Economic Growth and National Security: The View from Europe

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1.**Introduction**

It has long been held by economists that the unfettered mobility of factors of production across national borders is conducive to long-run economic growth.[1] The major impact of trans-national labor mobility was to increase the supply of labor, and ultimately restore the labor market to equilibrium levels of desired wages. While some G-8 countries were more hospital to foreign labor, the impact was generally thought to be similar throughout the G-8.

In the post Berlin Wall era, however, the comparative advantage of the G-8 countries evolved from being based on the factors of capital and labor to that of knowledge. Along with this shift in comparative advantage, came the recognition that knowledge capital was also important for economic growth (Lucas, 1993, Romer, 1994). The emerging role of knowledge workers as the crucial factor generating economic growth resulted in a chasm between Europe and North America. The recognition that the economic value of knowledge and human capital is conditional upon complementary knowledge and human capital at a specific geographic location (Audretsch and Feldman, 1996, Audretsch and Stephan, 1996), accentuated the contribution of trans-border knowledge worker mobility to economic growth. While the North American countries made attempts to bias immigration towards knowledge workers, Europe maintained the more traditional approach towards the inward migration of foreign workers. For example, in an article titled, "Brains Not Welcome Here: The Difficulty of Changing a Policy that Drives Talent Away," the *Economist* observes that, "Sending foreigners home after paying to educate them is not the only contradiction in Germany's immigration rules."[2]

As the gap in economic growth between Europe and North America increased during the 1990s, public policy in Europe began to link the higher levels of economic performance in

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[1] See for example, http://commdocs.house.gov/committees/judiciary/hju58001.000/hju58001_0f.htm

[2] [2] „Brains Not Welcome Here: The Difficulty of Changing a Policy that Drives Talent Away," *The Economist*, 1 May, 2004, p. 30.

North America to immigration policies with a greater focus on facilitating access to knowledge workers. The growing recognition that knowledge workers were essential for a knowledge-based economy has led to a number of reforms in Europe facilitating the entry and integration of foreigners into Europe. For example, in the late 1990s the German Government introduced a Green Card for information-technology workers that targeted the immigration of high-technology workers. As *The Economist* points out, "Things started to change in the late 1990s. The new coalition of Social Democrats and Greens changed the citizenship law, making it easier for immigrants and their children to become German. And it dawned on the country that, in the internet era, it was losing the 'battle for the best brains.'"[3]

September 11 changed the growing consensus among the G-8 that mobility of knowledge workers across national boundaries was essential to generate economic growth. Rather, a priority for homeland security pre-empted the principle of unfettered mobility of knowledge workers. For example, in an article titled, "Short-Sighted: A Visa System Tangled in Red Tape and Misconceived Security Rules is Hurting America," *The Economst* reports that, "The number of scientists and engineers going to America to study and work is dropping precipitously. An important reason is the length of time it now takes to get a visa. This is both deterring would-be visitors from coming, and hindering some of of those who try. Not only may this lead to a decline in America's scientific strengths, it is also an underserved obstacle for many students….The current mess could prove costly to America."[4]

Thus, there is an opportunity cost of attaining homeland security – the forgone knowledge workers that would have added to the stock of knowledge capital results in lower levels of entrepreneurship, innovation and ultimately economic growth. The purpose of this paper is to make the policy tradeoff between economic growth and homeland security

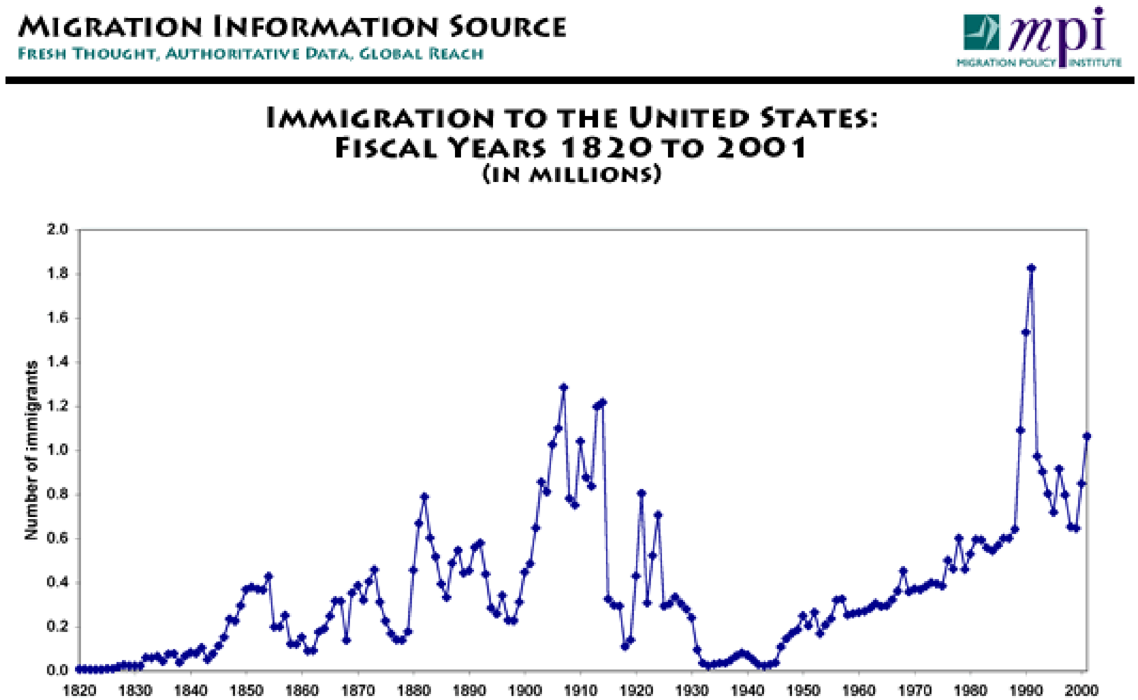
[3] „Brains Not Welcome Here: The Difficulty of Changing a Policy that Drives Talent Away," *The Economist*, 1 May, 2004, p. 30.
[4] "Short-Sighted: A Visa System Tangled in Red Tape and Misconceived Security Rules is Hurting America,“ *The Economist*, 8 May, 2004, p. 13.

explicit. In the second section of the paper, the traditional role contributed by immigration is contrasted to the role emerging in the knowledge-based economies of the G-8 countries. The cross-border mobility of knowledge workers is found to be not only important for increasing the stock of knowledge, but also the magnitude of knowledge spillovers through entrepreneurial activity. In the third section, the link between entrepreneurship and economic growth is found to exist within the European context. Since homeland security increases the cost of trans-national mobility of knowledge workers, Section 4 depicts the tradeoff between homeland security and economic growth. Finally, a summary and conclusions are provided in the last section. In particular, only by working together with a common goal, can the G-8 mitigate the tradeoff that has emerged between Homeland Security and economic growth.

2.Trans-Border Labor Mobility and Homeland Security

The traditional labor market view of immigration is that it equilibrates labor markets at targeted wage levels. While some G-8 countries experienced higher levels of immigration, the impact was of a similar qualitative nature, if not a quantitative nature. High immigration countries, such as the United States, as depicted in Figure 1, received a greater injection of

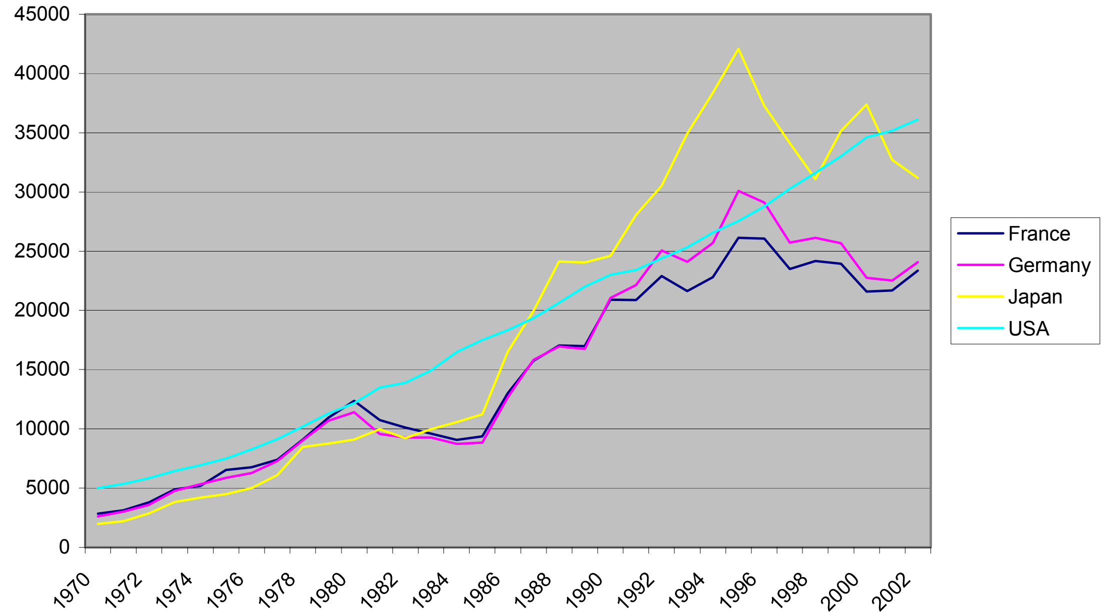
Figure 1



the factor of labor.

As growth rates diverged in GDP per capita in the 1990s (Figure 2), the qualitiative as well as the quantitative contribution of trans-national labor mobility became increasingly clear.

Figure 2 Per Capita GDP, 1970-2002



Along with globalization has come a shift in the comparative advantage of G-8 countries towards knowledge. This has altered the economic impact of transnational border mobility of workers. Rather than merely impact the labor market by the supply effect, the stock of knowledge in the economy is increased. As Romer (1992) and Lucas (1993) emphasize, the spillover of knowledge implies that the impact of knowledge workers on economic growth is convex and associated with increasing returns. Policy responded to the new role for immigration as knowledge workers by enacting the Immigration Act of 1990 (IMMACT), which defined and divided high-skilled immigrants into work visa categories. One prime example of the need for a more educated workforce is in the information technology industry. The Department of Labor reports that this will be the fastest growing industry over the next ten years and that the three fastest growing occupations will be information technology occupations. H.R. 3736, the "Workforce Improvement and Protection Act of 1998" will raise the cap on the number of H–1b employment visas issued to highly skilled foreign professionals hired by American businesses. High technology businesses and research universities vitally need this program to recruit foreign talent, especially where an insufficient number of highly skilled Americans are available to fill current job openings. One recent report states that the computer industry has 340,000 unfilled jobs, while American universities produce only 130,000 computer science graduates a year. In order to compete globally, American businesses and universities need the ability to freely hire foreign talent to fill some of these positions.

Figure 3

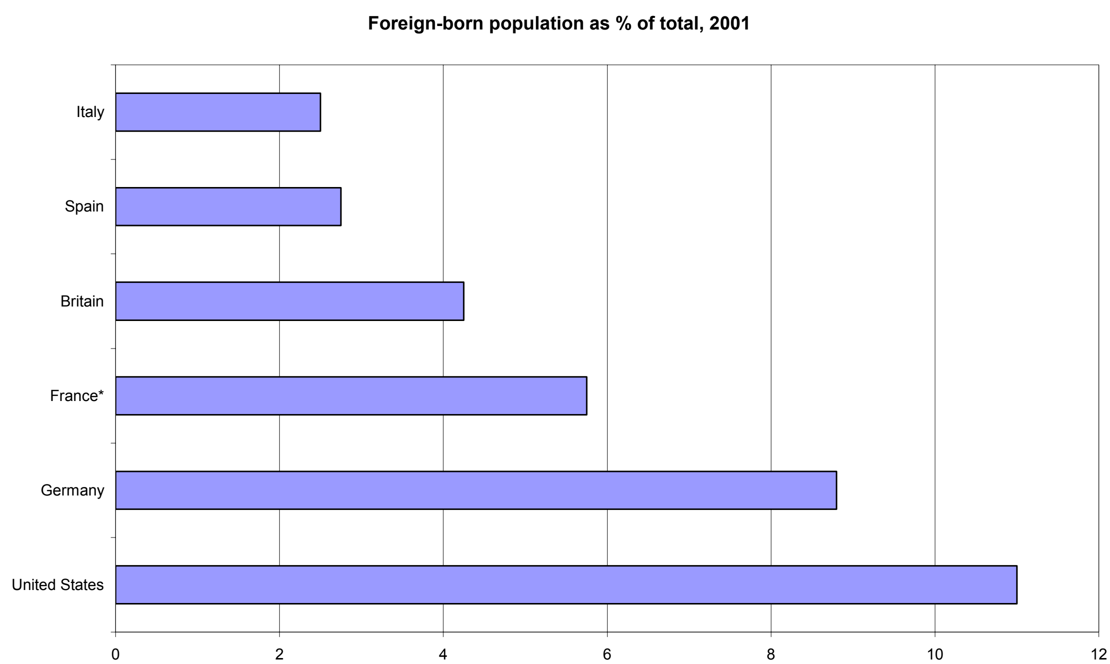
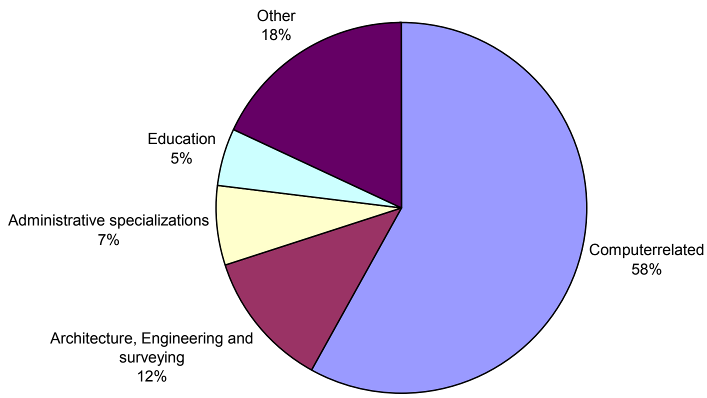


