THE ECONOMICS OF THE LIGHT ECONOMY. GLOBALIZATION, SKILL BIASED TECHNOLOGICAL CHANGE AND SLOW GROWTH

THE ECONOMICS OF THE LIGHT ECONOMY. GLOBALIZATION, SKILL BIASED TECHNOLOGICAL CHANGE AND SLOW GROWTH[1]

Cristiano Antonelli, Dipartimento di Economia, Università di Torino & BRICK Collegio Carlo Alberto.

Claudio Fassio, Dipartimento di Economia, Università di Torino & BRICK, Collegio Carlo Alberto

ABSTRACT

The paper provides an interpretative framework and structured empirical evidence of the processes leading to the emergence of a light and slow growth economy in advanced countries. The interpretative framework rests upon the grafting of a) the Schumpeterian hypothesis about the determinants of the rate of technological change with b) the Kuznets approach on the strict complementarity of structural and technological change, and c) the new approach about the direction of technological change biased towards the most intensive use of locally abundant production factors, into d) the dynamic version of the Heckesher-Ohlin analysis of international economics that accounts the introduction of new technologies as the endogenous search for a new specialization. The analysis of the stylized facts and the empirical evidence confirms that the twin globalization of product and capital markets brought about by the entry of new labor abundant countries in international markets had profound effects on advanced countries leading to the introduction of skill biased technological change with the consequent decline of the role of the manufacturing industry and the emergence of a strong knowledge intensive business service sector. The new biased direction of technological change accelerated the substitution of both capital and unskilled labor with skilled workers with the ultimate effect of reducing the stock of working capital and hence the rates of growth of advanced economies. The slow growth is a physiological feature of the new emerging light economies that rely upon knowledge intensive but capital saving technologies.

[1] The authors acknowledge the financial support of the European Union D.G. Research with the Grant number 266959 to the research project 'Policy Incentives for the Creation of Knowledge: Methods and Evidence' (PICK-ME), within the context of the Cooperation Program / Theme 8 / Socio-economic Sciences and Humanities (SSH), in progress at the Collegio Carlo Alberto and the University of Torino.

KEY WORDS: TWIN GLOBALIZATION; SKILL BIASED TECHNOLOGICAL CHANGE; KNOWLEDGE ECONOMY; SLOW GROWTH.

JEL CODE: O31

1. INTRODUCTION

Slow growth has been characterizing advanced countries since the late 1990s. A variety of interpretations and explications have been elaborated. A general consensus about the pathological character of the slow growth has emerged. Macroeconomic and fiscal policies aimed at reducing the deficit of public administrations and even their debt levels have been suggested. Increased liberalizations of both product and factor markets have been advocated and often implemented, with little positive effects.

This paper elaborates and tests an interpretative framework that calls attention upon the tight relationships between globalization of both product and capital markets, the rate and direction of technological innovations and the structural change according to which slow growth is the physiological result of a major re-organization of the economic systems of advanced countries and their evolution into light knowledge intensive economies.

In the economics of growth much analysis of the aggregate performances of the advanced economies in the last decades has been paid to explaining the causes of the slow growth of the advanced economies paying very little attention to the role of the radical changes that have been taking place at the meso level. In the economics of innovation and technological change much attention has been paid to the analysis of the causes and consequences of the rate of technological change. Much less attention has been given to the direction of technological change and the parallel

changes in the structure of the advanced economic systems. Yet the direction of technological change has important consequences on the structure of the economic system, the international specialization of each country and on its economic growth. The paper elaborates an analytical approach where the international institutional changes affect both the rate and the direction of technological and structural change, the role of a country in the international division of labor and ultimately its aggregate performances. This framework is applied to provide an interpretative framework of the stylized facts about the evolution of the advanced economies since the last decades of the XX century and supported by structured empirical evidence.

The analytical framework relies upon the grafting of three distinctive and yet separated theoretical pillars of the economics of innovation: the Schumpeterian hypothesis that innovation is a form of creative reaction stirred by un-expected changes in product an factor markets, the Kuznets hypothesis that structural and technological change are two intertwined facets of the same process of economic change and the new induced technological change approach according to which technological change is biased towards the use of production factors that are locally more abundant. The integration of these three complementary approaches enables to substantiate the dynamic version of the Heckesher-Ohlin frame so as to provide a coherent interpretation of the interaction between changes in the international division of labor, endogenous changes in the rate and direction of technological and structural change, changing specialization and role in the international division of labor and macroeconomic performances.

The basic hypothesis is that the entry of new labor-intensive economies in product markets and the creation of an international financial market that favored the outflow of capital from advanced countries, and the access to low cost capital to industrializing countries, have induced advanced economies to implement a new knowledge-intensive technological system that uses much less capital substituting both unskilled labor and capital with skill-intensive labor and a new specialization in the generation and exploitation of technological knowledge.

Drawing upon the large literature available the analytical framework enables to elaborate an interpretative framework of the main stylized events that have characterized the advanced economies since the last decades of the XX century. The twin globalization stirred radical technological and structural changes and reshaped the international division of labor, with the ultimate effect of engendering: i) a persistent decline in the price of manufactured goods, ii) reduction in the levels of capital intensity in advanced countries and iii) a new specialization in knowledge intensive activities characterized by high levels of skilled-labor intensity. The fall in the levels of prices of tangible goods and the decline in the capital intensity associated with the new emerging knowledge economy reduced the value added of the production processes into which advanced countries specialize, favoring the emergence of a light and slow growth economy.

The consequent slow growth of the light economy is likely to last as long as the decline of the manufacturing sector and the disposal of excess capital from advanced countries to industrializing ones. When the transformation will end approaching a new long term configuration based upon a tiny manufacturing industry and a large share of employment in knowledge intensive business services, the knowledge economies will be able to experience faster rates of growth based upon total factor productivity growth.

The rest of the paper is structured as it follows. Section 2 provides the analytical framework and elaborates the hypothesis. Section 3 presents an interpretative framework of the evolution of the advanced economies based upon a survey of the existing literature articulated by means of the analytical framework. Section 4 presents the empirical evidence. The conclusions summarize the result and highlight the implications and consequences both for economic analysis and policy.

2. THE ANALYTICAL FRAMEWORK

Much theorizing assumes as a starting point of the analysis the increasing levels of globalization under way since the late 1990s and more

specifically the globalization of product markets brought about by the entry in international markets of new large and labor abundant economies.

According to the traditional interpretative framework based upon the static version of the well-known Heckesher-Ohlin model, the entry of new labor abundant competitors should have pushed advanced countries to increase the production of capital-intensive goods and reduce the production of labor-intensive ones. Labor abundant newcomers should have on the opposite increased their specialization in labor intensive goods and rely upon imports from advanced countries in capital intensive ones. Correspondingly, newcomers should have increased their specialization in labor intensive products and hence experienced a decline in the levels of capital intensity. On the opposite advanced countries should have experienced a strong increase of the capital intensity of their production processes due to the decline of labor intensive activities and their substitution with capital intensive ones.

According to the Heckesher-Ohlin model, the entry of new labor-abundant countries in international product markets should have brought about a drastic fall in the prices of labor-intensive manufactured goods but an increase, in relative terms, of the price of capital-intensive goods, with positive effects on the terms of trade of advanced countries. After the initial shock equilibrium should have been restored in international product markets and the flows of imports and export should match in the balance of both newcomers and incumbents.

The empirical evidence suggests that these dynamics have not been taking place. Quite on the opposite the capital intensity of advanced incumbents declined as well as the labor intensity of newcomers. Labor abundant countries became net exporters of both capital and labor intensive products. The prices of both capital intensive and labor intensive products declined and the balance of payments of advanced countries exhibited a persistent and even increasing deficit. These contradictions require an explanation that can help to grasp the persistent slow growth of advanced economies.

