policy was reshaped to dovetail with a greater regional and sectoral differentiation in the German innovation system. This, in turn, provided the institutional underpinnings for technological change and competitive performance (Heidenreich, 2005; Arnesley, 2004).

**Dynamics of the German innovation system**

The German innovation system is characterized by a pattern of predominantly incremental and process innovation in its key manufacturing industries, based on a skilled and relatively autonomous workforce. It combines strengths in high-quality competitive innovations in the chemical, pharmaceutical, me-
knowledge-intensive services. Moreover, Germany’s share of international R&D investment was only about 20 percent, far below the OECD average; the same holds for the 20 percent share of basic research in the overall R&D portfolio (Lejem, Krawczyk, and Leidmann; 2009; Rammer et al., 2004; Prange, 2005). These statistics already point to a kind of entrepreneur-
ship gap and indicate the need for change in the institutional setup of the German innovation system, away from a focus on innovation support that benefits research consortia and to the establishment of large firms with an international reach. A telling illustration of this problem is provided by empirical assessments of attitudes towards innovation problems in national populations, using such sources as the World Values Survey or other primary data (Mitchell et al., 2000; Witt and Redding, 2009). Theoretical models integrate cognitive and normative with more formal regulatory dimensions (Busenitz, Gomper, and Spencer, 2000). In the case of Germany, it is primarily science and technology, which are appreciated, whereas the view of start-up activities and entrepreneurial risk-taking remains below the OECD average (Beltz and Kirn, 2008).

The reconfiguration of the German innovation system towards greater diversity in entrepreneurship and innovation is being supported by innovation policies in the multi-level setting of national as well as regional and European initiatives (Kaiser and Prange, 2004). Most recently, the Merkel government has implemented a so-called ‘High-tech strategy for research and development’ that should boost R&D spending by €6 billion, although even this sum is not sufficient to reach the goal of 3 percent GERD in 2010, as was announced in the ambitious earlier plan. But the need for financial resources is not the only problem. Even more pressing is the need for adequate manpower to maintain adequate innovation performance in an entrepreneurial and science-based context. Some 100,000 additional research scientists and engineers—representing a substantial increase in human capital—would need to be recruited to achieve a GERD of 3 percent. This gap in human resources becomes even more problematic when we take into account the current decline in the number of engineering graduates. To address this gap, the government initiated a program in 2000 (the green card for foreign IT experts) to attract international manpower in knowledge-intensive industries. However, neither this effort, nor the reforms of the German system of higher education in 1998 and 2002, which were aimed at increasing the autonomy of universities to make them more compatible with international models, could meet the needs. Indeed, it would appear that what is required to meet the need for qualified personnel, especially in science-based industries, is a concerted effort at the level of Europe as a whole (Grupp, Schmoch, and Breitschopf, 2008).

Financing innovation

The mode of strategic non-market decision-making in the business sector mentioned above (e.g., in labor relations) also applies to the German financial system, which relies on bank-based governance procedures for capital allocation. While the system has been undergoing a major shift to a stronger role for capital markets, it still differs markedly from those of Britain or the United States, which are market-based. This is reflected in Germany’s underdeveloped corporate governance system. As a consequence, the post-war model of a coordinated market economy with close linkages between banks and industry, based in a neo-corporatist setting of intermediate institutions, the so-called Deutschland AG, is in the process of partial dismantling and restructuring. The German economy has become an institutional hybrid, subject to path-dependent institutional change (Streeck, 2009). The most significant changes to the financial landscape have been the advent of venture capital (VC) and more recently, start-up market segments focused on entrepreneurial firms and their need for growth capital, such as the NASDAQ or the German Neuer Markt, which failed spectacularly after the burst of the dot-com bubble (Vitalis and Engelder, 2005).

Venture capital (VC)—sometimes called risk capital—arose first in the United States and its more risk-friendly economy. In Germany, however, VC is still relatively marginal, given the size of the economy and the strong tradition of bank financing. However, together with the UK, Germany accounts for 50 percent of VC investment in Europe. Despite the fundamental differences in the financial systems of the UK and Germany, the former being market-based and the latter bank-oriented, the German VC landscape is closer to that of the UK than of Japan, another economy with a relationship-oriented financial system dominated by banks. Banks are a major source of VC finance in most countries, and they are particularly important in Germany and Japan, while in Israel corporations are most prominent and in the UK-en-
sion funds. Interestingly, however, government funding plays a more important role in the UK than in Germany (Mayer, Schoors, and Yafeh, 2005).

In contrast to independent and corporate private equity providers, banks and government funds tend to have a less pronounced role in corporate governance and in monitoring the companies they finance, and often serve only as bridge investors (Tykocin, 2006). There is evidence that European venture capitalists engage in less monitoring and thus adopt a more hands-off approach to their portfolio companies, as compared to those in the United States. The use of convertible securities is markedly lower in Europe than in the U.S. (Schwenk, 2008). Furthermore, investors have less control, fewer veto rights, and use common equity in countries of German legal origin, relative to those of social-scandinavian, or French legal origin (Mayer, Schoors, and Yafeh, 2005; Cumming and Johan, 2008). For the bank-based systems of Germany and Japan, one potential explanation lies in the finding that prior relationships with a company in the venture capital market increase the likelihood of banks granting loans (Hollerman, Lindsey, and Pur, 2008).

Given the more risk-averse nature of German investors, VC is more easily available—especially from institutional sources—after a new venture has passed the early growth stage and begun to prove itself. In other words, very early seed-funding, where some call "business angels," is rarely available from financial investors in Germany. Therefore, entrepreneurs are restricted in their risk-taking due to the limited availability of funds, even in new high-technology industries, such as biotechnology. German VCs do not favor any industry in particular, as compared with their strong inclinations to IT and software in Israel and Japan; however, there is a slight tendency towards chemicals and manufacturing. In contrast, in Israel, known for its thriving high-tech industry, VC funds focus on the type of early-stage investment with which VC is commonly associated (Mayer, Schoors, and Yafeh, 2005). Table I illustrates the sources of funds and characteristics of investments by VC firms in Germany, Israel, Japan, and the UK.

The failure of the Neuer Markt had serious implications for VC funding, because venture capitalists see stock markets as their exit route to reap the benefits of their risk investment through initial public offerings (IPO). Originally, the Neuer Markt was designed to mimic a number of aspects of the US NASDAQ, enabling young firms an easier route to capital markets than the regular market segment, thereby increasing the match between supply and demand of risk capital. In particular, it was supposed to bring

- greater transparency for investors, particularly for smaller "outsider" investors who did not have intimate access to company management;
- liberal listing requirements, which allowed relatively new, as well as loss-making, companies to get a listing;
- increased protection for small shareholders, e.g., in defining a minimum period of time after the IPO during which insider investors could not sell their shares;
- greater liquidity, that is, the ability to buy or sell shares near the current market price, provided through a system of designated sponsors obligated to provide bid-ask market quotes.

While the Neuer Markt started slowly—there were only 12 listings in 1997—by 2000, it had become the most important market for growth stocks in Europe, overtaking the UK's AIM and France's Nouveau Marché by a large margin (with 50 percent market capitalization) and attracting IPOs from other countries, including the US. However, this was largely attributed to the dot-com bubble. After it burst, the Neuer Markt never picked up again in activity and eventually had to be discontinued. Competing explanations for the breakdown of the Neuer Markt abound and most scholars attribute its failure to agency problems related to lax regulation and moral hazard of financial market actors, as illustrated by a number of scams during the high noon of the New Economy frenzy. Institutional theories, on the other hand, take a more nuanced approach and dig deeper into the intricate web of relationships in German society. For instance, Vito and Engelsenhart (2005), use the "varieties of capitalism" perspective to investigate the Neuer Markt. They find that there was a mismatch between the liberal market institutions Neuer Markt and the generally coordinated market economy of Germany. In particular, most firms in the German economy are rather conventional, as compared to the entrepreneurial ones that are striving for growth markets in the Neuer Markt. The archetypal, conventional German automotive or manufacturing firms emphasize incremental innovation and low risk, while entrepreneurial firms are risk averse. Moreover, labor markets are an important determinant of the risk profiles of firms; Germany never developed an entrepreneurial culture of risk takers like those in the America's high-tech community of Silicon Valley, where experienced managers, scientists, and personnel were always in short supply for the growth companies of the New Economy.

Using the VC approach, Vito and Engelsenhart explain not only the failure of the Neuer Markt, but also why it never recovered to earlier levels, while IPOs in the U.S. and UK did. Hence, there seem to be some fundamental differences in the institutional structure of the German innovation system itself, which increases the likelihood that partial attempts toward innovation and change are going to fail. In other words, more entrepreneurial-oriented financial markets would need to be complemented by similar measures in other realms.

**Patents and other legal issues**

We outlined above Germany's strong bureaucratic tendency and its adherence to a sometimes stifling, regulatory system. A number of factors relating to the business environment are regularly observed by the World Bank under its Doing Business initiative. Table 2 illustrates such measures as "starting a business," "employing workers," "registering property," "protecting investors," or "enforcing contracts" and aggregates them in an "Ease of Doing Business Rank.

It should be noted that most of the leading economies are small, such as those of Singapore, New Zealand, Hong Kong, and Denmark. As the table shows, Germany has a disappointing rank of 25, lagging behind many industrialized countries.
such as follow OECD members U.S., UK, or Japan. Germany also trails behind many emerging economies, such as Thailand, and Malaysia. Most surprisingly, among the countries ahead of Germany are the likes of Georgia, Saudi Arabia, and Bahrain. While Germany scores better than the average in dealing with construction permits, getting credit, trading across borders, and enforcing contracts, it scores dramatically low in employing workers, starting a business, and protecting investors. Probably the most telling statistic with regard to entrepreneurial policies, however, is the relationship between "Starting a Business" and "Closing a Business." Apart from Korea, no other country in the top 25 scores as poorly as Germany. In fact, with the exception of Japan, the difference in ranking between "Starting a Business" and "Closing a Business" for all other countries is at least 39 points.

The one area in which Germany has a clear advantage is the legal system covering property rights, in particular for intellectual property (IPR). Germany is arguably one of the countries with the strongest IPR protection and contract enforceability. As a result, Germany is one of the leading countries in the world in terms of triadic patenting (Figure 2). Most importantly, it is the leading patentee in Europe, accounting for more than 40 percent of triadic patents, and making it the third most active economy after the U.S. and Japan. Moreover, according to reports by the OECD, Germany also ranks fourth with respect to triad patents relative to GDP and third relative to population (OECD, 2007). In particular, Germany is a world leader in technological niches such as nanotechnology, fuel cells, and wind energy, as well as other environmentally friendly technologies. More broadly, however, German industry is not focusing its R&D efforts in high-technology sectors such as pharmaceuticals, IT, and aerospace, but rather in mature sectors such as automobiles, chemicals, and machine tools. In other words, Germany's presence in dynamically growing high-tech and services sectors is low both in terms of output as well as R&D (Harhoff, 2008).

However, the ability to patent and enforce IPR is not always a necessary, certainly not a sufficient, condition to actually commercialize inventions, as in the case of the digital MP3 format, invented by the Fraunhofer Society in Germany and commercialized by US and Japanese firms. Referring back to Schumpeter's (1939) distinction between invention and innovation, having an idea or even developing a new product is not enough to successfully put it on the market and benefit from it economically.

One reason behind Germany's weakness in high-technology is that innovation processes in Germany are mainly oriented toward incremental innovation (Soucie, 1997). Across Europe, this is done predominantly in the large R&D labs of established and mature firms, whereas other countries, notably the U.S., have a larger share of young firms which account, for instance, for more than 50 percent of new pharmaceuticals (Sapir et al., 2003). The low rate of entrepreneurship is often ascribed to bureaucratic red tape that impedes new venture formation. These include the cost of establishing a new venture, in particular one of limited liability, in order to protect the founders' private assets. For instance, the capital requirements for establishing a limited-liability company in Germany is €25,000, as compared to the low 4-digit figure in other EU countries. This stems from the traditionally creditor-oriented values in Germany, which impose a serious ex-ante obstacle to firm formation. The reason that this is so serious is that limited liability companies are particularly appropriate for knowledge-intensive businesses (Harhoff, 2008).

Another component of regulatory impediment is the tax system, which offers weak incentives for innovation and entrepreneurship. The uncertain and intangible nature of innovation makes it less suitable for credit financing, as high risk cannot be collateralized by assets such as machinery. However, the German tax system and other arrangements have led to a high dependence of SMEs upon credit, as outlined in the previous section. This is best exemplified by the differential
taxation of profits from innovation financed through debt vs. equity, the latter being almost twice as high. This kind of incentive leads to higher amounts of debt financing, with the associated risk of bankruptcy, which, in turn, reduces the inclination of firms to take further risks in the form of innovative activities. This imbalance is lower in countries with generally lower taxation levels than those of Germany. Similarly, there is a comparative disadvantage in the form of reduced possibilities for tax loss carry-forwards. While countries such as Britain, Sweden, and even France do not impose restrictions on this, Germany limits it in order to minimize the cross-border transactions of multinational companies. As an (unintended) consequence, this reduces the attractiveness of investment in innovative projects of longer duration and uncertain payoff patterns. With lower capital endowments and turnover, SMEs are most affected by this measure (Hashoff, 2008).

Yet another key player in the German innovation system is the competition regime of the Federal Cartel Office (Bundeskartellamt), which governs competition regulations in harmony with the European Commission and its Directorate for related issues. Next to the matter of business mergers and monopolistic market settings, the infrastructure conditions of competition are subject to its operations. This emphasizes the primacy of the concept of the ‘dominant position’ of a firm, with all of its various forward and backward linkages in the market. The reports and recommendations of the German Monopolies Commission (Monopolkommission), consisting of selected academic and business representatives, parallel these policy concerns. Yet, despite its seemingly clear-cut mandate, the actual practice of German competition policy is typically filled with exemptions from the more rigid rules. This means, for instance, that mergers leading to market dominance may be legal when they are in line with industrial policy concerns for R&D synergies, illustrating a problem of rules, exemptions and efficiency trade-offs in the domain of competition and innovation that is also prevalent on the European policy level (Motta, 2004; Khins, 1997).

Conclusion
In conclusion, innovation in Germany presents challenges that require an urgent institutional response. First, venture capital is in short supply. The federal government implemented a law on the modernization of the framework for capital equity in 2008, aimed at setting incentives for providing equity for startup enterprises that were not yet subject to procedures for initial public offerings. Because of its initial regulations, the effects of this law have been limited. Second, while the share of innovative SMEs in Germany is above the OECD average, their relatively low equity shares contribute a hindrance for R&D, as the latter is primarily financed by equity capital. Moreover, public support for R&D in SMEs is insufficient. Third, while knowledge-intensive services are an employment-creating expanding sector in the world economy, the German service sector lags behind. This is an energy-demanding focus in reconceptualizing the German innovation system. Fourth, the research and educational system must be made more attractive to human capital in the high-technology industries, enhancing university-industry relations, in particular when it comes to the commercialization of knowledge in science-based industries (EEF, 2009).

To summarize, the current challenges of the German innovation system may be analyzed in terms of the following SWOT analysis:

**Strengths**
- Human resources in manufacturing and engineering
- Innovative performance in private and public R&D
- Surplus source of research capacity
- Capital availability

**Weaknesses**
- Lack of human capital
- High capital requirements
- Insufficient supply of human capital
- Lack of innovative small enterprises
- Governmental restrictions and innovation

**Opportunities**
- Knowledge flow in medium-size companies
- Consulting and consulting services with global communication network
- Innovative cooperation in a multi-level system of innovation
- STRATEGIC ENTREPRENEURSHIP with a balanced self-system

**Threats**
- Regionalization of innovation
- Substitution of industrial districts
- Competitive policy monopoly (obviously promising paradigms)
- Climate support may lead to the closure of industrial networks
- Enhanced political economic reform may result in stagnation

While the German economy is still one of the strongest and most innovative in the world, its orientation is very backward-looking. The structure of industrial sectors is centered on mature industries of the early 20th (and even 19th) century, indicating that most innovation in these areas is incremental, rather than radical. This might strengthen its resilience in economic crises such as the current one with its steady growth of a new product development. However, it might have more severe effects, if other countries use the crises for restructurings to reposition themselves in the new, high-tech service industries and industries of the future. One of the areas in which Germany is a world leader is green technologies. However, thus far, most technological innovations in this realm have come from the more mature automotive and chemical industries. In order to broaden the industrial basis for sustainable innovation, Germany has to adopt the framework for entrepreneurship, in particular in the field of high-technology industries. As a note of caution, this is not meant to suggest that extant practices and existing industries should be abandoned; rather, that Germany must complement its strengths with new institutional rules, thereby enabling and providing incentives for innovation through a more flexible regulatory and financial environment.

**References**