Figure 4

Leading Occupation in H-1B Workers FY 2001



The impact of the knowledge worker immigration on economic growth has not gone unnoticed.[5] For example, Alan Greenspan, the Federal Reserve Chairman, has observed that, "Under the conditions that we now confront, we should be carefully focused on the contribution which skilled people from abroad can contribute to this country."[6]

The divergence in growth rates between Europe and North America in the 1990s did not escape the attention of European policy makers. While it had always been recognized that the U.S. was a "melting pot", the contribution from foreign-born knowledge workers in generating economic growth became increasingly apparent. For example, in Germany the traditional post-war view was that being German was based on blood links. As *The Economist* observes, "For older folk, at least, being German is a question of blood links, which makes integration of non-Germans harder. Yet in reality, Germany needs more, not less, immigration…This is one of the less open countries in an increasingly global marketplace.

[5] "How Immigrants Keep the Hive Humming," *Business Week*, 24 April, 2002.
[6] Cited in http://www.migrationinformation.org/USfocus/display.cfm?id=69

The world's best brains will surely take note – and go elsewhere." As the Foreign Minister, Joshka Fisher observes, "Other countries would slip a passport to such talented people."[7]

2.Entrepreneurship Capital and Growth

The insights of the great classical economists, such as Adam Smith, focused on the allocation and distribution mechanisms of the economy, as well as the roles of capital, labor and land, while paying only nominal attention to knowledge as an economic phenomenon. Writing in the post-war era, Robert Solow followed in this classical tradition. Solow (1956) based his model of economic growth on the neoclassical production function with its key factors of production – capital and labor. Solow, of course, did acknowledge that knowledge contributed to economic growth, but in terms of his formal model, it was considered to be an unexplained residual, which "falls like manna from heaven." A generation of economists subsequently relied upon the model of the production function as a basis for explaining the determinants of economic growth.

The focus on labor and capital as the primary factors of production, and the general exclusion or trivialization of the role of knowledge, was not limited only to the sphere of macroeconomics. The most compelling theories of international trade were based on factors of capital and labor (and sometimes land). For example, the fundamental theorem for international trade, the Heckscher-Ohlin theory, later extended to the Heckscher-Samuelson-Ohlin model focused on the factors of land, labor and capital. According to the Heckscher-Ohlin theory, the proportion of productive factors determines the trade structure. If there

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[7] „Brains Not Welcome Here: The Difficulty of Changing a Policy that Drives Talent Away," *The Economist*, 1 May, 2004, p. 30.

exists an abundance of physical capital relative to labor, a country will tend towards the export of capital-intensive goods; an abundance of labor relative to physical capital leads to the export of labor-intensive goods.

In fact, what became known as the Leontief Paradox, was based on the statistical evidence refuting, or at least not consistent with the Heckscher-Samuelson-Ohlin model. In particular, the Leontief Paradox pointed out that the actual patterns of U.S. trade did not correspond to the predictions of the model (Bowen, Leaner, and Sveikauskas, 1988). Rather than import labor-intensive goods and export capital-intensive goods, systematic empirical evidence found exactly the opposite for the U.S., which suggested that the comparative advantage for post-war U.S. was based on (unskilled) labor rather than on capital.

As economists struggled to resolve the Leontief Paradox, they began shifting the perspective of the model from an exclusive focus on the factors of inputs of capital and labor, to probing inclusion of various aspects of knowledge. Early extensions included human capital and skilled labor, and technology. The neo-technology theories focused on the role of R&D and the creation of new economic knowledge in shaping the comparative advantage and flows of foreign direct investment. Gruber et al. (1967) suggested that R&D expenditures reflect a temporary comparative advantage resulting from products and production techniques that have not yet been adapted by foreign competitors. Thus, industries with a relatively high R&D component are considered to be conducive to the comparative advantage of firms from the most developed nations.

The human skills hypothesis extended the Heckscher-Ohlin theory by including human capital as a third factor (Keesing, 1966 and 1967). In the presence of a relative abundance of a labor force with a high level of human capital, countries were found to export human capital-intensive goods. Similarly, the abundance of skilled labor tended to promote the export of skill-intensive goods.

The introduction of knowledge into macroeconomic growth models was formalized by Romer (1986) and Lucas (1988). Romer's (1986) critique of the Solow approach was not with the basic model of the neoclassical production function, but rather what he perceived to be omitted from that model – knowledge. Not only did Romer (1986), along with Robert E. Lucas (1988) and others argue that knowledge was an important factor of production, along with the traditional factors of labor and capital, but because it was endogenously determined as a result of externalities and spillovers, it was particularly important.

There are two assumptions implicit that drive the results of the endogenous growth models. The first is that knowledge is automatically equated with economic knowledge. In fact, as Arrow (1962) emphasized, knowledge is inherently different from the traditional factors of production, resulting in a gap between knowledge and what he termed as economic knowledge, or economically valuable knowledge. The second involves the assumed spillover of knowledge. The existence of the factor of knowledge is equated with its automatic spillover, yielding endogenous growth.

suggest that another key factor has been omitted from the neoclassical production function – entrepreneurship capital. By entrepreneurship capital we mean the capacity for economic agents to generate new firms. As William B. Gartner and Nancy M. Carter (2003) state, "Entrepreneurial behavior involves the activities of individuals who are associated with creating new organizations rather than the activities of individuals who are involved with maintaining or changing the operations of on-going established organizations."

Entrepreneurship has typically been referred to as an action, process, or activity. We propose that it can also be considered to constitute a stock of capital, since it reflects a number of different factors and forces, legal, institutional and social, which create a capacity for this activity (G. Hofstede et. al., 2002). A recent literature has emerged suggesting that entrepreneurship capital may be something of a missing link in explaining variations in economic performance (Zoltan J. Acs and David B. Audretsch, 2003).

William J. Baumol (2002, pp. 58-59) has argued that entrepreneurial activity may account for a significant amount of the growth left unexplained in traditional production function models. While the traditional factors of labor and capital, and even the addition of knowledge capital are important in shaping output, the capacity to harness new ideas by creating new enterprises is also essential to economic output. A counter-example is instructive. In the former Soviet Union, while the exact measures of the stocks of capital and labor, and even knowledge, were questionable, their existence was not. By contrast, entrepreneurship capital, at least as it could be legally applied, was minimal.

The most prevalent and compelling views of entrepreneurship focus on the perception of new economic opportunities and the subsequent introduction of new ideas in the market. Just as entrepreneurs are agents of change; entrepreneurship is thus about the process of change. This corresponds to the definition of entrepreneurship proposed by the OECD, "Entrepreneurs are agents of change and growth in a market economy and they can act to accelerate the generation, dissemination and application of innovative ideas… Entrepreneurs not only seek out and identify potentially profitable economic opportunities but are also willing to take risks to see if their hunches are right" (OECD, 1998, p. 11).

While the entrepreneur undertakes a definitive action, starting a new business, her action cannot be viewed in a vacuum devoid of context. Rather, as Audretsch et al. (2002) show, the determinants of entrepreneurship are shaped by a number of forces and factors, including legal and institutional but also social factors as well. The study of social capital and its impact on economic decision making and actions stems back to classic literatures in economics and sociology in which social and relational structure influence market processes (Mark S. Granovetter 1985). Patricia H. Thorton and Katherine H. Flynne (2003) and

Saxenian (1994) attribute the high economic performance of Silicon Valley to a rich endowment of what could be termed as entrepreneurship capital,“ It is not simply the concentration of skilled labor, suppliers and information that distinguish the region. A variety of regional institutions – including Stanford University, several trade associations and local business organizations, and a myriad of specialized consulting, market research, public relations and venture capital firms – provide technical, financial, and networking services which the region's enterprises often cannot afford individually. These networks defy sectoral barriers: individuals move easily from semiconductor to disk drive firms or from computer to network makers. They move from established firms to startups (or vice versa) and even to market research or consulting firms, and from consulting firms back into startups. And they continue to meet at trade shows, industry conferences, and the scores of seminars, talks, and social activities organized by local business organizations and trade associations. In these forums, relationships are easily formed and maintained, technical and market information is exchanged, business contacts are established, and new enterprises are conceived…This decentralized and fluid environment also promotes the diffusion of intangible technological capabilities and understandings”[i] (Saxenian, 1990, pp. 96-97).

Such contexts generating a high propensity for economic agents to start new firms can be characterized as being rich in entrepreneurship capital. Other contexts, where the startup of new firms is inhibited, can be characterized as being weak in entrepreneurship capital.

Entrepreneurship capital exerts a positive impact on economic output for a number of reasons. The *first* is that it is a mechanism for knowledge spillovers. Romer (1986), Lucas (1988 and 1992) and Gene M. Grossman and Elhanan Helpman (1991) established that knowledge spillovers are an important mechanism underlying endogenous growth. However, they shed little light on the actual mechanisms by which knowledge is transmitted across firms and individuals. The answer to this question is important, because a policy implication commonly drawn from the new economic growth theory is that, as a result of convexities in knowledge and the resultant increasing returns, knowledge factors, such as R&D should be publicly supported. While this may be valid, it is also important to recognize that the mechanisms for spillover transmission may also play a key role and may also serve as a focus for public policy enhancing economic growth and development.

The literature identifying mechanisms actually transmitting knowledge spillovers is sparse and remains underdeveloped. However, one important area where such transmission mechanisms have been identified involves entrepreneurship. Entrepreneurship involves the startup and growth of new enterprises.

Why should entrepreneurship serve as a mechanism for the spill over of knowledge from the source of origin? At least two major channels or mechanisms for knowledge spillovers have been identified in the literature. Both of these spillover mechanisms revolve around the issue of appropriability of new knowledge. W. Cohen and D. Levinthal (1989) suggest that firms develop the capacity to adapt new technology and ideas developed in other firms and are therefore able to appropriate some of the returns accruing to investments in new knowledge made externally. This view of spillovers is consistent with the traditional model of the knowledge production function, where the firm exists exogenously and then undertakes (knowledge) investments to generate innovative output.

By contrast, Audretsch (1995) proposes shifting the unit of observation away from exogenously assumed firms to individuals, such as scientists, engineers or other knowledge workers – agents with endowments of new economic knowledge. When the lens is shifted away from the firm to the individual as the relevant unit of observation, the appropriability issue remains, but the question becomes, *How can economic agents with a given endowment of new knowledge best appropriate the returns from that knowledge?* If the scientist or engineer can pursue the new idea within the organisational structure of the firm developing the knowledge and appropriate roughly the expected value of that knowledge, he has no reason to leave the firm. On the other hand, if he places a greater value on his ideas than do the decision-making bureaucracy of the incumbent firm, he may choose to start a new firm to appropriate the value of his knowledge. Small enterprises can compensate for their lack of R&D through spillovers and spin-offs. Typically an employee from an established large corporation, often a scientist or engineer working in a research laboratory, will have an idea for an invention and ultimately for an innovation. Accompanying this potential innovation is an expected net return from the new product. The inventor would expect to be compensated for his/her potential innovation accordingly. If the company has a different, presumably lower, valuation of the potential innovation, it may decide either not to pursue its development, or that it merits a lower level of compensation than that expected by the employee.

In either case, the employee will weigh the alternative of starting his/her own firm. If the gap in the expected return accruing from the potential innovation between the inventor and the corporate decision maker is sufficiently large, and if the cost of starting a new firm is sufficiently low, the employee may decide to leave the large corporation and establish a new enterprise. Since the knowledge was generated in the established corporation, the new start-up is considered to be a spin-off from the existing firm. Such start-ups typically do not have direct access to a large R&D laboratory. Rather, these small firms succeed in exploiting the knowledge and experience accrued from the R&D laboratories with their previous employers.

The research laboratories of universities provide a source of innovation-generating knowledge that is available to private enterprises for commercial exploitation. Adam B. Jaffe (1989) and Audretsch and Maryann P. Feldman (1996) found that the knowledge created in university laboratories "spills over" to contribute to the generation of commercial innovations by private enterprises. Acs, Audretsch, and Feldman (1994) found persuasive evidence that spillovers from university research contribute more to the innovative activity of small firms than to the innovative activity of large corporations.

In the metaphor provided by Albert O. Hirschman (1970), if voice proves to be ineffective within incumbent organizations, and loyalty is sufficiently weak, a knowledge worker may resort to exit the firm or university where the knowledge was created in order to form a new company. In this spillover channel the knowledge production function is actually reversed. The knowledge is exogenous and embodied in a worker. The firm is created endogenously in the worker's effort to appropriate the value of his knowledge through innovative activity. Thus, entrepreneurship serves as the mechanism by which knowledge spills over from the source creating to a new firm where it is commercialized.

A *second* way that entrepreneurship capital exerts a positive influence on economic output is through the increased competition by the increased number of enterprises. Jacobs (1969) and M. Porter (1990) argue that competition is more conducive to knowledge externalities than is local monopoly. It should be emphasised that by local competition Jacobs does not mean competition within product markets as has traditionally been envisioned within the industrial organisation literature. Rather, Jacobs is referring to the competition for the new ideas embodied in economic agents. Not only does an increased number of firms provide greater competition for new ideas, but in addition, greater competition across firms facilitates the entry of a new firm specializing in some particular new product niche. This is because the necessary complementary inputs and services are likely to be available from small specialist niche firms but not necessarily from large, vertically integrated producers.

Both Feldman and Audretsch (1999) as well as Glaeser, Kallal, Sheinkman and Schleifer (1992) found empirical evidence supporting the hypothesis that an increase in competition, as measured by the number of enterprises, in a city increases the growth performance of that city.

A *third* way that entrepreneurship capital generates economic output is by providing diversity among the firms. Not only does entrepreneurship capital generate a greater number of enterprises, but it also increases the variety of enterprises in the location. A key assumption made by Hannan and Freeman (1989) in the population ecology literature is that each new organization represents a unique approach. There has been a series of theoretical arguments suggesting that the degree of diversity, as opposed to homogeneity, in a location will influence the growth potential.

The theoretical basis linking diversity to economic performance is provided by Jacobs (1969), who argues that the most important source of knowledge spillovers are external to the industry in which the firm operates and that cities are the source of considerable innovation because the diversity of these knowledge sources is greatest in cities. According to Jacobs, it is the exchange of complementary knowledge across diverse firms and economic agents which yields a greater return on new economic knowledge. She develops a theory that emphasizes that the variety of industries within a geographic region promotes knowledge externalities and ultimately innovative activity and economic growth.

The first important test linking diversity to economic performance, measured in terms of employment growth was by E. Glaeser, H. Kallal, J. Sheinkman and A. Schleifer (1992), who employ a data set on the growth of large industries in 170 cities between 1956 and 1987 in order to identify the relative importance of the degree of regional specialization, diversity and local competition play in influencing industry growth rates. The authors find evidence that diversity promotes growth in cities.

Feldman and Audretsch (1999) identified the extent to which the extent of diversity influences innovative output. They link the innovative output of product categories within a specific city to the extent to which the economic activity of that city is concentrated in that industry, or conversely, diversified in terms of complementary industries sharing a common science base.

Entrepreneurship capital therefore can contribute to output and growth by serving as a conduit for knowledge spillovers, increasing competition, and by injecting diversity. Inclusion of measures of entrepreneurship capital would be expected to be positively related to output.

Using a specification of the Cobb-Douglas type we obtain

$$Y_i = \alpha K_i^{\beta_1} L_i^{\beta_2} R_i^{\beta_3} E_i^{\beta_4} e^{\varepsilon_i} , \tag{1}$$

where K represents the factor of *physical capital*, L represents *labor*, R represents *knowledge capital*, and E represents *entrepreneurship capital*. The subscript i refers to German regions. Measurement of entrepreneurship capital is no less complicated than is measuring the traditional factors of production. Just as measuring capital, labor and knowledge invokes numerous assumptions and simplifications, creating a metric for entrepreneurship capital presents a challenge. Many of the elements determining entrepreneurship capital defy quantification. In any case, entrepreneurship capital, like all of the other types of capital, is multifaceted and heterogeneous. However, entrepreneurship capital manifests itself in a singular way – the startup of new enterprises. Thus, we propose using new-firm startup rates as an indicator of entrepreneurship capital. *Ceteris paribus*, higher startup rates reflect higher levels of entrepreneurship capital. Our data will consist in a cross-section of 327 West-German regions or *Kreise* for the year 1992 if not indicated otherwise. Sources and construction of the data is as follows.

Output is measured as Gross Value Added corrected for purchases of goods and services, VAT and shipping costs. Statistics are published every two years for *Kreise* by the Working Group of the Statistical Offices of the German Länder, under "Volkswirtschaftiche Gesamtrechnungen der Länder'".

Physical Capital: The stock of capital used in the manufacturing sector of the *Kreise* has been estimated using a perpetual inventory method which computes the stock of capital as a weighted sum of past investments. In the estimates we used a β-distribution with p=9 and a mean age of q=14. Type of survival function as well as these parameters have been provided by the German Federal Statistical Office in Wiesbaden. This way, we attempted to obtain maximum coherence with the estimates of the capital stock of the German producing sector as a whole as published by the Federal Statistical Office. Data on investment at the level of German *Kreise* is published annually by the Federal Statistical Office in the series "E I 6". These figures however are limited to firms of the producing sector, excluding the mining industry, with more than 20 employees. The vector of the producing sector as a whole has been estimated by multiplying these values such that the value of the capital stock of Western Germany - as published in the Statistical Yearbook - was attained. Note that this procedure implies that estimates for *Kreise* with a high proportion of mining might be biased. Note also that for protection purposes, some *Kreise* did not publish data on investment (like e.g. the city of Wolfsburg, whose producing sector is dominated by Volkswagen). Therefore five *Kreise* are treated as missing.

Labor: Data on labor is published by the Federal Labor Office, Nürnberg which reports number of employees liable to social insurance by *Kreise*.

Knowledge Capital is expressed as *number of employees engaged in R&D* in the public (1992) and in the private sector (1991). With this approach we follow the examples of of Zvi Griliches (1979), Jaffe (1989), and Audretsch and Feldman (1996). Data have been communicated by the *Stifterverband für die Wissenschaft* under obligation of secrecy. With these data, it was impossible to make a distinction between R&D-

employees in the producing and non producing sectors. Regression results therefore will implicitly include spillovers from R&D of the non producing sector to the producing sectors. We presume however that this effect is rather low.

Entrepreneurship Capital is computed as the *number of startups in the respective region relative to its population*, which reflects the propensity of inhabitants of a region to start a new firm. The data on startups is taken from the ZEW foundation panels that is based on data provided biannually by *Creditreform*, the largest German credit-rating agency. This data contains virtually all entries – hence startups – in the German Trade Register, especially for firms with large credit requirements as e.g. high-technology firms.[ii] By now, there are 1.6 million entries for Western-Germany. Since number of startups is subject to a greater level of stochastic disturbance over short time periods, it is prudent to compute the measure of entrepreneurship capital based on startup rates over a longer time period. We therefore used the number of startups between 1989-1992. Lagged values of start-up rates are used in order to avoid problems of simultaneity between output and entrepreneurship. This lagged relationship reflects causality between entrepreneurship capital in one period and economic output in subsequent periods. While we argue in this paper that entrepreneurship capital should include startup activity in any industry, some scholars have suggested that it should only apply to startups involving innovative activity. Therefore, we compute two modified measures of entrepreneurship. The first one restricts entrepreneurship capital to include only startup activity in high-technology manufacturing industries (whose R&D-intensity is above 2.5 percent). The second measure restricts entrepreneurship capital to include only startup activity in the ICT industries, i.e. firms in the hard- and software business. Some of these industries are also classified under high-technology manufacturing.

Estimation of the production function model of Equation 1 produced the results displayed in Table 1. The first equation estimates the traditional Solow model of the production function. As the positive and statistically significant coefficients suggest, both physical capital and labor are important factors of production in determining output in German regions. In the second column the factor of knowledge capital is added. The positive and statistically significant coefficients of all three variables lend support to the Romer view that knowledge matters as a factor of production.

Table1: Results of Estimation of the Production Function Model for German Regions

	(1)	(2)	(3)	(4)	(5)
Constant	-2.755*** (-10.749)	-2.305*** (-7.807)	-1.822*** (-4.866)	-1.810*** (-4.363)	-1.474*** (-3.804)
Capital	0.270*** (5.312)	0.279*** (5.366)	0.276*** (5.333)	0.294*** (5.587)	0.287*** (5.603)
Labor	0.805*** (13.241)	0.736*** (11.410)	0.748*** (11.606)	0.715*** (10.897)	0.734*** (11.554)
Knowledge		0.030** (2.199)	0.022 (1.540)	0.027** (1.987)	0.014 (0.954)
Entrepreneurship			0.112** (2.078)		
High-Tech Entrepreneurship				0.043* (1.694)	
ICT Entrepreneurship					0.104*** (3.244)
R2	0.611	0.691	0.816	0.813	0.812

Notes: t-statistic in brackets.

* Statistically significant at the two-tailed test for 90 percent level of confidence

** Statistically significant at the two-tailed test for 95 percent level of confidence

**** Statistically significant at the two-tailed test for 99 percent level of confidence*

The third column shows the results when entrepreneurship capital is also included in the production function model (1). The positive and statistically significant coefficient indicates that entrepreneurship is a key factor in explaining variations in output across German regions. Those regions with a greater degree of entrepreneurship capital exhibit higher levels of output, *ceteris paribus*. Columns (4) and (5) show the results for equation (1) if we use startup rates in high-tech manufacturing or in ICT industries instead of startup rates of all industries. The results indicate that using these two alternative measures of entrepreneurship capital still generates a positive and statistically significant coefficient, suggesting that entrepreneurship capital is an important addition to the model of the production function.

An alternative specification estimates *labor productivity*. This is obtained by dividing both sides of Equation (1) by L. In this equation, we also restrict the production elasticities of capital and labor to sum to unity, hence in terms of equation (1) we have $\beta_1 + \beta_2 = 1$. Hence we obtain

$$(2) \qquad (Y_i / K_i) = \alpha (K_i \; / L_i)^{\gamma_1} R_i^{\gamma_2} E_i^{\gamma_3} e^{\varepsilon_i}$$

The results for estimating labor productivity in Equation (2) are presented in **Table2**. As the positive and statistically significant coefficients indicate, not only do labor, capital intensity and knowledge influence labor productivity, but entrepreneurship capital does as well. Those regions with a greater degree of entrepreneurship capital exhibit systematically higher levels of labor productivity than do those regions with lower endowments of entrepreneurship capital. These results prove to be robust for the two alternative measures of entrepreneurship capital, which are restricted to high technology and ITC industries.

Table2: Results of Estimation of the Model of Labor Productivity in German Regions

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Constant	1.888*** (-19.235)	-2.175*** (-16.683)	-1.645*** (-5.566)	-1.730*** (-6.060)	-1.299*** (-6.060)
Capital Intensity	0.332*** (6.814)	0.283*** (5.535)	0.283*** (5.551)	0.296*** (5.747)	0.293*** (5.807)
Knowledge		0.035*** (3.673)	0.030*** (3.028)	0.030*** (3.005)	0.021** (2.032)
Entrepreneurship			0.107** (1.993)		
High-Tech Entrepreneurship				0.044* (1.747)	
ICT					0.102***

Entrepreneurship					(3.203)
R2	0.125	0.169	0.179	0.177	0.195

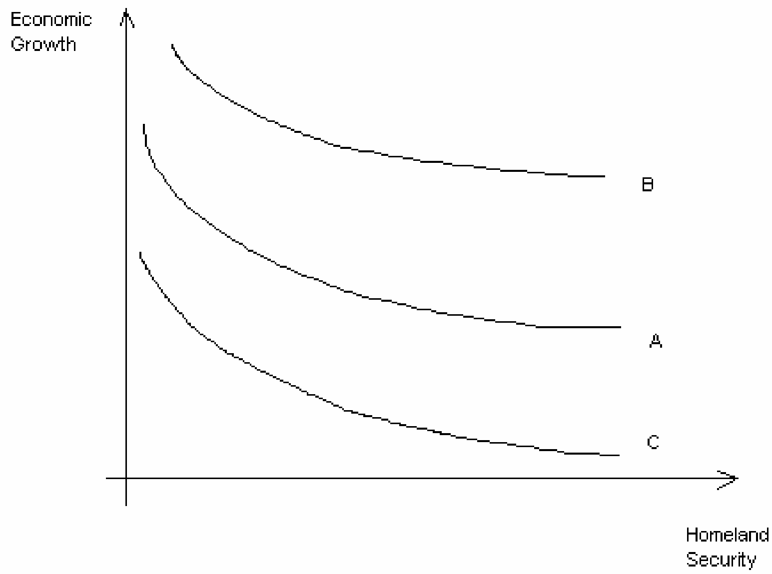
Notes: t-statistic in brackets.
* Statistically significant at the two-tailed test for 90 percent level of confidence
** Statistically significant at the two-tailed test for 95 percent level of confidence
****Statistically significant at the two-tailed test for 99 percent level of confidence*

4.The Security-Growth Tradeoff

The aftermath of September has triggered an unprecedented mandate for homeland security. Not only is there a direct cost of undertaking this security, but also the indirect cost of mitigating the inward flow of scientists, engineers and other knowledge workers, that will ultimately generate less economic growth. As The Economist reports, "The State Department and the Deaprtment of Homeland Security, which are jointly responsible for visas, are struggling to respond to the concerns of scientists but are woefully ill-equipped – files are exchanged twice weekly with the Federal Bureau of Investigation (FBI) on computer disks, while the FBI takes up to three days to reply that a person has not appeared on its database. Furthermore, the State Deapartment keeps inadequate data about visa delays and applications. This is inexcusable. All manner of businesses use software today to segment and understand their customers' behaviour. The government's failure to use the same technology is leading to both inefficiency and a decrease in security."[8]

[8] "Short-Sighted: A Visa System Tangled in Red Tape and Misconceived Security Rules is Hurting America," *The Economist*, 8 May, 2004, p. 13.

Figure 1: The Trade-Off between Homeland Security and Economic Growth



The above figure depicts the fundamental short-run tradeoff between Homeland Security and economic growth. Raising the costs of trans-national mobility of knowledge workers as a result of increased Homeland Security, leads to an inverse relationship, at least in the short run. A reduced terrorist threat will shift the tradeoff from curve A to curve B, indicating that at each level of homeland security, additional growth can be attained. By contrast, an increased terrorist threat will shift the tradeoff from curve A to curve C, indicating that at each level of homeland security, less growth will be attained. A more efficient homeland security administration will also shift the curve from A to B, while a less efficient homeland security administration will shift the curve from A to C.

5.Conclusions

Globalization triggered a new role for trans-border labor mobility. While immigration has always had an impact, the emergence of knowledge capital as a driving force for economic growth meant that highly skilled knowledge workers make a crucial contribution to economic growth. Not only can such knowledge workers contribute the knowledge stock of an economy, but they are also an important source for entrepreneurial activity, which can provide a key mechanism for the spillover of knowledge. The empirical evidence suggests that, even in the European context, entrepreneurship is positively associated with economic growth.

However, the demand for homeland security has impeded the trans-border flows of knowledge workers, resulting in a tradeoff between homeland security, on the one hand, and economic growth on the other hand. Homeland security may have not only a direct cost, but also an indirect cost, in terms of lower rates of economic growth. By working towards a common goal, the G-8 can address this tradeoff, enabling the attainment of Homeland Security at the lowest possible cost in terms of foregone economic growth.

Appendix

Table 2.5 Educational Attainment of the Population by Sex and Year of Entry: March 2002
(Numbers in thousands. 1/)

Total

EDUCATIONAL ATTAINMENT	Total		YEAR OF ENTRY							
			1990 or later		1980-1989		1970-1979		Before 1970	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total 2/	25,790	100.0	10,220	100.0	6,924	100.0	4,539	100.0	4,107	100.0
Less than 9th grade	5,639	21.9	2,258	22.1	1,534	22.2	998	22.0	849	20.7
9th to 12th grade (no diploma)	2,821	10.9	1,186	11.6	854	12.3	441	9.7	340	8.3
High school graduate	6,513	25.3	2,521	24.7	1,733	25.0	1,079	23.8	1,180	28.7
Some college or associate degree	3,987	15.5	1,266	12.4	1,169	16.9	794	17.5	758	18.5
Bachelor's degree	4,381	17.0	1,860	18.2	1,112	16.1	818	18.0	591	14.4
Advanced degree	2,448	9.5	1,129	11.0	521	7.5	410	9.0	389	9.5
Less than high school diploma	8,460	32.8	3,443	33.7	2,389	34.5	1,439	31.7	1,189	29.0
High school graduate or more	17,330	67.2	6,777	66.3	4,536	65.5	3,100	68.3	2,917	71.0
Less than bachelor's degree	18,961	73.5	7,231	70.8	5,291	76.4	3,311	73.0	3,127	76.1
Bachelor's degree or more	6,830	26.5	2,989	29.2	1,634	23.6	1,227	27.0	980	23.9

1/ Age 25 years and over.
2/ Years of school completed, not attended.

SOURCE: U.S. Census Bureau, Current Population Survey, March 2002
Ethnic and Hispanic Statistics Branch, Population Division
Internet Release date: March 10, 2003

References

Aldrich, Howard E. and Martinez, Martha. "Entrepreneurship as Social Construction," in Zoltan J. Acs and David B. Audretsch, eds., *The International Handbook of Entrepreneurship.* Dordrecht: Kluwer Academic Publishers, 2003.

Arrow, Kenneth J. "Economic Welfare and the Allocation of Resources for Invention," in R.R. Nelson, ed., *The Rate and Direction of Inventive Activity.* Princeton, NJ: Princeton University Press, 1962, pp. 609-626.

Audretsch, David B. and Feldman, Maryann P. "R&D Spillovers and the Geography of Innovation and Production." *American Economic Review*, June 1996, 86(3), pp. 630-640.

Audretsch, David B. and Stephan, Paula. ""Company-Scientist Locational Links: The Case of Biotechnology," *American Economic Review*, 86(3), June1996, 641-652.

Audretsch, David B., *Innovation and Industry Evolution*, 1995, Cambridge: MIT Press.

Baumol, William J. *Free Market Innovation Machine: Analyzing the Growth Miracle of Capitalism.* Princeton: Princeton University Press, 2002.

Bowen, H.P., E.E. Leamer, and L. Sveikauskas, 1987, "Multicountry, Multifactor Rests of the Faactor Abundance Theory," *American Economic Review*, 78, 791-809.

Cohen, W. and Levinthal, D. "Innovation and Learning: The Two Faces of R&D." *Economic Journal,* 1989, 99(3), pp. 569-596.

Feldmann, Maryann P. and Audretsch, David B. "Innovation in Cities: Science Based Diversity, specialization and Localized Competition." *European Economic Review,* 1999, 43, pp. 409-429.

Gartner, William B. and Carter, Nancy M. "Entrepreneurship Behavior: Firm Organizing Processes," in Zoltan J. Acs and David B. Audretsch, eds., *The International Handbook of Entrepreneurship.* Dordrecht: Kluwer Academic Publishers, 2003.

Glaeser, E., Kallal, H., Scheinkman, J. and Shleifer, A. "Growth of Cities." *Journal of Political Economy,* 1992, 100, pp. 1126-1152.

Granovetter, Mark S. "The Strength of Weak Ties: A Network Theory Revisited," In Randall Collins, ed., *Sociological Theory.* San Francisco: Jossey-Bass, 1983, pp. 201-233.

Griliches, Zvi. "Patent Statistics as Economic Indicators: A Survey." *Journal of Economic Literature,* 1990, 28(4), pp. 1661-1707.

Griliches, Zvi. "Issues in Assessing the Contribution of R&D to Productivity Growth." *Bell Journal of Economics,* 1979, 10(Spring), pp. 92-116.

Grossman, Gene M. and Helpman, Elhanan. *Innovation and Growth in the Global Economy.* Cambridge, MA: MIT Press, 1991.

Gruber, W.H., D. Mehta, and R. Vernon, 1967, "The R&D Factor in International Trade and Investment of the Untied States," *Journal of Political Economy* 75, 20-37.

Hannan, Michael T. and Freeman, John. *Organizational Ecology.* Cambridge, MA: Harvard University Press, 1989.

Harhoff, D. and Steil, F. “Die ZEW-Gruendungspanels: Konzeptionelle Ueberlegungen und Analysepotential,” in D. Harhoff, ed., *Unternehmensgruendungen - Empirische Analysen fuer die alten und neuen Bundeslaender.* 7, Baden-Baden, 1997.

Hirschman, Albert O. *Exit, Voice, and Loyalty.* Cambridge, MA: Harvard University Press, 1970.

Hofstede, G., Noorderhaven, N. G., Thurik, A. R., Wennekers, A. R. M., Uhlaner, L. and Wildeman, R. E. “Culture's Role in Entrepreneurship,” in J. Ulijn and T. Brown, eds., *Innovation, Entrepreneurship and Culture: The Interaction between Technology, Progress and Economic Growth.* Brookfield, UK: Edward Elgar, 2002.

Jacobs, Jane. *The Economy of Cities*. Random House, 1969

Jaffe, Adam B. "Real Effects of Academic Research." *American Economic Review,* 1989, 79(5), pp. 957-970.

Keesing, D. B., 1966, “Labor Skills and Comparative Advantage,” *American Economic Review*, 56, 249-258.

Keesing, D.B., 1967, “The Impact of Research and Development on United States Trade,” *Journal of Political Economy* 75, 38-48.

Lazear, Edward. “Entrepreneurship.” NBER Working Paper 9109, NBER, 2002.

Lucas, Robert E. “On the Mechanics of Economic Development.” *Journal of Monetary Economics,* 1988, 22, pp. 3-39.

Lucas, Robert E. Jr. “Making a Miracle." *Econometrica,* 1993, 61, pp. 251-272.

Organisation for Economic Co-Operation and Development (OECD). *Fostering Entrepreneurship.* Paris: OECD, 1998.

Porter, M. *The Comparative Advantage of Nations.* New York: Free Press, 1990.

Romer, Paul M. “Increasing Returns and Long-Run Growth.” *Journal of Political Economy*, October 1986, 94(5), pp. 1002-37.

Saxenian, Annalee. “Regional Networks and the Resurgence of Silicon Valley.” *California Management Review*, 1990, 33, pp. 89-111.

Saxenien, Annalee. *Regional Advantage.* Cambridge, MA: Harvard University Press, 1994.

Solow, Robert. “A Contribution to The Theory of Economic Growth.” *Quarterly Journal of Economics*, 1956, 70, pp. 65-94.

Thorton, Patricia H. and Flynne, Katherine H. “Entrepreneurship, Networks and Geographies,” in Zoltan J. Acs and David B. Audretsch, eds., *The International Handbook of Entrepreneurship.* Dordrecht: Kluwer Academic Publishers, 2003.

[i] Saxenian (1990, pp. 97-98) claims that even the language and vocabulary used by technical specialists can be specific to a region: “…a distinct language has evolved in the region and certain technical terms used by semiconductor production engineers in Silicon Valley would not even be understood by their counterparts in Boston’s Route 128.”

[ii] Firms with low credit requirements, with a low number of employees or with illimited legal forms are registered only with a time lag. These are typically retail stores or catering firms. See Harhoff and Steil (1997) for more detail on the ZEW foundation panels.