Unlike previous experiences in economic history, however, the current globalization process concerns both product and financial markets. The

globalization of international product markets has changed the fundamentals of the division of labor undermining the competitiveness of advanced countries and pushing them towards a new specialization. The globalization of capital markets has favored the growing outflow of capital both via foreign direct investment and the international mobility of finance. The twin character of the current globalization pushed the emergence of a new systemic gale of radical technologies associated with structural changes that enabled advanced countries to change their role in the international division of labor specializing in the provision of knowledge intensive services to the rest of world.

The twin globalization of both product and capital markets that has characterized the last decades of the XX century has stirred a chain reaction of structural and technological changes that have affected in depth the evolution of the organization and the performances of advanced economies. As a matter of fact these intertwined and interacting dynamic processes have altered the expected reorganization of the international division of labor and the specialization of advanced economies leading to the emergence of a light and slow growth economy.

The remaining of this section elaborates an analytical framework based upon the grafting of the Schumpeterian analysis of innovation as a form of creative response on the analysis of induced structural and technological change. The Schumpeterian inducement approach and its integration with the Kuznets analysis of structural change and the new induced technological change approach, that highlights the role of the bias in favor of the intensive use of locally abundant factors, provides the foundations to elaborate a dynamic version of the Heckesher-Ohlin model (Rivera-Batiz, and Romer, 1991).

We contend that this integrated framework provides the tool to grasp the key effects of the changes at the meso level on the dynamics at the aggregate level and helps explaining the causes and the consequences of both structural and technological changes in advanced economies. This framework helps understanding how and why their transformation from industrial to knowledge economies is at the origin of their persistent slow growth.

Following the Schumpeterian hypothesis, firms are induced to innovate by the emergence of unexpected out-of-equilibrium conditions in product and factor markets. Myopic firms unable to foresee the changing conditions of international product markets were caught in out-of-equilibrium conditions with falling markets shares and profitability because of the new and unexpected competition from new competitors based in labor abundant countries. Their successful creative reaction led to the introduction of a new gale of convergent information and communication technologies characterized by a strong skill bias that favored the specialization of advanced countries in the new knowledge-intensive business service industry.
[2]

Following the Schumpeterian hypothesis we contend that firms in advanced countries were caught in out-of-equilibrium conditions by the drastic and unexpected changes in their product markets brought about by the entry of new competitors specializing in labor intensive production processes and based in labor abundant countries. Firms in advanced countries, relying on rich innovation systems, could react to the fall of their performances, the reduction of their rates of growth and profitability via the introduction of new technologies.

The gale of new information and communication technologies was the result of the drastic effort of advanced countries to cope with the changing conditions of the international division of labor. The convergence of a variety of diverse and yet complementary technological changes, introduced by a large variety of diverse innovators, active in different industries and relying on different knowledge bases, all stirred by the effort to elaborate a creative response, brought about the emergence of a new technological system that helped industrializing the generation of scientific knowledge, its direct application to empowering technological knowledge and its widespread dissemination for productive uses (; Antonelli, 2011a; Stephan, 2011).

[2] According to the late Schumpeter innovation is the creative response that firms caught in out-of-equilibrium conditions by unexpected changes in both product and factor markets try and introduce. When and where knowledge externalities are missing the reaction of firms is just adaptive and consists in the changes of techniques within a given technological space: standard substitution takes place. When and where knowledge externalities actually support their reaction and make available external knowledge at costs that are below its reproduction, firms can actually introduce new superior products, processes and organizations (Schumpeter, 1947; Antonelli, 2008, 2011a).

The accelerate pace of generation of technological knowledge, stirred by the changes in the international division of labor, and made possible by the collective recombination of diverse and yet complementary unit of new knowledge favored the increased rate of technological change. The direction of technological change was, instead, biased by the decline of the comparative advantage based upon the relative abundance of capital in advanced countries.

Building upon the Kuznets hypothesis, technological and structural change are strictly intertwined and cannot be separated: when technological change is radical the structure of the economic system is profoundly affected with radical changes in the organization of the economy and in its mix of activities. The gale of new information and communication technologies favored the industrialization of the generation and exploitation of knowledge as an economic activity leading to the emergence of a knowledge-intensive-business service- industry and the rapid decline of the manufacturing industry (Kuznets, 1965; North, 2005, Dopfer, 2012).

Here the new induced technological change approach fits into the framework suggesting that firms caught in out-of-equilibrium conditions by radical changes in their product and factor markets did try and react directing technological change towards the most intensive use of knowledge and skilled labor that were by far the locally more and most abundant production factors.

The analysis of the induced direction of technological change as distinct from the analysis of the rates of technological change has been revived recently after decades of oblivion (Acemoglu, 2002, 2003, 2010). Our approach builds upon the traditional inducement approach according to which technological change is induced by the relative abundance of inputs rather than by their changing prices (Hicks, 1932) or factor shares (Samuelson, 1965), but makes an important step forward. The analysis of the role of the relative abundance of inputs in assessing the efficiency of the production makes it possible to grasp the role of technological congruence i.e. the relationship between the relative abundance of an input and its output elasticity (Ruttan, 1997 and 2001; Abramovitz and David,

1996). In our approach the direction of new technologies is induced by the search for congruence efficiency that stems from the directed technologies that enable to take advantage of the comparative abundance of production factors (Antonelli, 2012).

As soon as we integrate the Heckesher-Ohlin framework with the hypothesis that technological change is endogenous as it is stirred by the changes in the international product markets, and directed by the changing relative endowments of production factors, we can grasp the relationship between the globalization of both product and capital markets, the search for a new specialization and the introduction of skill biased innovations. In the dynamic version of the Heckesher-Ohlin framework incumbents can face the changes in the international division of labor determined by the entry of new competitors and the consequent decline of their international competitivity by means of the introduction of technological changes directed towards the more intensive use of locally abundant inputs upon which they can structure a new specialization in international markets (Rivera-Batiz and Romer, 1991).

Our hypothesis is that the twin globalization has induced advanced countries to elaborate a new specialization based upon the systematic generation and exploitation of technological knowledge embodied in knowledge intensive business services. This led to the gradual emergence of a new skill intensive knowledge economy based on the new information and communication technologies that paralleled the shift of economic activity away from the manufacturing industry towards knowledge intensive business services. This process reduced the demand and the use of capital and made the decline of the prices of manufactured products persistent with negative effects on the rates of growth that are likely to last as long as the transformation of heavy industrialized economies into light knowledge ones.

Each of these processes is typically intertwined and feed each other with spiraling effects. The search for new investment opportunities in industrializing countries increased the globalization of financial markets. The globalization of financial markets accelerated the outflow of capital from advanced countries and the access of industrializing economies to the provision of cheap capital. The provision of cheap capital provided

additional momentum on the one hand to the rapid industrialization of the newcomers and to the decline of capital as a source of competitive advantage for advanced economies on the other. This further reinforced the skill bias of the induced technological change in advanced economies and hence the substitution of skilled labor to fixed capital with the ultimate consequence of increasing the outflow of capital from advanced countries and the supply of cheap capital to the fast growing once-labor-intensive industrializing economics, favoring their competitiveness in international product markets and the further decline of the prices of manufactured goods (Modelski, Devezas, Thompson, 2008; Devezas, 2010).

The new endogenous skill biased direction of technological change and the structural shift towards the specialization in knowledge intensive services are the consequence of economic changes as well the cause of further economic changes. The emerging knowledge economy is in fact characterized by decreasing levels of the output elasticity of capital, decreasing levels of capital intensity and investments with the consequent net decline of the actual levels of capital at work in advanced economies.

The slow growth of output associated with the emergence of a light economy is a physiological rather than pathological process that is bound to last as long as the process of transformation of the economic system and the reduction in the levels of fixed capital at work. Building upon this analytical framework we can articulate a number of specific hypotheses:

A) The skill intensive direction of technological change is the result of the intentional effort of firms in advanced countries in the effort to cope with the twin globalization. Hence we expect to test a clear positive relationship between the intensity of R&D development expenditures and the growth of knowledge intensive business services.

.

B) Skill intensive technological change parallels the consolidation of a knowledge ‘light’ economy characterized by the decline of the capital intensity

C) The increase of knowledge intensive business services accounts for the slow growth of advanced economies.

3. THE HISTORIC EVIDENCE: AN INTERPRETATIVE FRAMEWORK

The analytical framework elaborated so far can be used to review the large literature on the changing structure of the economic systems of advanced economies so as to provide an interpretative framework that integrates into a structured context the analysis of the intertwined processes of technological and structural change and international re-specialization that have characterized the evolution of the advanced economies since the last decades of the XX century (Madison, 2007; Modelski, Devezas, Thompson, 2008).

The starting point is the rapid globalization with the liberalization of international product markets that favored the entry of new competitors in international markets for manufactured goods and the strong decline in market prices. The decline of the prices of manufactured goods favored consumers in advanced countries but put at risk their industrial base with a marked reduction of their rates of growth, destabilizing incumbents with the sharp decline of their performances (Krugman, 2009).

The liberalization of international financial markets and the creation of an integrated financial system at the global level favored the access of newcomers to international credit and made possible an abundant supply of cheap capital. A major outflow of capital has been taking place from advanced economies towards the new labor abundant industrializing ones with major effects in terms of relative and comparative endowments.

The expected Heckesher-Ohlin drift of advanced economies towards the increased specialization in capital intensive productions was contrasted by the waning of the relative abundance of capital in their factor markets. Because of the creation of a globalized financial market, capital was becoming equally abundant in advanced incumbents and in industrializing newcomers. The absolute cost of capital was becoming more and more homogeneous across international markets. The creation of an integrated international financial market deprived advanced countries with the opportunity to direct technological change towards the traditional bias in

favor of capital, the production factor most abundant in rich countries with high levels of savings (Zeira, 1998).

The decline in the relative abundance of capital in advanced countries activated a search process that made it possible to identify knowledge intensive activities based upon skilled labor as the new source of competitive advantage and the production factor upon which to implement a new specialization, a new role in the international division of labor, a new organization of the production process and a new economic structure.

Advanced countries discovered that the direction of technological change towards knowledge intensive activities based upon skilled labor was the new possible source of competitive advantage. Advanced economies have a strong comparative advantage in the generation of technological knowledge and skilled labor is much more abundant and relatively cheaper in advanced countries than in industrializing ones. Moreover advanced countries were able to attract skilled labor from industrializing countries favoring a major brain-drain. The relative abundance of skills was not endangered by any risk of mobility towards industrializing countries (Agosis, Alvarez, Bravo−Ortega, 2012).

Skilled labor and the institutional fabric of knowledge generation activities at the end of the XX century were much abundant in advanced economies and happened to be in relative terms the production factor for which the comparative abundance was far larger than any other traditional input such as unskilled labor and capital. In the search for congruence technological change stirred by the globalization of product markets was directed towards the most intensive use of the most abundant production factors in domestic factor markets (Abramovitz and David, 1996; Antonelli, 2012).

The introduction of directed technological change biased towards high levels of skill intensity had strong consequences on the international division of labor. Advanced countries specialized more and more in the production of skill-intensive products with a strong content in terms of technological knowledge. Advanced countries reduced their markets shares in tangible products concentrating in the export of capital goods and high quality fashion products and specialized in the export of non-tangible services. New industrializing countries became net exporters of

manufactured, tangible products especially in the markets for final goods (Nickell, Redding, Swaffield, 2008).

With respect to the domestic factor markets of advanced countries, the new skill bias of technological change led to the substitution of both capital and unskilled labor, with the reduction of the derived demand for both. In the capital markets the new direction of technological change engendered the downward shift of the derived demand for capital with a reduction in the levels of working capital. Investments in fixed capital declined. This reinforced and strengthened the international mobility of capital both in the form of international direct investments with the growth of multinational companies and in the form of an augmented global financial market (Figini and Görg, 2011).

The emergence of the global corporation characterized by high levels of internal division of labor across countries favored the specialization of headquarters based in advanced countries in skill-intensive activities and the displacement of manufacturing activities towards labor intensive countries with major flows of foreign direct investments from advanced to industrializing countries (Caves, 2007; Dunning, 2008; Helpman, 2006).

The financial companies of advanced countries found new opportunities for growth specializing in the provision of finance to the new industrializing countries. They could make use of the large supply of excess capital that was becoming available in the internal financial markets activating new channels of distribution of credit to the newcomers in the international economy.

In the labor markets, average wages, consistently with the factor equalization theorem, declined (Samuelson, 1948). This trend however was contrasted by the new direction of technological change biased towards higher levels of skill intensity. As a result the variance of wage levels increased with increasing levels of inequality engendered by the creation of a highly segmented labor market with two emerging submarkets separated by strong differences in terms of professional requirements and little opportunities for retraining and hence low levels of mobility (Wood, 1994).

The changes in the demand for labor engendered an increasing mismatch with the current supply of labor. The supply of skilled labor was unable to match the increasing derived demand with increasing tensions in terms of wages. On the other labor market the supply of unskilled labor was much larger than the demand with lowering wages and increasing levels of structural unemployment (Lee and Vivarelli, 2004; Autor and Dorn, 2011).

Within advanced economies the new biased technological change paralleled a major structural change with the growth of a new service economy, the fast rise of the knowledge intensive business services, the decline of the manufacturing industry and its radical reorganization based upon skill-intensive production processes with a high content of knowledge intensity embodied in skilled labor (Bonatti, Felice, 2008; Maroto-Sánchez, Cuadrado-Roura, 2009).

In advanced countries a new 'light' knowledge and skill intensive economy is substituting the heavy fixed capital intensive economy that characterized the first part of the XX century. Skill biased technological change has been the result of a strong endogenous process of inducement activated by the changing relative prices in both product and factor markets engendered by the fast globalization based upon the entry of new labor abundant economies that could take advantage of the large and increasing supply of cheap capital (Kang and Lee, 2011).

It is clear that the direction of technological change towards the skill bias was induced by the globalization of product and financial markets and yet reinforced it. The substitution of skilled labor to fixed capital decreased the derived demand for capital and increased the availability of capital in the internal financial markets of advanced countries leading to the emergence of idle financial resources. The reduction of the levels of working capital pushed the financial system to try and make some use of it: excess investment in the real estate was a typical consequence (Stiglitz, 2010; Gatti et al., 2012).

The new foundations of production processes in advanced economies with lowering levels of fixed capital and increasing levels of human capital has direct effects not only on the specialization of the advanced economies, but also on their aggregate performances in terms of rates of growth. It is

clear in fact that the reduction in the output elasticity of capital and the relative decline in the intensity of fixed capital of production processes exert a negative effect on the amount of value added that the system is able to generate.

The general outcome of the structured review of the literature available confirms that globalization induced a new flow of technological changes, biased towards the creation of a light economy with high levels of skill intensity and more specifically a new structure of the economy of advanced countries, characterized by lowering levels of employment in the traditional manufacturing industries and increasing levels of employment in the knowledge intensive business services. Advanced economies built a new specialization in the world economy characterized by high knowledge intensity with high levels of research and development activities. These processes favored the reduction of the amount of capital at work in advanced economies and its transfer to industrializing ones. The reduction of the amount of capital at work, associated with the skill bias of technological change and the consequent decline of its output elasticity, explains the structural and short-term contraction in the rate of growth of output of advanced countries. The conjunctural effects are determined by the contraction of the aggregate demand stemming from the fall of investments and hence of the derived demand for capital goods. The structural effects are determined by the sheer contraction of the amount of fixed capital at work in the economy. The empirical evidence provided by Chapter 4 will focus the structural effects.

4. THE EMPIRICAL EVIDENCE

4.1 THE DATA

We check the empirical validity of our analytical framework by using three different sources of data. The first database draws on data from OECD STAN and STAN BERD, providing economic data at the sectoral level on value added, capital stock, employment, wages and R&D expenditures disaggregated at the sectoral level, covering most of the OECD countries. These data allowed us to build a fairly balanced panel with 24 countries, for the time-span 1990-2007 (see the Appendix for the list of countries included and for descriptive statistics).

We integrated the OECD data with a second source of data: is the EU-KLEMS database (O'Mahony, and Timmer, 2009), This database provides extremely detailed and reliable information at the sectoral levelfor the main economic variables of European economies, as well as US, Australia, Japan and Canada.
Finally, in order to include in our analysis also developing and newly industrialized countries, as a third source of data we used the Total Economy Database (TED)[3], which covers more than 120 countries and, among other important economic variables, provides data about the growth of capital services, thus allowing us to check for the intensity of the process of capital accumulation.

4.2. TECHNOLOGICAL AND STRUCTURAL CHANGE IN ADVANCED ECONOMIES

As already stated our hypothesis is that the twin globalization of both product and financial markets pushed advanced countries to specialize in skill-intensive economic activities, taking advantage of the relative abundance of educated workforce among their internal labour markets. Such a dynamic led to the transformation of manufacturing-based economies into knowledge 'light' economies, with a predominance of skill-intensive service industries with a high content of knowledge intensity.

In order to provide empirical evidence to our statements we decided to analyze the patterns of development of manufacturing sectors, on the one hand, and of a set of economic activities that can well represent the Knowledge Intensive Business Sectors (henceforth KIBS) on the other hand. Indeed the wide literature related with KIBS (Boden and Miles, 1999; Di Maria, Grandinetto, Di Bernardo, 2012), has identified these service sectors as those in which the knowledge intensity is higher: we can hence consider them as a good proxy of the new skill-biased types of economic activities. Muller and Doloreux (2009) provide a useful description of what KIBS and highlight the main features that distinguish KIBS from other types of private services. KIBS rely heavily on professional knowledge, are themselves primary sources of information

[3] The database is managed by the Conference Board and created through the harmonization of the Total Economy Growth Accounting Database of the Groningen Growth and Development Centre and the world economy productivity data set created by Dale Jorgenson and Khuong Vu.

and knowledge and use knowledge to produce intermediate services for their clients' production processes.

Yet we need to choose the sectors that in the international sectoral classifications can be identified as KIBS. We follow Freel (2006), who identifies KIBS sectors with the two-digit sectors 72, 73 and 74 of the ISIC Rev. 3 classification. In order to maximize the number of observations we include also sector 71, which in many countries' national accounts is aggregated together with the other 3 two-digit sectors. We hence classified as KIBS the following 2-digit ISIC Rev. 3 sectors:

- The renting of machinery and equipment (71)
- Computer and related activities (72)
- Research and development (73)
- Other business activities (74)

Our aim is to show the gradual decrease of centrality of manufacturing sectors among advanced countries and the corresponding growth of KIBS. We chose to do that through the analysis of the changing shares of employment between KIBS and manufacturing sectors. In order to provide the highest level of detail and use the number of hours worked within both aggregates we rely upon the EU-KLEMS database, which provides the most accurate data. KLEMS data range from 1970 to 2010. We then plotted the number of hours worked in the manufacturing sectors and in the KIBS sectors in a selected number of developed countries.

INSERT FIGURE 1 HERE

Figure (1) shows the generalized decline of the hours worked within the manufacturing sectors: even industry-based countries such as Germany, Japan and Italy display a constant decrease of the hours worked in industrial sectors, especially after 1990. The other countries show an even steeper decline of the number of hours worked in manufacturing, with United Kingdom displaying the sharpest decrease. After 1980 we observe a large increase of the number of hours worked in KIBS, with Australia, the Netherlands and United States displaying the highest rates of increase

in the last 30 years. Furthermore in specific countries such as the United States, Australia, France, the Netherlands and United Kingdom, starting from 2000 onward, the hours worked in the KIBS sectors overtook the number of hours worked in the manufacturing sectors. In countries such as Germany, Italy, Spain and Japan the gap between KIBS and manufacturing did not disappear also after 2000, although it largely decreased with respect to the beginning of the 80's.

A major structural change occurred in the last 30 years within advanced economies and the growth of KIBS is its most evident facet. This structural change was the outcome of a process of technological change biased towards the use of the most abundant resource, present in advanced capitalistic countries, i.e. skilled-labour. If this is the case we expect to find a positive correlation at the aggregate level between the efforts directed towards the improvement of the technologies at stake and the structural change represented by the growth of KIBS.

In this respect the investments in Research and Development performed by private companies represent a very good proxy of the technological effort of a country. If the effort of countries to specialize towards technologies with a high knowledge-content also led to the growth of KIBS, we should observe the following relationship between KIBS and R&D intensity:

$$KIBS = a + b\ RDint \qquad (1)$$

In which we expect the coefficient of R&D to be strictly positive. Here we take advantage of our OECD-based panel database for the years 1990-2010and provide a preliminary test on the existence of this relationship. We proxy the two variables of interest with the following measures:

$$KIBS_{it} = \frac{KibsL_{it}}{L_{it} - PubL_{it}} \qquad (2)$$

and

$$RD\,\mathrm{int}_{it} = \log\left(\frac{RD_{it}}{L_{it} - PubL_{it}}\right) \qquad (3)$$

i and *t* are respectively country and time indexes. *KibsL* is the number of workers employed in the KIBS sector (as previously defined in the ISIC Rev. 3 classification), *L* is the total employment within a country and *PubL* is the total number of workers employed in the public sector, that is all the two-digit sectors of the ISIC Rev. 3 classification grouped together as "Community, Social and Personal Services" (75-99)[4]. We subtract the number of employees in the public sector from the total number of person employed in order to make sure that our data are not influenced by dynamics that are not strictly related to private economic activities. By excluding the public sector we can be sure that what we are observing is not influenced by the implementation of public policies that might alter the aggregate results.

RDint instead measures the intensity of R&D expenditures per worker (OECD STAN-BERD): *RD* is the yearly expenditures in R&D (in constant prices and 2005 Purchasing Power Parities) performed by private firms. The intensity of R&D per worker is computed dividing the expenditures in R&D by the total number of workers in the economy (as we did before for KIBS share of employment, we subtract the number of employees belonging to the public sector) and taking its log.

INSERT FIGURES 2 AND 3 HERE

We are not really interested in determining the degree to which R&D expenditures Granger-caused the growth of employment in KIBS sectors, since this is not the main object of this paper. Hence we limit ourselves to a rather "visual" analysis of the relationship between the two variables: for the sake of our analysis it is sufficient to speak of a positive correlation between KIBS and R&D intensity. In Figures (2) and (3) we plotted the two variables for 4 different years between 1990 and 2007, we also report the heteroskedasticity-robust OLS estimates (and their standard errors) of

[4] The set of economic activities included within the "Community, Social and Personal Services" group are the following: Public Admin. and Defence - Compulsory Social Security (75); Education (80); Health and Social Work (85); Other Community, Social and Personal Services (90-93); Sewage and Refuse Disposal, Sanitation and Similar Activities (90); Activities Of Membership Organizations N.E.C. (91); Recreational, Cultural and Sporting Activities (92); Other Service Activities (93); Private Households with Employed Persons (95); Extra-Territorial Organizations and Bodies (99)

the estimation of equation (1) in the different years. As it is evident in the figures the number of observation increases as time goes by, since data on R&D expenditures and KIBS employment in some countries are available only for more recent years. Starting from 1996 the positive relationship between the two variables becomes significant and strictly positive. The figures also allow to identifying which countries have a higher share of KIBS employment and what is their R&D intensity.

As expected more advanced countries such as United States and the main European countries occupy the top-right area of the plot, while on the opposite Southern and Eastern European countries such as Greece, Portugal, Hungary and Czech Republic display low values both in terms of KIBS employment and R&D intensity. Although the relationship is statistically significant for the years from 1996 onward, it is interesting to note that also among advanced countries there are different patterns of development: the actual fitted line is an average between more industrial-oriented countries like Japan and Germany, in which R&D intensity is relatively higher than KIBS employment, and services-based countries like the Netherlands, UK and US in which the opposite occurs. Notwithstanding these differences it seems quite evident that these two variables show a clear positive correlation, which highlights the fact that in the last 20 years technological change and the growth of KIBS have grown together.

4.3. STRUCTURAL CHANGE IS CAPITAL SAVING

The next step consists in exploring the direction of technological change. According to our hypothesis technological change introduced in advanced economies since the emergence of the twin globalization is strongly biased in favor of skill intensive activities and away from capital intensive ones. Building upon the strict complementarity between the intensity of technological change and the structural change consisting in the specialization in knowledge-intensive business service industries tested in the previous step, we explore now the relationship between the emerging specialization in knowledge intensive business services and the capital intensity.

INSERT FIGURE 4 HERE

Since we have already shown that KIBS sectors are those that benefited the most from the process of structural change and displayed the highest rates of growth of employment, a first way to check whether their growth could possibly affect the flows of investment in fixed capital within a country is to compare the levels of capital intensity of the expanding KIBS and those of the declining manufacturing sectors. In Figure (4) we plot the capital intensity of the whole of the manufacturing sectors and of the KIBS sectors for the years 1990-2007. In order to compute the capital intensity (K) of manufacturing and KIBS sectors we use the following formula:

$$K_{ijt} = \frac{CAP_{ijt} - RESID_{ijt}}{H_{ijt}} \qquad (4)$$

Where *i*, *j* and *t* are respectively country, sector and time indexes. Again we take advantage of the EU-KLEMS database since it allows to discriminate among different types of capital: *CAP* denotes the overall fixed capital stock of each sector (in constant prices and 2005 Purchasing Power Parities), while *RESID* indicates the part of the capital stock that is made of residential structures.[5] *PPP* is the usual Purchasing Power Parity deflator derived from the GDP deflator (OECD Economic Outlook), while *H* denotes the number of hours worked in each national sector analyzed.

As Figure (4) shows, in the great majority of the cases we observe a sustained gap between the two levels of capital intensity. If we exclude Italy[6] and Germany the level of capitalistic intensity in the manufacturing sectors is always higher than in the KIBS sectors. In Table (1) the average levels of capital intensity in two different sub-periods (1990-2000 and 2000-2007) for the selected countries are reported. The Table highlights two main facts: first of all on average the capital intensity within KIBS is broadly 60% of that of the manufacturing sectors, with Germany, Italy and Japan representing the upper bound and Spain displaying the lowest ratio among all countries. Second of all we do not observe any reduction of the

[5] We decided to subtract the residential structures since the different accounting methods implemented by each country could possibly create some cross-country variability in the shares of these component on the total capital stock, which might eventually influence the overall levels of capital intensity, and hence the comparability among countries.

[6] The steep downward sloping curve of Italian capitalistic intensity within KIBS sectors, however, raise some doubts about the reliability of the KLEMS data for this country.

gap between the two levels of capital intensity in the second sub-period: in the years between 2000 and 2007 the ratio is stable around 60%, the only countries that experienced a substantial growth of this ratio are the United Kingdom and the United States.

Once we have shown that KIBS sectors have become increasingly central within advanced economies and that their capitalistic intensity is substantially lower with respect to manufacturing sectors, we can check whether these structural changes also modified the overall role of capital within advanced economies. If that was the case we might be able to link the slow growth of investments within advanced economies with the upsurge of knowledge-based services sectors.

In order to test this relationship we measure to what extent the growth of KIBS influences the growth of capital intensity. Through our OECD-based panel database covering 15 countries and the years 1990-2007 we test the following equation:

$$\Delta_n \ln K_{it} = a + b\Delta_n KIBS_{it-j} + c\Delta_n RD_{it-j} + c\Delta_n w_{it-j} + \\ + dOPEN_{it-j} + \lambda_i + \eta_t + \varepsilon_{it} \qquad (5)$$

Where the index *n* denotes the number of years used in the computation of the differences (Δ_n indicates differences between *t* and *t – n*). The indexes *i* and *t* denote country and time, *j* instead indicates the number of lags used (as a matter of example $\Delta_1 x_{it-1}$ indicates that we are taking the differences between the levels of *x* in *t-1* and *t-2*). Finally λ_i and η_t indicate respectively country and time fixed effects, while ε_{it}, denotes a country-specific, idiosyncratic shock.

Our measure of capital intensity (K_{it}) is computed as follows:

$$K_{it} = \frac{CAP_{it} - PubCAP_{it}}{L_{it} - PubL_{it}} \qquad (6)$$

CAP_{it} is the overall net capital stock at the country level, $PubCAP_{it}$ instead is the country-level net capital stock that refers to the public sector. [7] L_{it} instead is the overall level of employment and $PubL_{it}$ is the number of workers employed in the public sector. Also in this case we subtract the public sector from the total capital stocks and from total GDP in order to make sure that our data are not influenced by dynamics that are not strictly related to private economic activities. [8]

The independent variables are the growth rate of the number of persons employed in KIBS and the growth rate of R&D expenditures. Furthermore we add two other control variables such as $\Delta_n w_{it-j}$, the growth rate of wages within a country, and $OPEN_{it-j}$, that is the share of international trade on total GDP.[9].

INSERT TABLE 2 ABOUT HERE

In Table (2) are presented the results from the estimation of equation (5), including country and time fixed effects.[10]

The first specification, in columns (1) to (3), introduces the contemporaneous one-year rates of growth of the independent variables. The results show that both the growth of employment in KIBS and the growth of R&D expenditures from one year to the other have a negative effect on the growth of the capital intensity within a country. Although we are using fixed effects, which should ensure that the results are not driven by unobserved heterogeneity included in the error term and correlated with the regressors, we chose to include additional variables in order to control as much as possible for the heterogeneity among countries. In column (3) we then include the growth rate of the average wage and the international

[7] As in the formulas (2) and (3) we classify all the two-digit sectors of the ISIC Rev. 3 classification grouped together within the macro category "Community, Social and Personal Services" (75-99) as public sectors.
[8] By excluding the public sector, we can be sure that what we are observing is not influenced by the implementation of public policies, in particular we are able to avoid problems related to the accounting methods of public investments, which very often differ across countries.
[9] The growth of real wages is proxied by the increase of the total sum of labour compensation in the private sector, as provided by OECD-STAN. The openness to trade variable (the share of imports and exports on GDP) is provided by the OECD TIP database.
[10] Random effects estimators have been discarded on the basis of the results of the Hausman test.

trade-over GDP ratio, as a proxy for the openness of a country: both variables show negative and significant coefficients, but do not affect the sign and significance of the KIBS and R&D variables.

In order to provide further robustness to our results, in columns 4 to 6 we lag the independent variable by one year, in order to check whether our previous results could be affected by problems of simultaneity: however the results remain unchanged, only the coefficient of the growth of wages loses its significance.

Finally we decided to check whether these results are driven by short run dynamics and whether they hold also when we introduce long differences. In columns (7) we present the results of the estimation of equation (5) with n=4; we hence confined our analysis to the time-spans 1991-1995, 1995-1999, 1999-2003, 2003-2007, reducing by far the overall number of observations. However the results are still in line with those obtained with first differences. In column (8) we also lagged by one year, as in the first-differences case, the independent variables, without any significant change in the results. Our results confirm that the increasing centrality of KIBS determined a slowdown of the overall capitalistic intensity within advanced economies.

4.4 THE CONTRASTING DYNAMICS OF CAPITAL DEEPENING IN ADVANCED AND INDUSTRIALIZING COUNTRIES

So far we have shown that the structural changed occurred in advanced capitalistic countries, and which is well represented by the growth of KIBS, determined a decrease of the intensity of the investments in fixed capital in these countries. Yet our hypothesis is that the international financial system has allowed for a rapid and increasing shift of capital resources from advanced economies, where the investment intensity was slowering, towards industrializing ones. This mechanism has inverted the well-known H-O mechanism, thus allowing developing countries to produce and specialize in capital-intensive products.

If that was the case then, when looking at the aggregate statistics of capital formation we should observe a sustained increase of investments among developing countries.

The TED Database allows to checking for this general pattern, since it provides detailed data on the growth rate of capital services also for non-OECD countries. Specifically we chose to focus on a group of industrializing and fast-growing countries, mainly located in Asia, and we compared them with Western European countries, Japan, the United States, Canada and Australia. We also chose to provide a thinner analysis of investment activities and take advantage of the distinction offered by the TED Database between investments in ICT assets and non-ICT assets, focusing only on the former ones, since these should represent more directly the investments in machinery and facilities usually associated with manufacturing activity and the production of goods.

In Table (3) and (4) we present the data on the growth rates of non-ICT capital services in the period 1990-2007 among advanced economies, as opposed to newly industrialized countries (mainly East Asian countries, including China, India and Brazil as the non-Asian country). The results strongly confirm our first statement: the average growth rates are substantially lower in advanced countries with respect to industrializing ones.

In Table (3) we notice that the average growth rate ranges between a minimum of 0.70 (Finland) to a maximum of 3.99 (Australia) percentage points within the subset of advanced economies. Among the group of industrializing countries instead the average growth rates for the same period are much higher, ranging between 4.47 (Singapore) and 9.12 (China), with the only exception of Brazil (1.97).

INSERT TABLES 3 AND 4 HERE

By plotting the average growth rate of the advanced countries and of the industrializing ones in the period 1990-2007, the graph in Figure (5) shows even more clearly the difference in the growth of non-ICT capital services between advanced and industrializing countries.

From 1990 until 1997 the two lines show opposite dynamics: while advanced countries experience a general decrease of investments from 1992 onward, the average growth rate of non-ICT capital services among

industrializing countries constantly increases. Not surprisingly in 1997-1998 we observe an abrupt fall of the average rate of growth of industrializing countries, due to the 1997 Asian financial crisis[11].However the average growth rate of industrializing countries remains higher than in European and North American countries also during these years. Furthermore during the first half of the 2000's the growth rate gradually recovers, although it does not reach the pre-crisis levels.

This kind of evidence provides a further confirmation of our hypothesis about the global division of labour: industrializing countries have kept accumulating fixed capital from 1990 onward, while advanced countries have experienced a much lower growth of the capital intensity of their productive structure. Advanced countries did not specialize in the production of capital intensive goods, as the H-O model would predict, but rather specialized in knowledge-intensive economic activities, well represented by KIBS.

4.5. THE EVIDENCE ON THE SLOW GROWTH HYPOTHESIS

We can now test the final equation where we assess the effects of the specialization in skill-intensive capital saving KIBS stemming from the new direction of technological change on the rates of growth of value added. As already spelled out in the previous sections, since growth is still mainly driven by the manufacturing sectors and by the accumulation of capital, we expect to find a negative or non-significant relationship between the size of KIBS and the growth of value added.

In order to measure the impact of KIBS on the growth rate of value added we take advantage of our OECD-based database covering the years from 1990 to 2007 and including 15 countries (see Table A1 in Appendix) and we assume a typical Cobb-Douglas production function that represents the technology by means of which countries transform inputs into output. L_{it} measures the number of employees within a country, K_{it} denotes the capital stock and Y_{it} the total value added, with constant returns to scale.

[11] As is well known the Asian financial crisis affected in particular Indonesia, Malaysia, South Korea and Thailand, while, as the data show, it did not lowered the growth of capital services of countries such as China or India

To complement the Cobb–Douglas aggregate production function approach with the necessary consideration of both technological and structural change we introduce two specific variables: A_{it} and S_{it}. These two variables represent the share of value added that is not accounted for by the levels of capital and labor, the well-known residual (Solow, 1957). Our hypothesis is that such residual is due to two different factors. The first –A_{it} – depends on the overall efficiency of the production process, while the second –S_{it} –is linked to the overall structure of the economy, to the specific sectoral specialization of a country. While A_{it} is expected to capture the Schumpeterian effect of innovation on the efficiency of an economy, S_{it} introduces also the Kuznets's concept of structural change.

The specification of the country-level production function is the following:

$$Y_{it} = K_{it}^{\alpha} L_{it}^{\beta} A_{it} S_{it} \tag{7}$$

We assume constant returns to scale at the country level, that is $\alpha + \beta = 1$. Dividing both sides by L_{it} we have:

$$\frac{Y_{it}}{L_{it}} = \left(\frac{K_{it}}{L_{it}} \right)^{\alpha} A_{it} S_{it} \tag{8}$$

Where Y_{it}/L_{it} is labor productivity and K_{it}/L_{it} is capital intensity. Then – writing $y_{it} = Y_{it} / L_{it}$ and $k_{it} = K_{it} / L_{it}$ – we take logs and transform equation (8) in growth rates, obtaining our structural model:

$$\dot{y}_{it} = \alpha \dot{k}_{it} + \dot{A}_{it} + \dot{S}_{it} \tag{9}$$

In order to estimate our equation of interest we need to identify a reduced form model, that is we need to proxy the growth rates of both A_{it} and S_{it}. Following Griliches (1979) and the literature on technological change and productivity growth (Griffith, Redding, Van Reenen 2004; Mairesse, Mohnen, 1990) our hypothesis is that the growth of the efficiency term A_{it} depends on each country's specific technological effort, proxied as usual

by the intensity of R&D expenditures (R&D over employment).[12] The rate of change of the structural parameter S_{it} instead is proxied by the intensity of the structural change occurred within a country. A good indicator of the extent of the process of structural change is the share of employment in KIBS sectors. Hence the growth rate of A_{it} and S_{it} can well be defined by the following equations:

$$\dot{A}_{it} = g + \gamma \ln RD\,\mathrm{int}_{it} \tag{10}$$

$$\dot{S}_{it} = d + \theta_1 KIBS_{it} \tag{11}$$

Where *RDint* is the ratio of the expenditures in R&D over the total employment in the private sector (see equation (3)), while *KIBS* is the ratio of employment in KIBS over total private employment (see equation (2)). Substituting equations (10) and (11) into equation (9) yields the following specification:

$$\dot{y}_{it} = \alpha \dot{k}_{it} + \gamma \ln RD\,\mathrm{int}_{it} + \theta_1 KIBS_{it} + \lambda_{it} + \eta_t + \varepsilon_{it} \tag{12}$$

Furthermore, given the deep intertwining and the high positive correlation between these two variables, as shown in section (4.2), we also include an interaction term between R&D intensity and the share of employment in KIBS. The interaction variable enables to capture the marginal effects of R&D expenditures and KIBS intensity. We assume, in fact, that the marginal effect of each of the two variables depends upon the level of the other variable. In other words the effect of R&D will be influenced by the KIBS intensity and *viceversa*. Our final equation is then:

$$\dot{y}_{it} = \alpha \dot{k}_{it} + \gamma \ln RD\,\mathrm{int}_{it} + \theta_1 KIBS_{it} + \theta_2 KIBS_{it} * RD\,\mathrm{int}_{it} + \lambda_{it} + \eta_t + \varepsilon_{it} \tag{13}$$

Finally we obtain the discrete approximation of the growth rates through the following expression:

[12] R&D expenditures are expressed in real prices and in Purchasing Power Parities US dollars, as provided by the OECD STAN-BERD database, in order to obtain comparable measures across countries.

$$\ln\left(\frac{y_{it}}{y_{it-1}}\right) = \alpha \ln\left(\frac{k_{it}}{k_{it-1}}\right) + \gamma \ln RD\text{int}_{it} + \theta_1 KIBS_{it} + \\ + \theta_2 KIBS_{it} * RD\text{int}_{it} + \lambda_i + \eta_t + \varepsilon_{it} \quad (14)$$

In equation (14) λ_i, η_t and ε_{it} denote respectively country, time and idiosyncratic shocks. In the estimation of equation (14) we introduce both country and time dummies in order to rule out λ_i and η_t from the error term. We are hence excluding the possibility that our independent variables are correlated with country-specific unobservables and with common time shocks.

INSERT TABLE 5 HERE

The results in column (1) of Table (5) show that the elasticity of capital (0.328) is perfectly in line with the size usually found in the literature (Griliches and Mairesse, 1998; Olley and Pakes, 1996); however what we are specifically interested in are the coefficients of R&D intensity and KIBS share of employment, that is the two variables that proxy the efficiency and structural parameter. Yet in column (1) the coefficients of the two variables are both small and display large standard errors, showing that apparently there is not a straightforward relationship between these variables and labour productivity growth. However when in column (2) we include the interaction term, the parameters of RDint and KIBS become negative and significant, while the interaction term shows a positive and significant coefficient.

These results are also robust to the inclusion, in column (3), of the openness-to-trade variable. In order to provide a proper interpretation of the results obtained with the interaction term, in Figures (6) and (7) we plotted the overall marginal effect of R&Dint and KIBS over labor productivity. Following simple algebra, and taking into account notation in equation (14), the marginal effect of each of these two variables will be equal to:

$$\frac{\partial \dot{y}_{it}}{\partial \ln RD\,\mathrm{int}_{it}} = \gamma + \theta_2 KIBS_{it} \tag{15}$$

$$\frac{\partial \dot{y}_{it}}{\partial KIBS_{it}} = \gamma + \theta_2 \ln RD\,\mathrm{int}_{it} \tag{16}$$

Figure (6) shows that the effect of R&D intensity over the growth of labor productivity growth becomes positive as the share of KIBS increases: in particular when a country exceeds the threshold of 10-11% of KIBS employment the effect of R&D intensity becomes positive. Looking at Figures 2 and 3 we notice that this threshold was crossed only by the most advanced countries in 1991, but already in 2001 the majority of countries was beyond this value. So we can state that for most of the advanced economies R&D intensity has a positive effect on the growth of labour productivity. Also the overall marginal effect of the KIBS share of employment on labor productivity growth is positively related with the intensity of R&D (Figure 7), but only quite high levels (higher than the value of 7 in log intensities) of R&D intensity allow KIBS to show a non-negative effect. When looking at Figures 2 and 3 we notice that only few countries attained these levels of R&D intensity, even in recent years.

INSERT FIGURES 6 AND 7 HERE

In columns from (4) to (6) in Table (5), we check whether our results are robust to different specifications. Specifically it could be the case that the effect of capital deepening and technological and structural change on labour productivity growth occurs after a certain lag. Hence in columns (4)-(6) we lag by one year all the independent variables: the results however are very robust and they confirm the previous findings.

Endogeneity issues

Even if the lagged specifications in columns (4)-(6) should partly reassure us about the possible problems of endogeneity of equation (14), it seems necessary to provide a more complete examination of these issues.

A great limitation of OLS estimators is that, even after controlling for country and time effects, we still need the assumption of strict exogeneity of all the independent variables with respect to the idiosyncratic shock ε_{it} (Griliches and Mairesse, 1998; Nickell, 1981), i.e,. we are assuming that:

$$E(x_{it}\varepsilon_{it+j}) = 0, \quad j \geq 0 \tag{17}$$

and

$$E(x_{it}\varepsilon_{it-s}) = 0, \quad s \geq 1 \tag{18}$$

In the case of the share of employment in KIBS sectors we consider these assumptions as tenable, since the process of structural change takes places at a very slow pace and is not influenced by temporary shocks in the growth rate of labor productivity. On the contrary it seems reasonable to assume that some of our regressors are uncorrelated with the error terms only when, in equation (17), j>0, that is they are uncorrelated only with future un-predicted shocks. Conversely a present or past shock in the productivity growth rate is likely to influence the present levels of these regressors. We suspect this to be especially important in the case of capital-intensity growth and R&D investments. Indeed if a country experiences a negative shock on labor productivity growth in time t, it is likely that such a shock will affect the investments in fixed capital and in R&D in the same period. Also a shock occurred in the previous year will probably influence the investments decisions in the following year, since it may affect the expectations about the future economic scenarios. We hence consider the growth of capital intensity and R&D intensity as endogenous variables (Blundell and Bond, 1998), which means that:

$$E(x_{it}\varepsilon_{it+j}) = 0, \quad j > 0 \tag{17}$$

and

$$E(x_{it}\varepsilon_{it-s}) \neq 0, \quad s \geq 0 \tag{18}$$

In order to solve this problem, following Anderson and Hsiao (1982) and the literature on GMM-based estimation of endogenous variable in a panel setting, we chose to instrument the independent variables with their own lags, exploiting the fact that:

$$E(\varepsilon_{it} \mid x_i^{t-1}) = 0 \tag{19}$$

where $x_i^{t-1} = (x_{i1},...,x_{it-1})$

In other words we take advantage of the fact that past realizations of the independent variables are uncorrelated with the contemporaneous idiosyncratic shock, but at the same time they are likely to be correlated with the contemporaneous level of the endogenous variable. These features make them a proper instrument for our estimation: we hence exploit the moments depicted in equation (19) for our estimation.

In order to check whether our assumptions about endogeneity are correct we rely on the usual Durbin-Wu-Hausman specification test (Wu, 1973; Hausman, 1978) which allows to check which of the variables of our estimation are actually endogenous. We run three different regressions and in each of them we instrument one of our variables of interest with its own lags[13]. After each estimation (shown in Table 6) we check the validity of our choice of instruments through a Sargan test of overidentifying restrictions, and then we check for the exogeneity of the variable itself[14]. The results confirm us that capital intensity growth and R&D investments are endogenous with respect to the growth of labour productivity, while the share of employment in KIBS can be considered as exogenous.

After these preliminary tests we estimate equation (14) through the Generalized Method of Moments (GMM) exploiting the moment conditions previously introduced. The set of instruments contains the two

[13] In order not to lose too many observations we decided to use only one and two years lags (x_{it-2} and x_{it-3},) of the independent variables.

[14] In order to implement the Durbin-Wu-Hausman test we used the Stata command *ivendog*, written by Baum, Schaffer and Stillman.

and three-years lags of capital intensity growth, R&D intensity, the KIBS share of employment and the openness to trade. In Table (7) we report the results of the GMM estimates.

In columns (1) and (2) of Table (7) are presented the result of the estimation of equation (14) when the contemporaneous levels of the independent variables are introduced. The F-test related with the first – stage estimation confirms us that our instruments are not weak, furthermore the Sargan test of overidentifying restrictions always accepts the null hypothesis of exogeneity of the instruments. These findings support our preliminary instruments choice. When we look at the coefficients of the regressors we find that the major findings observed in the OLS specification are left unaffected: R&D intensity and KIBS share of employment are not significant as far as their interaction variable is not included, while they become negative and significant when the interaction term is introduced, the interaction term is always positive and significant. The openness to trade variable is instead always positive and significant, but it does not influence the size and sign of the other variables.

In columns (3) and (4) instead the regressors are one-year lagged: also in this case the F-test and the Sargan test confirm our choice of instruments. What is more important the coefficients of our variables of interest are left unaffected, thus confirming the robustness of our previous estimates.

These results contrast and complement at the same time the stream of literature focused on the role of R&D activities in productivity and growth at large. The evidence provided by Bassanini and Scarpetta (2001) and Guellec and Pottelsberg de la Pottery (2001) suggests the existence of a positive relationship between R&D and productivity growth. However it must be stressed that these authors, through the use of panel cointegration analyses, have explored the long-run relationship between R&D activities and GDP, that is their steady state relationship. In this study instead, by using the growth rates of labour productivity and capital intensity (rather than their levels), we have investigated the short run dynamics occurring between R&D and productivity growth. In other words the positive relationship does not necessarily apply during the process of structural change shaped by the decline of manufacturing industry and the complementary increase of the share of employment in KIBS. In such a

transition phase indeed the direction of technological change favors the reduction of the manufacturing industry and hence of capital intensity with the consequent reduction of the rates of growth of output and labor productivity. The traditional expectation of a positive relationship between the intensity of technological change, as proxied by the intensity of R&D activities, and economic performances applies instead before and after the transition to a knowledge economy.

5. CONCLUSIONS

The paper provides an analytical framework supported by qualitative and empirical evidence on the effects of the twin globalization of product and financial markets on the rate and direction of technological innovation and structural change and ultimately on the performances of the economic system of the advanced economies in the last two decades. The interpretative framework integrates in a single approach the analysis of the intertwining dynamics of the changing international division of labor, the new pace and direction of technological change and the rapid structural change in advanced countries.

The framework rests upon the grafting of four distinct and yet complementary theoretical traditions: a) the Schumperian approach about innovation as a form of creative reaction spurred by unexpected changes in product and factor markets, b) the Kuznets analysis of the relations between technological and structural changes as intertwined and inseparable aspects of economic change, c) the induced technological change approach and d) the Heckesher-Ohlin analysis of international economics.

The integration of these separated literatures enables to articulate a far-reaching interpretative framework that draws on the Schumpeterian hypothesis about the determinants of the rate of technological change, according to which innovation is the creative response of firms caught in out-of-equilibrium conditions. The Schumpeterian hypothesis allows to explain how and why firms in advanced countries reacted to the globalization of product markets with the introduction of a new

technological system based upon the new gale of in information and communication technologies. Furthermore, following the Kuznets intuition about the strict complementarity between radical technological change and structural change, the paper suggests that new technological system enabled the emergence of a new knowledge-intensive business service industry, where knowledge could be generated and exploited as a service activity. It combines these arguments with the new emphasis of the induced technological change approach upon the role of technological congruence, defined in terms of the matching between the bias in the direction of technological change and the local endowment of production factor.

This perspective allows to account for the consequences of the twin globalization of product and capital markets, the consequent identification of skills as the most abundant input in advanced countries and the induced skill intensive bias of technological change in advanced economies into a dynamic version of the Heckesher-Ohlin that is able to explain the endogenous changes in their international specialization.

According to this framework globalization brought about by the entry of new labor abundant countries in international markets had profound effects on advanced countries. It changed the specialization of incumbents and their role in the international division of labor and caused the introduction of a new gale of technological innovations characterized by a strong skill bias. Technological change favored a major structural change with the decline of the role of the manufacturing industry and the emergence of a strong knowledge intensive business service sector. The new biased direction of technological change accelerated the substitution of both capital and unskilled labor with skilled workers. The globalization of both product and capital markets engendered the fall in the prices of manufactured goods ad the net outflows of capital from advanced countries. This in turn stirred the introduction of skill intensive information and communication technologies that paralleled the marked decline of the manufacturing industry and its substitution with skill intensive knowledge business services, with the ultimate effect of reducing the growth rates of working capital and hence the rates of growth of advanced economies.

The slow growth experienced by advanced economies in the last two decades is the physiological consequence of the systemic transformation of their economic structure into light economies.

6. REFERENCES

Abramovitz, M. and David, P. A. (1996), Convergence and delayed catch-up: Productivity leadership and the waning of American exceptionalism, in R. Landau, T. Taylor and G. Wright (eds.), *The Mosaic of Economic Growth*. Stanford: Stanford University Press, 21- 62.

Acemoglu, D. K. (2002), Directed technical change, *Review of Economic Studies* 69, 781-809.

Acemoglu, D. (2003), Labor- and capital-augmenting technical change, *Journal of European Economic Association*, 1, 1–37.

Acemoglu, D.K. (2010), When does labor scarcity encourage innovation? *Journal of Political Economy* 118, 1037-1078

Acemoglu, D.K. and Guerrieri, V. (2008), Capital deepening and non-balanced endogenous growth, *Journal of Political Economy*, 116, 467–98.

Acemoglu, D., Zilibotti, F. (2001), Productivity differences, *Quarterly Journal of Economics* 116, 563–606.

Agosis, M.R., Alvarez, R., Bravo Ortega, C. (2012), Determinants of export diversification around the world (1962-2000), *The World Economy*, 35, 296-316.

Anderson, T. W. and C. Hsiao (1982) Formulation and estimation of dynamic models using panel data, *Journal of Econometrics*, 18, 570-606.

Antonelli, C. (2003), *The Economics of Innovation New Technologies and Structural Change,* London, Routledge.

Antonelli, C. (2008), *Localized Technological Change. Towards the Economics of Complexity*, London, Routledge.

Antonelli, C. (2009), Localized appropriability: Pecuniary externalities in knowledge exploitation, *Technology Analysis and Strategic Management* 21, 727-742.

Antonelli, C. (ed.) (2011a), *Handbook on the Economic Complexity of Technological Change,* Edward Elgar, Cheltenham.

Antonelli, C. (2011b), Induced technological change and the search for technological congruence in an open economy, Paper for the Conference in Honor of Mario Amendola, Rome, 17-19 November, 2011.

Antonelli, C. (2012), Technological congruence and productivity growth, in Andersson, M., Johansson, B., Karlsson, C., Lööf, H., (eds.), *Innovation and Growth - From R&D strategies of innovating firms to economy-wide technological change*, Oxford University Press, Oxford, pp. 209 –232.

Antonelli C., C. Fassio (2011), Globalization and innovation in advanced economies, *Advances in the Study of Entrepreneurship, Innovation and Economic Growth* 22 Emerald Publishing, Cambridge.

Antonelli C., A. Colombelli (2011), Globalization and directed technological change at the firm level. The European evidence, *Advances in the Study of Entrepreneurship, Innovation and Economic Growth* 22, Emerald Publishing, Cambridge.

Arellano, M. and S. Bond (1991), Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations, *Review of Economic Studies*, 58, 277-297.

Autor, D., Dorn, D. (2011), The Growth of Low-Skill Service Jobs and the Polarization of the U.S. Labor Market. MIT Working Paper, June.

Bassanini, A., Scarpetta, S. (2001), The driving forces of economic growth: Panel data evidence for the OECD countries, *OECD Economic Studies 33, 10-56.*

Binswanger, H. P. and Ruttan, V. W. (1978*), Induced Innovation. Technology Institutions and Development*, The Johns Hopkins University Press, Baltimore.

Blundell, R. and S. Bond (1998), Initial Conditions and Moment Restrictions in Dynamic Panel Data Models, *Journal of Econometrics*, 87, 115-143.

Boden, M., Miles, I. (eds.) (1999), *Innovation and the Service Based Economy*, London: Cassell Academic.

Bonatti, L., