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This submission consists of two papers.

The first, by Hao, Manole and Van Ark has been submitted as well as contributions to individual country data gathering and so if has been considered before can be discarded. It is appended here since it contains cross country analysis as well as within country analysis. The cross-country analysis is what is called for here, whereas the other deliverables are calling for within country analysis. The cross country analysis points out the differences between countries in intangibles (which the second paper here explores) and the consequent effects on growth and competitiveness, the subject of this deliverable. The paper documents the important contribution of intangibles for growth in the different countries.

The second paper by Hao, with Haskel, does not take the investment in intangibles as a given. Rather, it looks at the correlation between the share of intangible investment in GDP for 16 countries from 2001-2004 with various measures of product and employment market regulations. The main finding is that intangible investment (as a proportion of GDP) is negatively and significantly correlated with all variables of product market regulation and employment market regulation. Thus countries with regulation suffer low intangible investment levels. As the paper discusses, if causal, this is an important finding for policy.

Intangible Capital and Growth – an International Comparison

Janet Xiaohui Hao, Vlad Manole and Bart van Ark*

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I. Introduction

We live in an era of innovation. Innovations have improved consumer welfare by introducing new goods and services, increasing the quality of existing goods, decreasing the costs of existing goods, and providing a great amount of information about available goods. Innovations have improved producers' efficiency by changing organizational structures. Innovation, however, is largely ignored in national accounts and corporate financial report because measuring innovation is hard. Indeed, innovation is one of the many assets that are hard to measure and thus are ignored because they are "intangible". Examples of those intangible assets are software, databases, brand equity and human capital.

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Intangible capital include a wide array of assets, including software, databases, R&D, mineral exploration and valuation, copyright and licenses, new products in financial industry, new architectural and engineering designs, brand equity, firm-specific human capital and organizational capital.[1] Economists find that developed countries invest substantially in intangible assets. In the US, the private sector invested 12.1% of GDP in intangible assets in 2003 (Corrado, Hulten and Sichel, 2005)[2]. In the UK, the private sector invested 10.1% of GDP on intangibles in 2004 (Marrano and Haskel, 2006). In Finland, the private sector invested 9.1% of GDP in intangible assets (Jalava, Aulin-Ahmavaara and Alanen, 2007). The Netherlands invested 8.3% of GDP between 2001 and 2004 (van Rooijen-Horsten, van den Bergen and Tanriseven, 2008), and Japan invested 7.5% of GDP from 1995 to 2002 (Fukao, Hamagata, Miyagawa and Tonogi, 2007).

Several of the studies above find that intangible assets promote labor productivity. In the US, intangible assets contributed to 0.4 percentage points of the annual growth of labor productivity on average from 1973 to 1995, which increased to 0.8 percentage points from 1995 to 2003. In the UK, Intangible assets increased labor productivity by an average of 0.4 percentage points per year from 1979 to 1995, which increased to 0.6 percentage points per year from 1995 to 2003 (MHW, 2007). In Finland intangible assets increased labor productivity by 0.6 percentage points annually on average from 1995 to 2000, and increased labor productivity by 0.9 percentage points annually on average from 2000 to 2005 (Jalava, Aulin-Ahmavaara and Alanen, 2007).

In this paper, we use the same methodology as CHS (2005) and Morrano, Haskel and Wallis (2007) to measure how much Germany, France, Italy and Spain invested in intangible assets in 2004. We use a wide range of data sources including national accounts, surveys provided by statistical offices, surveys provided by trade associations and

[1] According to Corrado, Hulten and Sichel (2005), the three categories of intangible assets include software, databases, R&D, mineral exploration and valuation, copyright and licenses, new products in financial industry, new architectural and engineering designs, brand equity, firm-specific human capital and organizational capital. This list includes intangible assets that can only be crudely measured at the macro level and may exclude some intangible assets that cannot be measured at the macro level, such as customer relationships.

[2] CHS (2005) provided intangible investment from 1998 to 2000. We requested the estimate of 2003 from them.

corporate financial reports. We estimate that Germany, France, Italy and Spain respectively invested 7.1%, 7.8%, 5.2% and 5.2% of GDP in intangible assets in the market sector in 2004. From 1995 to 2003, intangible assets contributed to 0.6 percentage points of the annual growth of labor productivity in France and Germany, followed by Italy (0.4 percentage points) and Spain (0.2 percentage points). We chose the period from 1995 to 2003, to be consistent with CHS (2006) and MHW (2007). We also carry out growth accounting for 1995-2000 and 2000-2004 for Germany, France, Italy and Spain. The growth rate of labor productivity was higher in the first period, and was lower in the second period. The contribution of intangible assets decreased from the first to the second period.

Spillover effects from intangible assets most likely account for a significant portion of MFP. If no spillover exists, after we include intangible assets in growth accounting, MFP should be uncorrelated with intangible capital deepening. The intangible capital deepening, however, is still strongly correlated with MFP, implying that intangible assets contribute to MFP through spillovers.

The structure of this paper is as follows. Section II estimates how much Germany, France, Italy and Spain invested in intangible assets from 1991 to 2004. Section III carries out growth accounting of labor productivity with and without intangible assets. We compare the results for Germany, France, Italy and Spain with the results for the US and the UK from 1995 to 2003. Moreover, we compare the results before and after 2000. Section IV concludes.

II. Intangible Investment in Germany, France, Italy and Spain.

Intangible investment in 2004.

Measuring intangible assets is the most difficult part of research on intangible assets. National statistical offices have no data on most intangible assets, so researchers have to find data from less reliable resources. We follow the same method as CHS (2005) and MH (2006) to estimate intangible investment in France and Germany. We use a wide range of data sources including national accounts, surveys provided by statistical offices, surveys provided by trade associations and corporate financial reports. Intangible assets include three major groups—computerized information, innovative property and economic competencies.

Computerized Information.

The major component of computerized information is software. The other component of computerized information is databases. The data source of software investment is the capital account of EU KLEMS, and the data source of database investment is the output account of EU KLEMS at the 3-digit industry level. The capital account of EU KLEMS provides the estimates of the investment and stocks of eight assets—(1) software, (2) computing equipment, (3) communications equipment, (4) transport equipment, (5) other machinery and equipment, (6) total non-resident investment, (7) residential structures, and (8) other assets. The output account of EU KLEMS provides the output of database industry (NACE 724). We approximate database investment with database output.

We estimate that Germany, France, Italy and Spain respectively spent 0.7%, 1.3%, 0.7% and 0.7% of GDP on software in the market sector in 2004. Germany, France, Italy and Spain respectively spent 0.02%, 0.04%, 0.01% and 0.03% of GDP on databases in the market sector in 2004.

Innovative Property.

Innovative property includes both scientific and artistic innovation. The components are (1) R&D in natural science and social science, (2) mineral explorations, (3) copyright and license costs, (4) development costs of new products in financial industry, and (5) new architectural and engineering designs. We estimate that Germany, France, Italy and Spain respectively spent 3.5%, 3.1%, 2.3% and 2.5% of GDP on innovative property in 2004.

(1) R&D. The data source is EUROSTAT. We estimate that the market sector of Germany invested 1.7% of GDP, France invested 1.3% of GDP, Italy invested 0.5% of GDP, and Spain invested 0.6% of GDP on R&D in 2004.

(2) Mineral explorations. The data source for German is the national accounts, and the data sources for France, Italy and Spain are financial reports of major oil and gas companies. We estimate that Germany spent as little as 0.005% of GDP on exploring costs, France spent 0.02% of GDP, and Italy and Spain spent 0.04% of GDP.

(3) Copyright and license costs. The data source for Germany is the national accounts, and the data source of France, Italy and Spain is Screen Digest (2005). Screen Digest provides production costs for 59 countries from 2000 to 2005. We approximate copyright and license costs at five times the production costs of movies[3]. We estimate that Germany spent 0.2% of GDP on copyright and licenses in the market sector in 2004, France 0.3%, Italy 0.1% and Spain 0.2%.

(4) Development costs of new products in financial industry were based on the OECD STAN database for Industrial Analysis. STAN provides the intermediate costs of the financial industry. We assume that the financial industry invested 20% of the intermediate costs in developing new products. We estimate that Germany spent 0.7% of GDP on developing new products in the financial sector 2004, France 0.6%, Italy 0.8% and Spain 0.4%.

[3] CHS (2005) estimate that the total copyright and license costs are three times the development costs of motion pictures. We modify the threes times to five times, because we find that copyright and license costs are five and a half times the development costs of motion pictures in Germany, and are four and a half times in the UK. We obtained copyright and license costs of the UK and Germany from national accounts.

(5) New architectural and engineering designs. The data source for investment in new architectural and engineering designs is the output measure for new architectural and engineering designs from EU KLEMS, with half of the gross output coming from Architectural, Engineering and Other Technical Activities (NACE 74.2). We estimate that Germany spent 0.9% of GDP on new architectural and engineering costs, France 0.9%, Italy 0.8% and Spain 1.4%.

Economic Competency.

Economic Competency includes brand equity, firm-specific human capital and organizational capital. We estimate that Germany, France, Italy and Spain respectively invested 3.3%, 3.9%, 2.7% and 2.2% of GDP on economic competency in 2004.

(1) Brand equity. Firms can increase their brand equity by advertising their brands or by researching the market. The data sources for advertisement are EU KLEMS and World Magazine Trends. EU KLEMS provides the gross output of advertising industry (NACE K744) from 1970 to 2004. We exclude half of newspaper advertisement, because it is likely to be classified as advertisement and does not increase brand equity. World Magazine Trends provide the percentages of advertisement on newspapers. The data source of market research is the Structural Business Statistics of EUROSTAT. It provides the turnover of Market Research and Public Opinion Polling (NACE, K7413).

Some of the advertising expenditure increases the current sales but not the sales after one year, so part of the advertising costs is not investment. We estimate investment in brand equity as 60% of spending on advertisement and 100% of spending on market research. We estimate that Germany, France, Italy and Spain respectively invested 0.8%, 1.5%, 1.2% and 0.6% of GDP on brand equity.

(2) Firm-specific human capital. We measure how much firms spent on firm-specific human capital, using spending on initial vocational training and continuing

vocational training. Initial vocational training relates to apprentice training (AT),whereas continuing vocational training (CVT) includes training courses, training at work places, training through job rotation, self-learning and learning at conferences, lectures and workshops. [4]

Our major data sources of AT and CVT are the Labor Cost Survey (LCS) 2004 provided by EUROSTAT, Continuing Vocational Training Survey (CVTS) 2005 provided by EUROSTAT, and labor compensations provided by EU KLEMS. We estimate that Germany spent 1.3% of GDP on firm-specific human capital, France 1.5%, Italy 1.0% and Spain 0.8%.

(3) Organizational structure. There are two major ways to improve organizational structure. Managers spend time on making the firms more efficient, or firms purchase management consultancy to solve problems of organizational structure. We assume that managers spend 20% of their time on improving organizational structures. Following CHS (2005), we assume that 4 percentage points of those efforts improve current organizational structure and 16 percentage points of those efforts improve future organizational structure. So we measure investment in organizational structures at 16% of managers' compensation and 100% of the revenues of the management consulting industry.

The data sources for managers' compensation are EU KLEMS and the Structure of Earnings Survey (SES) 2002 from EUROSTAT. The data source of management consultancy is the 2004 Annual Survey of the European Management Consultancy Market, provided by the European Federation of Management Consultancies Associations (FEACO). We estimate that Germany, France, Italy and Spain respectively invested 1.1%, 0.9%, 0.5% and 0.8% of GDP in organizational structure.

[4] Initial vocational training includes apprentice training and full-time schooling. Since firms do not pay for full-time schooling, we exclude it.

We stress that these are still relatively crude measures of intangible investment. A major difficulty in studying intangible assets is that since it is a new research field, statistical offices and other agencies do not have data on most intangible assets, and research is scarce on most intangible assets. First, we have no data on imports and exports of intangible assets. Jalava, Ahmavaara and Alanen (2007) use imports, exports, fixed investment in R&D to adjust the R&D spending of BERD for Finland in 2005. They estimate that Finland invested 4275 million Euros in R&D in 2005, 399 million Euros larger than our unadjusted estimation. Second, the CHS (2005) method has its own shortcomings. For example, CHS (2005) crudely assume that the financial industry spend 20% of their intermediate costs on developing new products and that managers spent 20% of their time improving organizational structure. We have no corroborating evidence that those percentages would hold in Germany, France, Italy and Spain.

International Comparison.

Below we compare how much Germany, France, Italy and Spain invested in intangible assets relative to the U.S. and the UK as a percentage of GDP, and how intangible investment compare in relative terms with tangible investment in the same country.

Countries differ in how much they invested in intangible assets (Table 1). In 2004, the U.S. invested in the most in intangible assets (11.7% of GDP), followed by the UK (10.1%), France (7.8%), Germany (7.1%), Italy (5.2%) and Spain (5.2%). Countries also differed in how much they invested in intangible assets compared with tangible investment (Figure 1). In the U.S. intangible investment was 37% larger than tangible investment from 1998 to 2000, and was 11% larger than tangible investment in France and the UK in 2004. In Germany intangible investment was 9% lower than tangible investment, in Italy was 69% less than tangible investment, and in Spain was 54% less than tangible investment.

Countries varied in the composition of intangible assets (Table 2 and Figure 2). In all six countries, computerized information is the smallest part of intangible investment, ranging

from 10% (in Germany) to 17% (in the UK) of total intangible investment. In the US, the UK and France, innovative property is the second largest component of intangible investment in the US, the UK and France ranging from 32% to 40%. Innovative property is the largest part of intangible investment ranging from 44% to 49% of total intangible investment. Economic competency is the largest part of intangible investment at between about 43% and 51%. In Germany, Italy and Spain, economic competency is the second largest part of intangible investment ranging from 38% to 43%.

When comparing the more detailed types of intangible spending, the difference among the countries is even larger. Countries varied the most on how much they spent on software, R&D, advertisement, firm-specific human capital and own-account organizational structure (Table 1). As to software, the UK and the US spent around 1.7% of GDP on software, while Germany, Italy and Spain spent less than 0.8% of GDP. As to R&D, the US spent 2.1% of GDP on R&D, while Italy and Spain respectively spent only 0.5% and 0.6% of GDP. As to advertisement, the US spent 2.3% of GDP on advertisement, while Spain spent only 0.3% of GDP and Germany spent only 0.7% of GDP. As to firm-specific human capital, the UK spent at least twice as much as the other countries. The UK spent 2.5% of GDP on firm-specific human capital, while Spain spent only 0.8% of GDP. As to own-account organizational capital, the US spent 2.3% of GDP, while Germany, Italy and Spain spent less than 0.6% of GDP.

Why do countries spend on intangible assets differently? While beyond the scope of this paper, it seems clear that the historical path of technological development and institutional change led to the emergence of different national innovation systems (Lundvall, 1992; OECD, 1997). This might have caused different proportions of R&D, firm-expenditure on human capital and organizational change. While warranting further research, these estimates are therefore very useful in their own right to evaluate how effective different national innovation systems are.

A problem of comparing intangible investment across countries is that different authors have used different data sources. For example, in this paper we make intensive use of data from trade associations because many data are unavailable in national accounts, while in

particular MH (2006) for the UK and RBT (2007) for the Netherlands rely heavily on the data from national accounts. It should be noted that the U.S. estimates also rely more strongly on trade association sources, because the U.S. National Income and Product Accounts often did not have the relevant data directly included either.

We have compared our data sources with those of MH (2006) and RBT (2007) to estimate intangible spending in the UK and the Netherlands, respectively. On this basis we estimate that the UK invested 10.1% of GDP on intangible assets in 2004, 0.8 percentage points of GDP less than what MH (2006) estimate (Table A2). We estimate that the Netherlands invested 10.5% of GDP on intangible assets in 2004, 1.2 percentage points more than what RBT (2007) estimate (Table A2).

We have examined the data sources of each detailed type of intangibles to analyze the differences further. The differences for investment in software and R&D are small, since we also directly measure those using national accounts. But our estimates for investment in copyright and licenses and investment in advertisement are generally lower than those provided by MH (2007) for the UK and RBT (2007) for the Netherlands.

Intangible investment from 1991 to 2004.

All four countries expanded intangible investment from 1991 to 2004 (Figure 3)[5]. Germany increased intangible investment from 6.9% of GDP in 1991 to 7.1% of GDP in 2004; France expanded intangible investment from 7.0% to 7.8% of GDP; Italy expanded intangible investment from 3.2% to 5.2% of GDP; Spain expanded intangible investment from 4.0% to 5.2% of GDP. In 1991, Italy and Spain invested much less in intangible assets than Germany and France. Partly because of that, from 1991 to 2004, Italy and Spain expanded intangible investment more rapidly than Germany and France.

[5] For more details on the time series, please see Appendix 1.

The composition of intangible investment changed from 1991 to 2004 (Table 2). The share of computerized information increased in all countries, the share of innovative property in total intangible investment increased in all countries except France, and the share of economic competencies decreased in all countries. The share of computerized information increased from 8.5% to 10.1% of total intangible investment in Germany, from 11.4% to 17.3% of intangible investment in France, from 12.6% to 12.9% in Italy, and from 11.3% to 14.3% in Spain. The share of innovative property increased from 44.1% to 49.1 % of intangible investment in Germany, from 42.4% to 43.8% in Italy, and from 39.0% to 48.2% in Spain, and decreased from 40.7% to 40.1% in France. The share of economic competencies decreased from 47.4% to 40.8% of intangible investment in Germany, from 47.9% to 42.7% in France, from 45.0% to 43.3% in Italy, and from 49.7% to 37.6% in Spain.

Germany and France shifted from tangible to intangible investment, while Italy and Spain seemed to prefer tangible to intangible investment. Germany and France decreased tangible investment as a percentage of GDP from 1991 to 2004 (Figure 4). In Germany tangible investment fell from 12.4% of GDP in 1991 to 7.8% of GDP in 2004 and in France from 9.6% of GDP in 1991 to 7.1% of GDP in 2004. Italy and Spain expanded tangible investment much more than intangible investment. Italy and Spain expanded tangible investment by 2.8% and 2.0% of GDP respectively from 1991 to 2004, while they expanded intangible investment by 2.0% and 1.2% of GDP respectively from 1991 to 2004.

III. Intangible Assets Contribute to Labor Productivity.

Intangible assets contribute substantially to labor productivity in recent years in the US and the UK (CHS, 2006 and MHW, 2007). Do intangible assets contribute to labor productivity in Germany, France, Italy and Spain? To answer this question, we carry out growth accounting of the market sector using our estimates of intangible assets.

1. Methodology

(1) Equation of Growth Accounting with Intangible Assets.

Growth accounting relates the growth of output to the growth of inputs. We use a Cobb-Douglass production function of constant returns to scale.

$$Y = AK^{\alpha} R^{\beta} (L \cdot L^{QA})^{\gamma}, \text{ where } \alpha + \beta + \gamma = 1. \quad (1)$$

Y is the value-added of the market sector. A is total-factor productivity. K is tangible capital stock. R is intangible capital stock. L is labor input. L^{QA} is labor quality. We divide both sides with L. So labor productivity (Y/L) is determined by tangible capital deepening (K/L), intangible capital deepening (R/L), labor quality (L^{QA}) and MFP (A).

$$(Y/L) = A(K/L)^{\alpha} (R/L)^{\beta} (L^{QA})^{\gamma}, \text{ where } \alpha + \beta + \gamma = 1.$$

$$\Delta \ln A = \Delta \ln(Y/L) - \alpha \Delta \ln(K/L) - \beta \Delta \ln(R/L) - \gamma \Delta \ln(L^{QA})$$

There are I types of tangible capital and J types of intangible capital, and our equation of growth accounting with intangible assets becomes the following.

$$\Delta \ln A = \Delta \ln(Y/L) - \sum_i \alpha_i \Delta \ln(K_i/L) - \sum_j \beta_j \Delta \ln(R_j/L) - \gamma \Delta \ln(L^{QA}),$$

$$\text{where} \sum_i \alpha_i + \sum_j \beta_j + \gamma = 1.$$

We also carry out growth accounting without intangible assets. The equation without intangible assets is the following.

$$\Delta \ln A' = \Delta \ln(Y/L) - \sum_i a_i \ln(K/L) - b \Delta \ln(L^{QA}),$$

$$\text{where} \sum_i a_i + b = 1.$$

(2) Estimating the shares of tangible capital, intangible capital and labor.

We calculate the values of α_i and β_j, following the method of CHS (2006). In an economy of constant returns to scale and perfect competition, α_i is the share of compensation of tangible capital i in value-add. β_j is the share of compensation of intangible capital j in value-added. γ is the share of labor compensation in value-added. The compensation of tangible capital i is the rental price of tangible capital i, P_i^K, multiplied by the stock of tangible capital i, K_i. The compensation of intangible capital is the rental price of tangible capital j, P_j^R, multiplied by the stock of intangible capital j, K_j.

$$Y = \sum_i P_i^K K_i + \sum_j P_j^R R_j + wL. \tag{2}$$

$$\alpha_i = \frac{P_i^K K_i}{Y} \tag{3}$$

$$\beta_j = \frac{P_j^R R_j}{Y} \tag{4}$$

$$\gamma = \frac{wL}{Y}$$

To calculate the values of α_i and β_j, we need the values of P_i^K and P_j^R. The following equations determine the values of P_i^K and P_j^R.

$$P_i^K = [r - \rho_i + (1+\rho_i)\delta_i]P_i^{IK} \quad (5)$$

$$P_j^R = [r - \rho_j + (1+\rho_j)\delta_j]P_j^{IR} \quad (6)$$

In equilibrium, the cost of buying an asset equals the cost of renting the asset. P_i^{IK} is the acquisition price of tangible capital i. r is the economy-wide rate of return. ρ_i is capital gains of tangible capital i. δ_i is the depreciation rate of tangible capital i. P_j^{IR} is the acquisition price of intangible capital j. ρ_j is capital gains of intangible capital j. δ_j is the depreciation rate of intangible capital j.

We do not know the value of r, but we know the value of the other variables. We plug equations (5) and (6) into equation (2) and solve for r.

$$Y = \sum_i [r - \rho_i + (1+\rho_i)\delta_i]P_i^{IK}K_i + \sum_j [r - \rho_j + (1+\rho_j)\delta_j]P_j^{IR}R_j + wL$$

$$r = \frac{(Y - wL) - \sum_i [-\rho_i + (1+\rho_i)\delta_i]P_i^{IK}K_i - \sum_j [-\rho_j + (1+\rho_j)\delta_j]P_j^{IR}R_j}{\sum_i P_i^{IK}K_i + \sum_j P_j^{IR}R_j}$$

We substitute the value of r into equation (5) and equation (6) to estimate P_i^K and P_j^R, and then plug the values of P_i^K and P_j^R into equation (3) and equation (4) to get the values of α_i and β_j.

(3) Labor Quality.

Just as tangible capital has I different types, labor input (hours worked) has inputs of three different qualities. Hours worked (L) is comprised of hours worked of high-skilled (L_h), medium-skilled (L_m) and low-skilled labor (L_l).

$$L = L_h + L_m + L_l$$

We break down the contribution of labor into the contribution of hours worked ($\Delta \ln(L)$) and the contribution of labor quality ($\Delta \ln(L^{QA})$).

$$\Delta \ln(L \cdot L^{QA}) = \Delta \ln(L) + share_h \Delta \ln(L_h / L) + share_m \Delta \ln(L_m / L) + share_l \Delta \ln(L_l / L),$$

where $share_h = \dfrac{w_h L_h}{w_h L_h + w_m L_m + w_l L_l}$,

$share_m = \dfrac{w_m L_m}{w_h L_h + w_m L_m + w_l L_l}$, and

$share_l = \dfrac{w_l L_l}{w_h L_h + w_m L_m + w_l L_l}$.

(4) Constructing Variables of the Market Sector.

A problem of aggregating industries of the market sector is that we cannot simply add up the real values of the value-added, investment and capital stock across industries. Suppose the market sector Z is made of two industries, X and Y. The nominal value of Z equals the nominal values of X and Y, and the real value of Z may not equal the real values of X and Y.

$$P_z Z = P_x X + P_y Y.$$
$$Z \neq X + Y$$

To estimate the real values of Z, we use the following equation.

$$\Delta \ln(Z) = \frac{P_x X}{P_x X + P_y Y} \Delta \ln(X) + \frac{P_y Y}{P_x X + P_y Y} \Delta \ln(Y)$$

2. Data sources.

Value-added and labor input. EU KLEMS provides the value-added and labor input by industry. Eight variables of labor input are available—(1) total hours worked, (2) hours worked of high-skilled labor, (3) hours worked of medium-skilled labor, (4) hours worked of low-skilled labor, (5) total labor compensation, (6) compensation of high-skilled labor, (7) compensation of medium-skilled labor and (8) compensation of low-skilled labor.

Investment and stock of tangible assets. EU KLEMS provides the investment and stocks of six tangible assets—(1) computing equipment (IT), (2) communications equipment (CT), (3) transport equipment, (4) other machinery and equipment, (5) total non-resident investment and (6) other assets. We construct three large groups of tangible assets - ICT tangible assets, non-residential buildings and other tangible assets. ICT tangible assets include computing equipment and communications equipment. Non-residential buildings are the EU KLEMS variable of total non-resident structures. Other tangible assets include transport equipment, other machinery and equipment and other assets. We exclude residential structures, because they are not used in production.

Investment and stock of intangible assets. The data source of intangible investment is our estimate. We extend our estimation back to the 1970s, and estimate the stock of each intangible asset using the perpetual inventory method. An exception is software. EU KLEMS provides the investment and stock data for software.

Deflators and Capital Gains. EU KLEMS provides the deflator of tangible assets. We use the deflator of value-added as the deflator of intangible assets, following CHS (2005). Also following the method of CHS (2006), we use a three-year average of deflators to calculate the capital gains of each asset.

Depreciation rates. EU KLEMS provides the depreciation rates of tangible assets, software and databases. CHS (2005) provides the depreciation rates of intangible assets except software and databases. Table 3 lists the values of depreciation rates.

3. Intangible Assets and Labor Productivity, 1995-2003.

In this section, we carry out growth accounting of the market sector in Germany, France, Italy and Spain, and compare our results with the results of the US and the UK. To be consistent with CHS (2006) and MHW (2007), we estimate how much intangible assets contributed to labor productivity from 1995 to 2003 in Germany, France, Italy and Spain. Market sector is the whole economy excluding public administration, education, health and real estate activities (EU KLEMS, 2008).

(1) Why we include intangible assets.

Including intangible assets is necessary for growth accounting. If we ignore intangible assets, we will under-estimate labor productivity, and over-estimate the contribution of MFP, tangible capital and labor quality to labor productivity. Ignoring intangible assets under-states labor productivity, because intangible investment adds to value-added. Adding intangible assets decreases the contribution of MFP, because the contribution of intangible assets is no longer hidden in MFP. Adding intangible assets decreases the contribution of tangible capital and labor decreases because their compensation shares decreases. The shares of tangible capital, intangible capital and labor add up to one, if we assume constant returns to scale.

Labor productivity measures how much an employee produces per hour on average. For example, labor productivity was 37.2 in the US in 2003, meaning one hour of work produced $37.2 of value-added on average (2000 constant prices). Labor productivity may

increase if producers use better tangible and intangible capital or if workers are of higher-skills.

National accounts treat most intangible investment as an intermediate input, not as capital formation. As a result, conventional national accounts exclude most intangible investment from value-added. Labor productivity is value-added divided by hours worked, so including intangible investment usually increases labor productivity.

From 1995 to 2003, including intangible assets increases the growth rates of labor productivity in the US, the UK, Germany, France, Italy and Spain. The growth rate increases from 2.8% to 3.1% per years in the US (CHS, 2006), increases from 2.6% to 2.9% per year in the UK (MHW, 2007), increases from 1.7% to 1.9% per year in Germany, increases from 2.1% to 2.4% per year in France, increases from 0.4% to 0.6% per year in Italy,and increases from 0.2% to 0.3% per year in Spain (Table 4).

From 1995 to 2003 including intangible assets changes MFP growth, and decreases the contribution of tangible capital and labor to productivity growth. MFP growth decreases by 0.3 percentage points in the US (CHS, 2006), 0.1 percentage points in the UK (MHW, 2007), 0.3 percentage points in Germany, and 0.2 percentage points in France. It changed from -0.3 percentage points to -0.4 percentage points per year in Italy and changed from -1.00 percentage points to -0.98 percentage points per year in Spain. The contribution of tangible capital (ICT and non-ICT tangible capital) decreases by 0.1 percentage points in the US, 0.1 percentage points in the UK, 0.1 percentage points in Germany, 0.1 percentage points in France, 0.04 percentage points in Italy and 0.1 percentage points in Spain. The contribution of labor quality decreases by 0.05 percentage points in the US, the UK and France, decreased by 0.02 percentage points in Italy, and decreased by 0.03 percentage points in Spain.

(2) International comparison (with intangible assets).

From 1995 to 2003 labor productivity grew the fastest in the US, 3.1% per year on average, followed by the UK (2.9%), France (2.4%), Germany (1.9%), Italy (0.6%) and Spain (0.3%).

Intangible assets contributed substantially to the growth of labor productivity in all six countries. It contributed to 0.8 percentage points of LP growth in the US, 0.6 percentage points in the UK, France and Germany, 0.4 percentage points in Italy and 0.2 percentage points in Spain. Economic competency contributes more than software and innovative property to labor productivity in the US, the UK and France, while innovative property contributes the most to labor productivity in Germany, Italy and Spain.

Tangible capital (ICT and non-ICT tangible capital) contributed the most in the UK (1.5 percentage points), followed by Germany (0.9 percentage points), the US (0.8 percentage points), France (0.6 percentage points), Spain (0.6 percentage points) and Italy (0.5 percentage points). Tangible capital contributed to labor productivity mostly because of ICT capital in the US and the UK and mostly because of non-ICT capital in Germany, France, Italy and Spain.

Labor quality contributed the most in Spain (0.5 percentage points), followed by France, the US and the UK (0.3 percentage points), Italy (0.2 percentage points) and Germany (0.1 percentage points). Spain benefited the most from labor quality possible because Spain started with many low-skilled workers and the share of low-skilled workers dropped from 1995 to 2003. In 1995, 69.6% of the labor force (hours worked) of Spain was low-skilled, and in 2003 the share of low-skilled labor dropped to 57%. In contrast, Germany benefited the least from labor quality possibly because Germany had a small number of low-skilled workers in 1995 and the room to decrease the number of low-skilled workers was small. In 1995, 28.7% of German labor force (hours worked) was low-skilled and that share increased to 30.0% in 2003.

How much did knowledge contribute to the growth of labor productivity? ICT tangible capital, intangible capital and labor quality all reflects progress in knowledge. We sum up the contribution of ICT tangible capital, intangible capital and labor quality. Knowledge contributes more than half of the growth in labor productivity in all countries. Knowledge contributes the most in the UK (1.9 percentage points), followed by the US (1.8 percentage points), France (1.1 percentage points), Germany (1.0 percentage points), Spain (0.9 percentage points) and Italy (0.7 percentage points).

Spillover effects of intangible assets may account for a significant portion of MFP growth. MFP measures the productivity growth unexplained by the growth of capital and labor inputs. If no spillovers exist, after we include intangible assets in growth accounting, the growth of intangible assets should be uncorrelated with MFP growth. Instead of using the growth of intangible assets, we use intangible capital deepening because CHS (2006) and MHW (2007) do not provide the growth rates. Intangible capital deepening is the growth of intangible assets multiplied by its share of compensation in total value-added. Intangible capital deepening is strongly correlated with MFP, implying that intangible assets contribute to MFP through spillovers (Figure 5).

4. The difference before and after 2000.

If we treat years before and after 2000 as one period, we obscure that labor productivity grew at different trends before and after 2000. The growth rate of labor productivity increased before 2000 and plummeted after 2000. The periods we cover are 1995-2000 and 2000-2004.[6] We examine Germany, France, Italy and Spain, and exclude the US and the UK because CHS (2006) and MHW (2007) do not provide the estimates of the US and the UK of the same periods.

[6] We would like to analyze the periods before 1995, but we have no data on the stock of intangible capital.

Adding intangible investment to value added increases the *growth rate* of labor productivity when intangible investment is expanding rapidly, and decreases the *growth rate* of labor productivity when intangible investment is slowing down. When intangible investment grew fast before 2000, it would raise the growth rate of labor productivity (Table 5 and Table 6). When intangible investment slowed down after 2000, it would depress the growth rate of labor productivity in Italy and Spain. As to the input contribution to labor productivity, adding intangible assets decreases the contribution of ICT tangible capital, non-ICT tangible capital, labor quality and MFP.

Table 6 reports the results of growth accounting using intangible assets. Labor productivity plummets from the first to the second period in Germany, France and Italy, but increased slighted in Spain. In all countries before and after 2000, the contribution of intangible assets to labor productivity is substantial. Before 2000 it contributes to 0.6 percentage points of annual growth of labor productivity in Germany, 0.7 percentage points in France, 0.5 percentage points in Italy, and 0.2 percentage points in Spain. After 2000 the contribution of intangible assets still remains strong in Germany, France and Spain, but plummeted in Italy.

We estimate the contribution of three groups of intangible assets. Innovative property contributed the most to labor productivity in Germany (0.4 percentage points), followed by France, Italy and Spain (0.2 percentage points) before 2000, and contributed the most in all four countries after 2000 (0.3 in Germany, 0.2 in France, 0.1 in Italy and 0.2 in Spain). Computerized information decreases it contribution in all four countries. Economic competency increases its contribution in Germany and Spain, and decreases its contribution in France and Italy.

The contribution of ICT assets follows a similar pattern as intangible assets. It is strong before 2000 and decreased after 2000 in all countries. The contribution of non-ICT tangible capital is slightly below the contribution of intangible assets before 2000, and remained strong after 2000. The contribution of labor quality increased in Germany and Italy, but decreased in France and Spain.

How much did knowledge contribute to the growth of labor productivity? ICT tangible capital, intangible capital and labor quality all reflects progress in knowledge. We sum up the contribution of ICT tangible capital, intangible capital and labor quality. Knowledge contributes more than half of the growth in labor productivity in all countries both before and after 2000. Before 2000 knowledge contributes the most in Spain (1.1 percentage points), followed by Germany and France (0.9 percentage points) and Italy (0.9 percentage points). After 2000 knowledge contributes the most in Germany (1.0 percentage points), followed by France and Spain (0.8 percentage points), and Italy (0.3 percentage points).

MFP measures the productivity growth unexplained by the growth of capital and labor inputs. In the first period, France has the largest MFP (1.2 percentage points), followed by Germany (0.8 percentage points), followed by Italy (0.2) and Spain (-0.9). In the second period, MFP decreased and turned negative in all countries. Italy has the largest negative MFP (-1.2 percentage points), followed by Spain (-0.9), Germany (-0.05) and France (0.3). The large negative MFPs in Italy and Spain imply that investing in tangible assets was unsuccessful to boost productivity.

IV. Conclusion

We estimate that Germany, France, Italy and Spain respectively invested 7.1%, 7.8%, 5.2% and 5.2% of GDP in intangible assets in the market sector in 2004, compared to 12.1% in the US in 2003 (CHS, 2005) and 10.1% in the UK in 2004 (MHW, 2007). Countries differ in how heavily they invested in intangible assets. The US, the UK and France invested more in intangible assets than tangible assets, Germany invested slightly less in intangible assets than tangible assets, and Italy and Spain invested much less in intangible assets than tangible assets.

Intangible assets contribute to the growth of labor productivity through increased capital input and through spillovers into MFP. As to increased capital input, we estimate that intangible assets contributed to 0.6 percentage points of the growth of labor productivity in France and Germany from 1995 to 2003, 0.4 percentage points in Italy and 0.2 percentage points in Spain. As to spillovers, we are unable to estimate the magnitude, but Figure 5 shows a strong relationship between MFP and intangible capital deepening.

A better understanding of MFP calls for research on the spillovers of intangible assets. Our findings imply that the spillover of intangible assets drives MFP. Research on intangible assets also calls for a standardized measure of intangible assets across countries. Because intangible assets are a new research field, national statistical offices have no data on most intangible assets, and researchers end up using data from different sources for different intangible assets and for different countries. Different data sources lead to different estimates of intangible investment.

This paper studies intangible assets at the national level, while within the same country some industries invest more in intangible assets than other industries. For example, pharmaceutical industries invest heavily in intangible assets. Bayer invested 2.6 trillion Euros in research and development in 2007 (Bayer Annual Report, 2007). In the future, we aim to measure intangible investment at the *industry* level and carry out growth accounting at the *industry* level. We aim to answer the following questions: How much did

intangible assets contribute to economic growth in different industries across countries? Did intangible assets change the comparative advantage of industries across countries?

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Table 1: Spending on Intangible Assets in the Market Sector (% GDP)

Type of Expenditure	Germany 2004	France 2004	Italy 2004	Spain 2004	UK 2004	US 1998-2000
1. Computerized information	**0.71**	**1.34**	**0.66**	**0.74**	**1.70**	**1.65**
a) Software	0.69	1.30	0.66	0.72		
b) Databases	0.02	0.04	0.01	0.03		
2. Innovative property	**3.47**	**3.11**	**2.26**	**2.51**	**3.23**	**4.57**
a) R&D, including social sciences and humanities	1.69	1.32	0.52	0.55	1.09	2.06
b) Mineral exploration and evaluation	0.00	0.02	0.04	0.04	0.04	0.19
c) Copyright and license costs	0.20	0.32	0.10	0.19	0.21	0.81
d) Development costs in financial industry	0.70	0.57	0.79	0.35	0.69	0.79
e) New architectural and engineering designs	0.87	0.88	0.80	1.38	1.2	0.73
3. Economic competencies	**3.27**	**3.93**	**2.67**	**2.19**	**5.95**	**6.91**
a) Brand equity	0.84	1.51	1.19	0.58	1.59	2.53
Advertising expenditure	0.69	1.24	0.91	0.33	1.2	2.33
Market research	0.15	0.27	0.28	0.25	0.39	0.2
b) Firm-specific human capital	1.34	1.51	1.00	0.83	2.45	1.25
Continuing vocational training	0.67	1.25	0.69	0.73		
Apprentice training	0.67	0.26	0.31	0.11		
c) Organizational structure	1.09	0.91	0.48	0.78	1.92	3.13
Purchased	0.50	0.31	0.11	0.25	0.6	0.87
Own account	0.59	0.60	0.37	0.53	1.31	2.26
Total Spending	**7.45**	**8.38**	**5.58**	**5.44**	**10.88**	**13.13**
Total Investment	**7.05**	**7.75**	**5.15**	**5.20**	**10.1**	**11.7**

Sources: The source of the US is CHS (2005). The source of the UK is MH(2006). For Germany, France, Italy and Spain, we use a wide range of data sources including national accounts, surveys of statistical offices, surveys of trade associations and corporate financial reports. For more details on data sources, please see Appendix 1.
Note: To convert spending into investment, 60% of expenditure on advertisement, 80% of expenditure on own-account organizational structure and 100% of all the other expenditure are investment (CHS, 2005).

Table 2: Composition of Intangible Investment (% of total intangible investment)

	Germany			France			Italy			Spain		
	Comp Info	Innov Prop	Econ Comp	Comp Info	Innov Prop	Econ Comp	Comp Info	Innov Prop	Econ Comp	Comp Info	Innov Prop	Econ Comp
1991	8.45	44.12	47.42	11.44	40.66	47.90	12.64	42.38	44.98	11.32	39.03	49.65
1992	8.36	43.43	48.20	11.52	41.16	47.32	11.37	47.19	41.44	10.54	38.53	50.92
1993	8.17	43.74	48.09	10.59	41.69	47.71	11.26	46.49	42.24	10.19	38.44	51.36
1994	8.19	43.99	47.81	11.45	42.71	45.83	11.81	45.62	42.57	11.14	37.09	51.77
1995	8.27	44.36	47.37	12.06	42.06	45.88	12.04	45.42	42.54	11.96	36.65	51.39
1996	8.71	44.11	47.18	13.15	40.76	46.09	13.01	42.47	44.52	12.58	36.57	50.85
1997	9.21	44.90	45.89	15.45	39.65	44.89	12.55	44.70	42.75	12.43	36.50	51.06
1998	9.67	45.74	44.58	17.79	39.77	42.43	12.83	41.02	46.14	12.82	36.42	50.76
1999	9.88	46.33	43.79	18.32	38.88	42.80	13.51	41.19	45.30	14.43	46.07	39.50
2000	10.33	49.00	40.67	17.75	36.98	45.27	13.24	40.03	46.73	14.03	43.97	41.99
2001	10.52	48.15	41.34	18.78	37.89	43.33	14.06	40.98	44.96	15.28	44.38	40.34
2002	10.08	48.13	41.79	18.27	39.55	42.18	13.27	41.29	45.45	14.85	46.46	38.69
2003	9.94	48.78	41.28	17.42	40.34	42.24	12.78	43.03	44.20	14.72	46.91	38.37
2004	10.07	49.14	40.79	17.29	40.06	42.65	12.86	43.83	43.31	14.30	48.15	37.55

Sources: We use a wide range of data sources including national accounts, surveys of statistical offices, surveys of trade associations and corporate financial reports. For more details of data sources, please see Appendix 1.

Table 3: Depreciation Rates

Assets	Depreciation Rates
Intangible Assets	
Software	0.315
Databases	0.315
R&D	0.2
Mineral exploration and evaluation	0.2
Copyright and license costs	0.2
Development costs in financial industry	0.2
New architectural and engineering designs	0.2
Advertising expenditure	0.6
Market research	0.6
Firm-specific human capital	0.4
Organizational structure	0.4
Tangible Assets	
Computing equipment (IT)	0.315
Communications equipment (CT)	0.115
Transport equipment	0.189
Other machinery and equipment	0.126
Non-resident structures	0.031
Other assets.	0.126

Sources: EU KLEMS provides the depreciation rates of tangible assets, software and databases. CHS (2005) provides the depreciation rates of intangible assets except software and databases.

Table 4: Annual Change in Labor Productivity in the Market Sector, 1995-2003

	US	UK	Germany	France	Italy	Spain
	Excluding Intangible Capital (%)					
Labor productivity growth	2.78	2.59	1.72	2.13	0.43	0.20
Contribution of Inputs						
ICT tangible capital deepening (ex. software)	0.70	1.13	0.34	0.20	0.19	0.27
Non-ICT tangible capital deepening	0.28	0.51	0.64	0.49	0.35	0.40
Labor Quality	0.38	0.36	0.08	0.38	0.17	0.53
MFP	1.42	0.58	0.65	1.07	-0.28	-1.00
	Including Intangible Capital (%)					
Labor productivity growth	3.09	2.93	1.90	2.38	0.59	0.28
Contribution of Inputs						
ICT tangible capital deepening (ex. software)	0.60	1.02	0.30	0.17	0.18	0.24
Non-ICT tangible capital deepening	0.24	0.52	0.55	0.40	0.32	0.34
Intangible Capital deepening	0.84	0.59	0.59	0.60	0.35	0.18
Labor Quality	0.33	0.31	0.08	0.34	0.15	0.50
MFP	1.08	0.48	0.39	0.87	-0.40	-0.98
Software	0.27	0.18	0.10	0.19	0.04	0.07
Innovative Property	0.22	0.14	0.38	0.20	0.16	0.23
Economic Competency	0.35	0.26	0.11	0.21	0.14	-0.11

Sources: The source of the US is CHS (2005). The source of the UK is MHW (2007). For Germany, France, Italy and Spain, the sources are EU KLEMS, CHS (2005), and our estimates of intangible investment. EU KLEMS provides the investment, stock, deflators and depreciation rates of tangible assets and the depreciation rates of software and databases. CHS (2005) provides the deflators of all intangible assets and the depreciation rates of intangible assets excluding software and databases. We estimate intangible investment using national accounts, surveys of statistical offices, surveys of trade associations and corporate financial reports.

Table 5: Growth Accounting without Intangible Assets, 1995-2000 and 2000-2004

	1995-2000				2000-2004			
	Germany	France	Italy	Spain	Germany	France	Italy	Spain
Annual growth rate of labor productivity of the business sector	1.95	2.43	1.13	0.07	1.40	1.51	-0.45	0.57
Contribution of Inputs								
ICT tangible capital deepening (ex. Software).	0.41	0.24	0.28	0.38	0.26	0.15	0.10	0.14
Non-ICT tangible capital deepening	0.60	0.38	0.32	0.14	0.58	0.51	0.43	0.77
Labor Quality	-0.04	0.58	0.14	0.62	0.29	0.26	0.18	0.46
MFP	0.98	1.24	0.39	-1.06	0.27	0.59	-1.16	-0.79

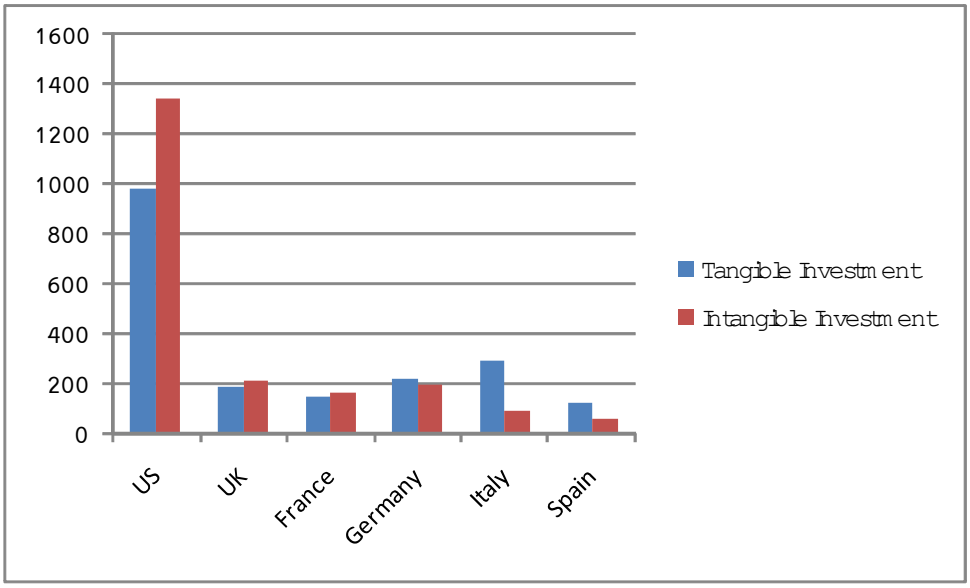
Sources: EU KLEMS provides the investment, stock, deflators and depreciation rates of tangible assets and the depreciation rates of software and databases. CHS (2005) provides the deflators of all intangible assets and the depreciation rates of intangible assets excluding software and databases. We estimate intangible investment using national accounts, surveys of statistical offices, surveys of trade associations and corporate financial reports.
Note: All values are for the market sector.

Table 6: Growth Accounting with Intangible Assets, 1995-2000 and 2000-2004

	1995-2000				2000-2004			
	Germany	France	Italy	Spain	Germany	France	Italy	Spain
Annual growth rate of labor productivity of the business sector	2.18	2.86	1.39	0.30	1.44	1.50	-0.49	0.50
Contribution of Inputs								
ICT tangible capital deepening (ex. Software)	0.37	0.20	0.26	0.34	0.23	0.13	0.09	0.13
Non-ICT tangible capital deepening	0.52	0.32	0.29	0.13	0.49	0.41	0.39	0.67
Intangible Capital deepening	0.56	0.65	0.46	0.19	0.52	0.46	0.08	0.20
Labor Quality	-0.04	0.51	0.13	0.57	0.26	0.23	0.16	0.42
MFP	0.78	1.17	0.24	-0.93	-0.05	0.27	-1.22	-0.91
Software	0.10	0.22	0.05	0.07	0.08	0.12	0.02	0.06
Innovative Property	0.38	0.16	0.18	0.21	0.32	0.23	0.10	0.22
Economic Competency	0.08	0.27	0.23	-0.09	0.11	0.10	-0.04	-0.08

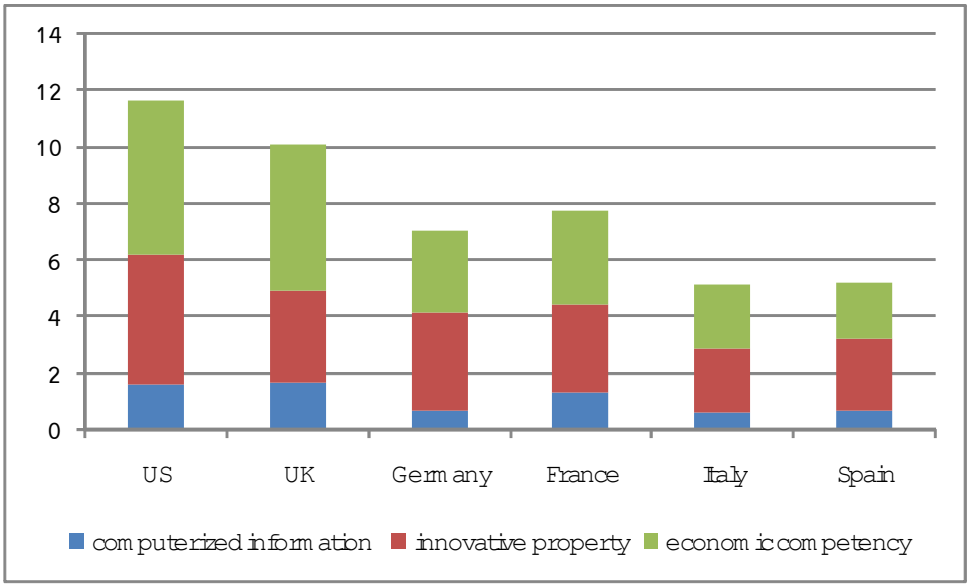
Sources: EU KLEMS provides the investment, stock, deflators and depreciation rates of tangible assets and the depreciation rates of software and databases. CHS (2005) provides the deflators of all intangible assets and the depreciation rates of intangible assets excluding software and databases. We estimate intangible investment using national accounts, surveys of statistical offices, surveys of trade associations and corporate financial reports.
Note: All values are for the market sector.

Figure 1: Intangible and Tangible Investment in 2004 ($billion, current prices)



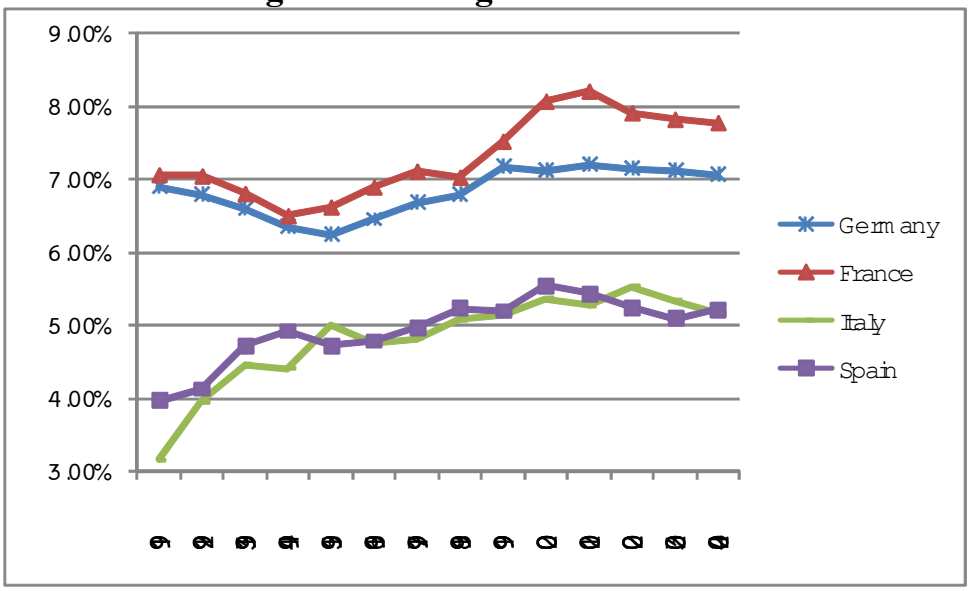
Note: The values of the US are the averages of 2000-2003.
Sources: The source of the US is CHS (2005). The source of the UK is MH (2006). For Germany, France, Italy and Spain, we use a wide range of data sources including national accounts, surveys of statistical offices, surveys of trade associations and corporate financial reports. For more details of data sources, please see Appendix 1.

Figure 2: Intangible Investment in the Market Sector (% GDP, 2004)



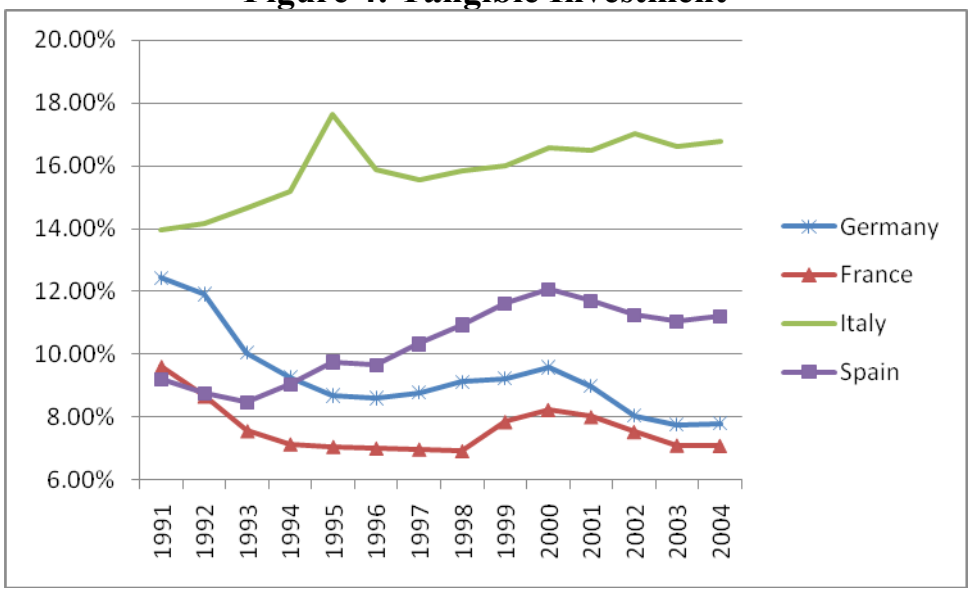
Note: The values of the US are the averages of 2000-2003.
Sources: The source of the US is CHS (2005). The source of the UK is MHW (2007). For Germany, France, Italy and Spain, we use a wide range of data sources including national accounts, surveys of statistical offices, surveys of trade associations and corporate financial reports. For more details of data sources, please see Appendix 1.

Figure 3: Intangible Investment



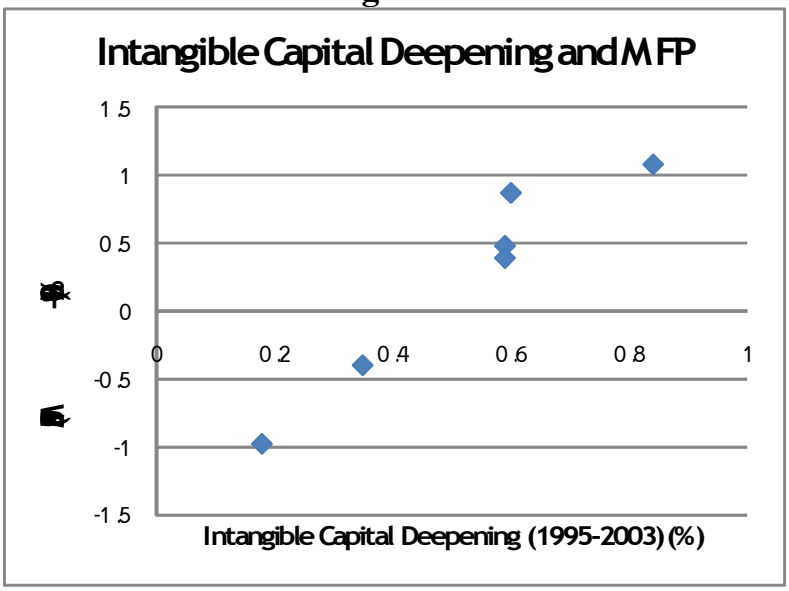
Sources: We use a wide range of data sources including national accounts, surveys of statistical offices, surveys of trade associations and corporate financial reports. For more details of data sources, please see Appendix 1.
Note: The values are for the market sector.

Figure 4: Tangible Investment



Source: EU KLEMS.
Note: the values are for the market sector.

Figure 5



Source: CHS (2006), MHW (2007) and our estimates.
Note: The six countries are the US, the UK, Germany, France, Italy and Spain. We use intangible assets in growth accounting to estimate MFP. Intangible capital deepening is the annual growth rate of intangible assets multiplied by its share of compensation.

Draft for discussion, please do not quote

Intangible Investment and Product Market Regulations[7]

Janet Hao, Conference Board, New York,
Jonathan Haskel, Imperial College Business School
Wednesday, March 02, 2011

5. Introduction.

As the economy slowly recovers, business leaders and governments are seeking new opportunities for profit and economic growth. Many firms outsource manufacturing to developing countries like China and India where labor is cheap. The domestic employees of those firms increasingly focus on product and service innovations. While cheap labor brings growth to developing countries, innovations have become an important driver of growth in advanced countries.

Most activities related to innovations form intangible assets. The classic knowledge investment that has been extensively studied is R&D. But it is important to realize that this is just one such investment in knowledge. For example, among the twelve major innovation activities reported in the UK Community Innovation Survey, ten activities are intangible investment, and only two activities are tangible investment. The two activities are computer hardware and advanced machinery. The ten activities related to intangibles are computer software, internal R&D, training, changes to product or service design, changes to marketing methods, all forms of design, advertising, market research, acquisition of external knowledge, and external R&D.

[7] This is the same document as the final report for COINVEST project, with an additional graph of intangible investment and the strictness of employment regulation. Financial support has been provided by the COINVEST project, www.coinvest.org.uk, funded by the European Commission Seventh Framework Programme, Theme 9, Socio-economic Science and Humanities, grant number 217512.,

It is also worth noting that in the current national accounts the most significant measured intangible investment is software. The decision to capitalize software was implemented in most national accounts only comparatively recently and in many countries software investment dwarfs R&D (although the wedge between private and social returns might of course be quite different). Intangible assets are a comprehensive measure of investment in innovations. Intangible assets are the property of firms that will bring profit in the future and that cannot be touched or seen unlike machines, equipments and buildings. Intangible assets have three major categories, computerized information, innovative property and economic competencies. Computerized information includes software and database. Innovative property includes R&D, mineral exploration and exploration, copyright and licenses, new products in financial industry, and architectural and engineering designs. Economic competencies include brand equity, firm-specific human capital and organizational structure .

Corrado and Hulten, 2010 shows that intangible capital is the most dynamic factor of investment in the US in the past 50 years. Tangible investment increased slightly from 11.1% of GDP in 1947 to 13.7% of GDP in 1985, and declined since then to 10.0 % of GDP in 2007. In contrast, intangible investment rises steadily from 4.5 % of GDP in 1947 to 13.7% of GDP in 2007. In Europe, the UK, Germany, France, the Netherlands invested between 7.2% and 10.6% of GDP in intangible assets in 2006. If macroeconomic measures ignore intangible assets, they are missing about half of the investment of the advanced economy.[8]

Economists find that intangible assets contributed substantially to productivity growth. Intangible capital contributed to about one quarter of the labor productivity growth in the US from 1995 to 2003 (Corrado, Hulten and Sichel, 2009). Moreover, intangible capital, rather than

[8] It should of course be acknoelwedged that in some countries long time series of intangible investment are more guestimates given the problems with contemporaneous data.

tangible capital or labor quality, explains why labor productivity grew much faster in the US than in Europe from 1995 to 2006 (van Ark, Hao, Corrado and Hulten, 2009).

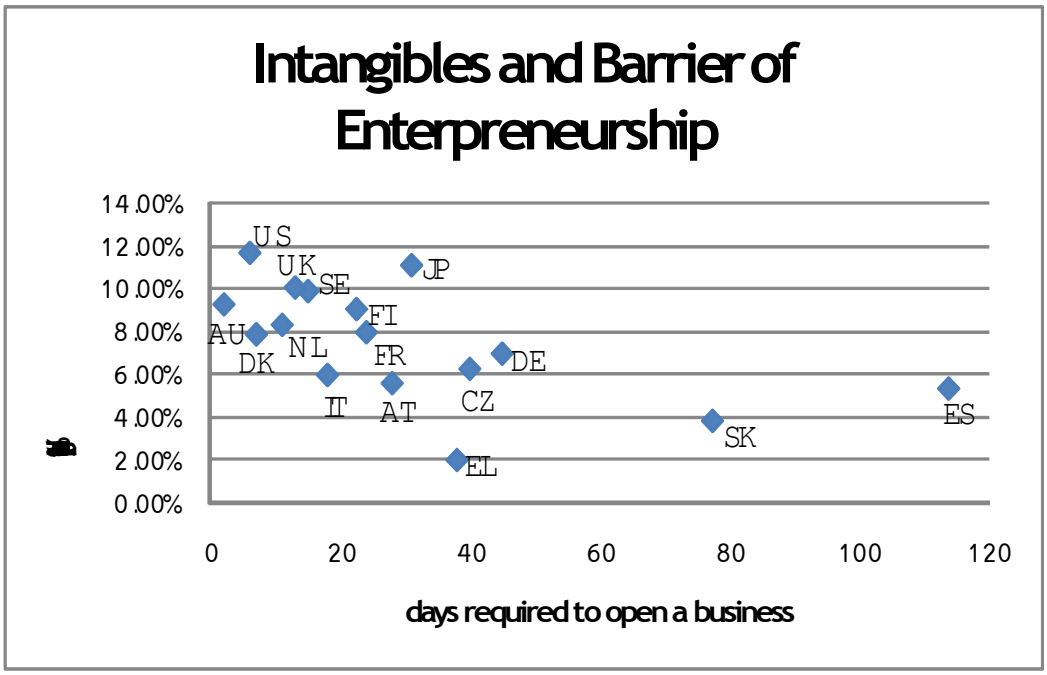
If one considers intangible spending to be investment, it is important for governments to consider intangible investment and intangible assets when governments make economic policies. One important type of economy policies is product market regulation. Product market regulation affect the state control, barriers to entrepreneurship and barriers to trade and investment (Wölfl, Wanner, Kozluk and Nicoletti, 2009). Different levels of product market regulations is one of the determinants of different level of growth among European countries (Nicoletti and Scarpetta, 2003). They examined manufacturing and service industries of OECD countries for the past two decades, and suggested that strict product market regulation hinders productivity growth.

Why might regulation affect intangible investment? There are a number of mechanisms. Investment is a fundamentally forward looking activity and therefore depends, at the margin, on costs and benefits of undertaking such spending and expectations of such costs and benefits. In addition, many such investments, especially for intangibles which often have little second hand market are sunk. So we would expect intangible investment to be particularly sensitive to any change that appropriates ex post returns from sunk investments. In the regulation literature, taxes and price caps are classic examples of this. In the labour economics literature, see e.g. firms are reluctant ex ante to undertake sunk investments unless workers can precommint not to bargain higher wages ex post. Labour market regulation is likely to put workers in a stronger bargaining position ex post and so raise their returns in the non-precommitment case, thus lowering intangible investment. Finally, product market regulation might of course increase ex post rents to incumbents. This increase in rents might make them more likely to invest ex ante but less likely if they are insulated from competitive pressure to improve.

We use data on intangible investment of 16 countries from 2001-2004, and correlate them with variables of product and employment market regulations (average of year 1998, 2003 and 2008). The data sources of intangible investments are various papers estimating the intangible investment of one or more countries in the COINVEST project. Since most papers provide the estimate of 2001-2004, we use the average of that period to decrease the effect of business cycles and investment cycles. The data source of variables of product and employment market regulations are the integrated PMR and EMR indicators from OECD and other cross-country institutions. We use the average of 1998, 2003 and 2008 to focus on the level of rather than the time trend of PMR indicators.

Our main finding is that intangible investment (as a proportion of GDP) is negatively and significantly correlated with all variables of product market regulation and most employment market regulation. This basic finding is summarized in figure 1a and b. Figure 1a plots the relation between intangible investment as a proportion of GDP and one of the product market regulation indices, the number of days required to open a business. A clear negative relation emerges suggesting that countries where it takes longer to open a business also have lower intangible investment.

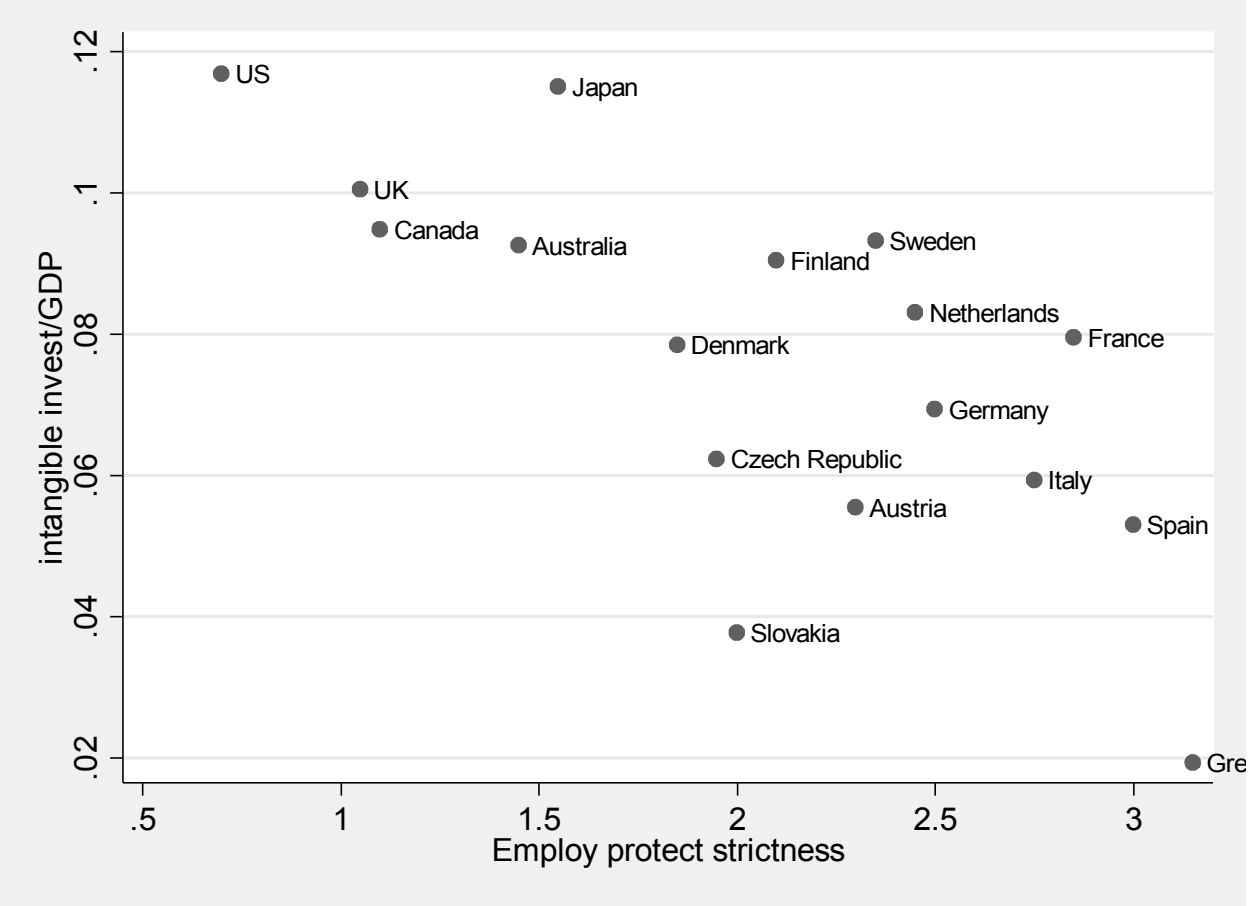
Figure 1a: intangibles and barriers to entrepreneurship



Source: Hao *et al.* (2009) for Germany, France, Italy and Spain; CHS (2009) for the US , Marrano *et al.* (2009) for the UK, Jalava *et al.* (2007) for Finland, Fukao *et al.* (2009) for Japan, Edquist (2009) for Sweden, Van Rooijen-Horsten *et al.* (2008) for the Netherlands and Barnes and McClure (2009) for Australia. Days required to open a business is from WDI of the World Bank.

Figure 1b plots the relation with the OECD employment protection index, which is an index of different dimesions of employment protection, with a higher figure indicating more severe protection.

Figure 1b: intangible investment as a proportion of GDP and employment protection



Soucrce: see figure 1b. Employment protection from OECD.

Interestingly, tangible investment is weakly positively correlated with most of these measures. The ratio of tangible to intangible is strongly positively correlated (and also with employment market regulation). Thus our overall conclusion is that product market regulation seems to impact negatively on intangible investment and whilst it might impact positively on tangible investment, the negative effect on intangibles is likely to lead to declining growth in the future as the economy becomes more intangible intensive. Of course, we cannot tell the direction of causation between intangible investment and product market regulations, so these results are

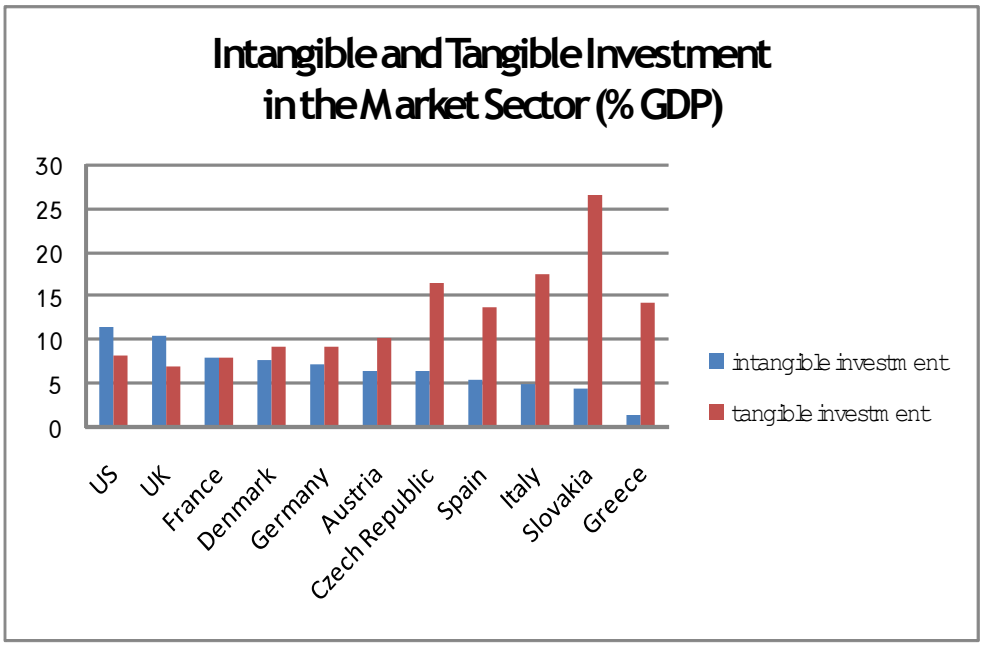
suggestive, but we discuss the possible explanations of the correlations and list the important issues of policy making below.

6. Literature review.

Literature on intangible assets.

If a country has a high GDP per capita, that country is likely to invest heavily in intangible assets (van Ark, Hao, Corrado and Hulten, 2009). Figure 1 shows the intangible and intangible investment of 11 countries. The US and the UK invested more in intangible assets than tangible assets, and they invested about 11% of GDP on intangible assets in 2006. Italy and Spain invested about 5% of GDP in intangible assets in 2006, less than half of their investment in tangible assets. The countries that invested the least in intangible assets are Slovakia, 4.5% of GDP, and Greece, 1.6% of GDP.

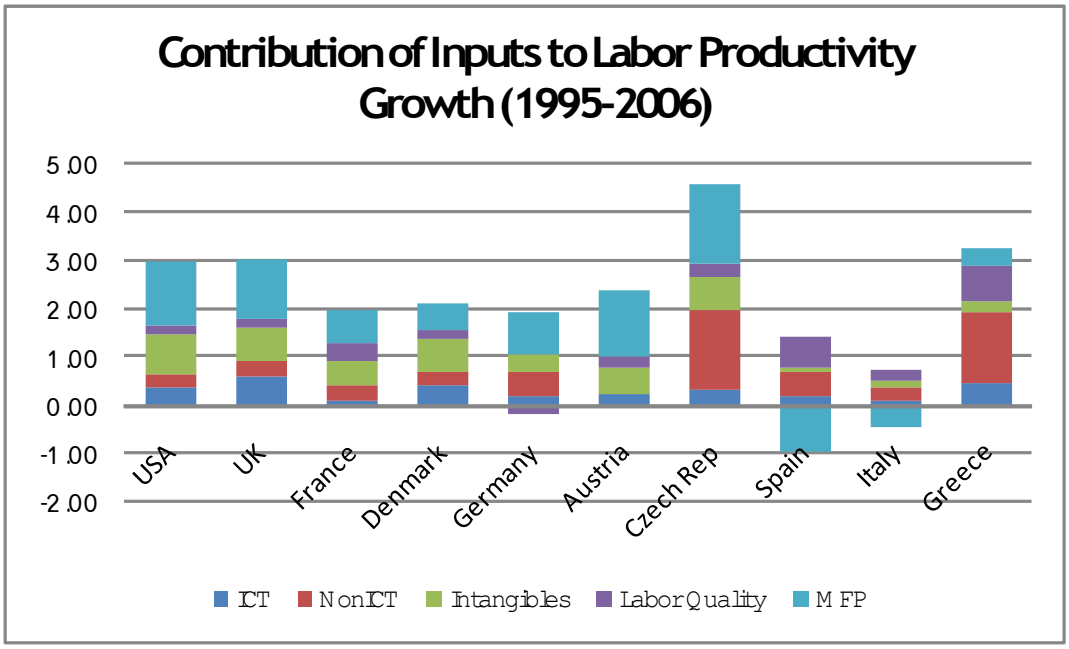
Figure 2:



Source: Hao *et al.* (2009) for Germany, France, Italy and Spain; CHS (2009) for the US , and Marrano *et al.* (2009) for the UK.

Intangible assets are an important driver of productivity growth. They contributed to about one quarter of productivity growth in the US from 1995 to 2003 (Corrado, Hulten and Sichel, 2009), and contributed to about one quarter of productivity growth in Germany, France, Italy, Spain, Austria and Denmark from 1995 to 2006 (van Ark, Hao, Corrado and Hulten, 2009). In particular, the contribution of intangible assets was great than that of ICT and non-ICT tangible capital in the US, and was only slightly less than ICT and non-ICT tangible capital in the UK from 1995 to 2006. This is summarized in figure 3 below and is amply discussed in Corrado, Hulten, Hao, and van Ark's report for the European Investment Bank (.

Figure 3:



Source: Hao *et al.* (2009) for Germany, France, Italy and Spain; CHS (2009) for the US , and Marrano *et al.* (2009) for the UK.

Measures of Product market regulation

Product market regulation has three categories—state control, barriers to entrepreneurship and barriers to trade and investment. Various researchers found that strict regulations damper economic growth. Nicoletti and Scarpetta (2003) examined manufacturing and service industries of OECD countries in the past two decades, and found that pro-competitive reforms and privatization policies tended to boost productivity. They suggested that the cross-country variation in regulations contributed to the increasing dispersion of growth in OECD countries. Alesina et. al. (2005) found that the deregulation of product markets increased tangible investment. Djankov et. al. (2006) used World Bank's data on business regulations, and found that countries have better scores also have higher GDP growth rates from 1993 to 2002. Jajilian et. al. (2007) used the regulation variables of World Development Indicators, and found that regulations strongly affected growth. Gorgens et. a. (2003) used the Fraser Institute's Index of Economic Freedom from 123 countries, and estimated that countries with strict regulations grew 2 to 3% less than those with liberal regulations. Similarly, Loyaza et al. (2004) constructed an overall regulation index using seven regulation indexes (entry regulation, labor regulation, fiscal burden, trade barriers, financial market regulations, contract enforcement and bankruptcy regulation), and concluded that strict regulations decreased the growth of GDP per capita.

Regulation of the product market may increase the efficiency of firms. Hsieh and Klenow (2006) use plant-level data for India and China, and estimated that government distorted returns to capital and labor across firms, and cause firms to misallocate resources. Moreover, reforms of product market regulations may increase the level of competition and thus the efficiency of firm management (Nickell, Nicolitas and Dryden, 1997). Managers will organize the firm more

efficiently when competition increased the risk of bankruptcy. Managers' efforts can be better evaluated by the performance of firms.

Regulations of the product market may affect innovation incentives, and may change the speed firms introduce new products and new processes. Excess regulation may protect inefficient firms, and may discourage firms from adopting new technologies, causing productivity gaps across countries (Parente and Prescott, 1994). Schumpeter (1942) implies that monopoly rents are incentives to innovation. If regulations decrease monopoly rents, monopolists will innovate less.

In addition, since innovation projects are usually risky and firms have to use internal funds for innovation, it is crucial that firms have enough financial resources to finance innovations. Monopoly rents help firms to accumulate enough innovation funds. If regulations decrease monopoly rents, firms are less likely to innovate (Aghion and Howitt, 1992, Grossman and Helpman, 1991, Romer, 1990). On the other hand, if incumbents are innovators, regulations provide incentives of innovation (Aghion and Griffith, 2005).

Employment protection legislation (EPL)

Similar arguments hold regarding the effects of EPL on productivity and investment. This issue is nicely surveyed by who make a number of points.

First, to set the scene, consider employment. The direct effect is to slow separations. That might be offset by efficient wage contracts, but if imperfections make that impossible then we have negative effects on both separations and on hiring, thus an ambiguous effect on equilibrium unemployment.

Second, the effects on efficiency are varied. One matter to consider is what costs EPL actually affects. One view is that they raise the cost of labour conditional upon a separation being made and hence are akin to an (external or internal) adjustment cost. The other is that they raise the cost of labour even with no adjustments: perhaps due to the implied costs of managerial time required e.g. in monitoring the law. This makes them more akin to an additional levy on labour costs regardless of adjustment or not.

In addition, we can indentify effects on the intensive and extensive margin of firm behaviour. Consider first the intensive margin. With a non-adjustment costs model, one expect raising labour costs would raise capital investment, thus suggesting a positive correlation between ELP and investment. Against, this, Belot et al suggest that EPL might induce workers to invest in firm-specific training, knowing they will stay longer at the firm, thus reducing relative labour costs. Note that this would predict that firm-specific training, an element of intangible investment would rise. This is something that we can examine. Another force against this is via Grout (1984) effects. In this model, workers are unable to commit ex ante to not bargaining for higher wages ex post when firms have sunk investment and so would earn quasi-rents. Thus investment falls. With EPL, workers bargaining positions are strengthened and one would expect therefore investment to fall. This effect is more likely of course with the sunkeness of investment and with the inability of workers to precommit. To a first approximation, intangible capital is almost entirely sunk since relative to tangible investment there no second-hand market. Thus one would expect intangible capital to be particularly vulnerable to this kind of effect. One would also expect the negative effect to be stronger with more EPL and more unions. The union

effect, however, might be moderated by centralized unions, who might find it easier to precommit, perhaps in national wage bargains. This is the story in the Sapir report, suggesting that centralised German unions were useful in the long period of post war tangible capital accumulation by Europe, but might be much less useful now when intangible capital and experimentation are required.

Note that the union effect might also be moderated with very small decentralised unions, none of whom would have a large effect on investment by themselves. On the other hand, the prevalence of multi-unions might make it harder for firms to get agreement in a particular plant thus lowering investment (. Overall then, one would expect a negative relation between intangible investment, EPL, union density and multiple unions, with the relation perhaps depending on the degree of union centralisation. Note that if EPL and unionisation are particularly problematic as regards the sunkenness of investment then the ratio of intangible to tangible capital will be lower in these circumstances.

Consider now the intensive margin with adjustment costs. Here there is an incentive for firms to attempt to avoid the adjustment costs of firing. suggest this might lower investment in risky technologies, such as those that might be needed in periods of rapid technical change since firms will be worried that such technologies might involve them in future layoffs. This would predict again a negative relation between intangible investment and EPL, and a negative relation between the intangible/tangible ratio and EPL, since countries with higher EPL would be more likely to opt for less risky tangible investment.

Consider now the extensive margin. In models of firm selection, such as Bartelsmann et al (2006), Hopehayn and Rogerson (1993) and Poschke (2007) there are typically two effects. First, conditional on technology levels, only the most efficient firms enter, which raise average productivity. Second, experimentation with risky technologies is lessened, so average productivity falls (although the variance falls too).

Data and summary statistics

The data sources of intangible investments are various papers estimating the intangible investment of one or more countries. Corrado, Hulten and Sichel (2009) estimated intangible investment in the US, Marrano, Haskel and Wallis (2009) estimated the UK, Edquist (2009) estimated Sweden, Jalava, Aulin-Ahmavaara and Alanen (2007) estimated Finland, Barnes and McClure (2009) estimated Australia, Fukao, Hamagata, Miyagawa and Tonogi (2007) estimated Japan, and Hao, Manole and van Ark (2009) estimated Germany, France, Italy and Spain. Van Ark, Hao, Corrado and Hulten (2009) estimated intangible investment in Austria, Denmark, Czech Republic, Slovakia and Greece, and summarized the estimates of the above sixteen countries and compared intangible investment across countries. We use the average of intangible investment from 2001 to 2004, because most papers provide estimates of that period.

The private sector of the US invested the most in intangible assets from 2001 to 2004 (just under 12% of GDP), followed by the Japan and the UK (11 and 10% of GDP). The private sector of Greece (EL) and Slovakia invested the least in intangible assets, 2% and 4% of GDP.

The data source of product market regulations is the OECD indicators of product market regulation (PMR). PMR indicators measure regulations at the economy-wide level. The

aggregate-level indexes are state control, barriers to entrepreneurship and barriers to trade and investment. Under state control, there are public ownership and involvement in business operations, with five disaggregate indexes under them. Under barriers to entrepreneurship, there are regulatory and administrative opacity, administrative burdens on start-ups and barriers to competition, with nine , disaggregate indexes under them. Under barriers to trade and investment, there are explicit barriers to trade and investment, and other barriers, with four disaggregate indexes under them. We focus on the three aggregate indexes and the seven medium-level indexes, because we would need disaggregate data on intangible investment to use the disaggregate indexes of PMR.

According to PMR indicators, the US, the UK, the Netherlands and Denmark are among the least restrictive, while Czech Republic is among the most restrictive. PMR indicators show that OECD countries have significantly relaxed product market regulations from 1998 to 2008 (Wolfl, Wanner, Kozluk and Nicoletti, 2009). Between 1998 and 2003, most OECD countries carried out strong reforms on product market regulations, while between 2003 and 2008, only Hungary, Spain and Netherlands significantly changed those regulations. As a result, the convergence of regulations happened before 2003, and slowed down after 2003.

7. Correlations and implications.

Van Ark, Hao, Corrado and Hulten (2009) compared the intangible investment in 16 countries, and discussed what might have caused the different levels of intangible investment. They listed four potential determinants of intangible investment—industrial structure, risk, financial market

and labor market. As to industrial structure, less-developed countries are likely to specialize in labor-intensive sectors, while more developed countries locate at the higher end of the supply chain, and are likely to develop leading edge R&D, design, marketing and so on. As to risk, innovations are usually high-risk and high-return. For example, it costs about $800 million and 15 years to develop a new drug and most drugs do not make to the market. Countries that invest a lot in intangible assets and innovations are usually countries that can bear the risk and that have the economic environment to react to risk and changes flexibly. As to financial market, it is related to risk. Risky innovations are usually funded by the internal fund of the firms or by venture capital. A large financial market and ample venture capital creates a friendly environment for innovations and intangible investment. As to labor market, it is also related to risk. Risky innovation projects are often discontinued, and have to relocate the employees of those projects. In countries with a strict labor market, firms usually find it costly to hire and fire employees for the risky and uncertain innovation projects.

Regulations of the product market are strongly and negatively correlated with intangible investment. Most importantly, regulations are strongly correlated with the distribution between tangible and intangible investment, not the total investment.

These correlations are summarized in Table 1

Table 1. Correlations of intangible, tangible investment with policy variables (all variables are averages 2001-04)

Correlations with	**Intangible Investment**	**Tangible Investment**	**Ratio Tangible to intangible investment**
PMR	-0.78	0.57	0.26
administrative regulation	-0.69	0.41	0.13
domestic economic regulation	-0.55	0.38	0.17
state control	-0.64	0.43	0.18
public ownership	-0.61	0.46	0.22
involvement in business operation	-0.45	0.26	0.07
barriers to entrepreneurship	-0.55	0.35	0.12
reg and admin opacity	0.23	-0.02	0.10
admin burdens on startups	-0.78	0.38	0.05
barriers to competition	0.09	-0.01	0.03
barriers to trade & investment	-0.82	0.69	0.39
explicit barriers to trade & investment	-0.70	0.79	0.56

Soucre: intangible data from COINVEST as above, PMR from the OECD.

We do not have enough information to claim the causality between regulations and intangible investment. We propose several ways to interpret the correlation.

The correlation between overall product market regulation and intangible investment is -0.78, consistent with existing literature on investment (Alesina et. al, 2005). Product market regulations affect investment through several channels. Regulations may affect firms' decision of entry, by affecting prices and entry barriers (Blanchard and Giavazzi, 2003). Moreover, regulations may affect the costs of expanding production capacity for existing firms. Finally, if regulations set a ceiling of the return on capital, that affects firms' allocation between capital and labor (Averch and Johnson, 1962).

The correlation is consistent with the theory that if regulations decrease monopoly rents, firms are less likely to innovate. Moreover, countries that investment heavily in intangible assets may intend not to be strict with regulations in general, including the regulation of product market.

Regulations of professionals

Our next set of investigations is around the regulation of professionals. We focus on the regulation of architects, engineers and designers. Several arguments support the regulation of those professions. One argument is the information asymmetry between the principal (the customer) and the agent (professionals). The customer may not have the ability to access the quality of the service provided by the professionals before purchasing and even after consumption. That may cause a problem of adverse selection. Consumers are willing to pay a price of the service of average quality, and drive the professionals of good services out of the market. The quality control problem gives justification for licensing and certification. The information asymmetry problem gives rise to fee settings, price controls and prohibition on advertisement.

Our data shows that the regulation of professional are strongly and negatively correlated with intangible investment. We do not argue for a causal relationship between regulation and intangible investment. Rather we propose several understandings of the correlation. The correlation may imply that countries with strict regulations of professionals have relatively weak design support of new goods and new services, or may imply that countries promoting innovations are also likely not to regulate professional services. The correlation does not imply that countries with many designers will have much intangible investment. Italy has about 2300 architects and engineers per million people, but Italy invests heavily on tangible assets, not

intangible assets. In contrast, Germany and France have 1500 architects and engineers per million people, and belong to the lower end of the density, but Germany and France invest heavily in intangible assets. Another problem we should notify is that architects and engineers can easily provide services cross borders, so the regulation of a country may affect the service in other countries, and some service of a country may not be affected by the regulation of that country.

Employment regulation

Finally, we examine some correlations with employment regulation, which as well known is positively correlated with product market regulation. Table 3 sets out the results and finds a very similar pattern to the above. Strict employment protection is negatively associated with intangible investment but positively associated with tangible. So the overall effect on the intangible/tangible ratio is positive. In the final column, we look at the relation between EP and training, which turns out to be negative. This goes against some who have argued that EP might raise the incentive to train.

Table 3, correlation of intangible, tangible shares of GDP, their ratio and spending on firm-specific training as a fraction of GDP with OECD employment protection measures (all correlations are statistically significant).

	Correlation with			
	intan	**tan**	**intan/tan**	**training**
Employment protection (EP)				
Overall EP strictness	-0.72	0.22	-0.55	-0.42
EP strictness for regular employment	-0.54	0.30	-0.51	-0.41
EP strictness for temporary employment	-0.57	0.08	-0.35	-0.33
Additional requirements for collective dismissals	-0.45	0.15	-0.42	-0.04

Source: COINVEST and OECD employment protection.

8. Discussion and Conclusion.

This paper has reviewed a number of issues. First, we have briefly reviewed the contribution of intangibles to productivity growth across European countries. As set out more fully in the above referenced papers and in other work for COINVEST, summarized in our final report, intangibles make an important contribution to productivity in Europe and the US. Investment in them is higher in the US and this accounts for a large portion of the US productivity growth lead. This approach also gives a coherent picture of innovation. The link between innovation and intangibles and other innovation measures is set out fully in Clayton, Del Borgo and Haskel (2009) submissions as part of the index, under deliverable D10, covering investment at the sector level (available also www.coinvest.org.uk). Intangibles and TFPG measure the contribution of knowledge spending to growth and this, under various definitions, is a usable definition of innovation. Finally, we equate competitiveness with productivity levels and growth, since that is the only way of making sense of the concept when applied to countries).

Second, we have uncovered a number of, we believe, interesting correlations between intangible investment, tangible investment and indices of product and labour market regulation. The main findings is a consistent negative relation between indices of regulation and the share of GDP accounted for by intangible investment; that is to say, the more regulation there is, the lower the share of a country's GDP accounted for by intangibles.

Of course causal relations are hard to establish here. But it would seem unlikely that employment regulation arises as intangible spending increases, so to the extent these relations are causal they support the OECD's general call for having less regulation in order to improve economic performance. It is of course the case that regulation is correlated with more tangible investment. So it might be argued that economic growth is perfectly consistent with regulation,

as indeed it is. Again, to the extent this is a causal relation, we would argue that our evidence is consistent with regulated economies remaining catch-up economies. That is to say, economies get whatever benefits from regulation, but the cost is that they rely on tangible capital formation to grow. Such tangible capital formation is typically a symptom of catch-up economies, for whom installing (typically imported machines) constitutes a catch-up method. If an economy wants to be a leader however, then the COINVEST project suggest it needs intangible investment, which is retarded by regulation.

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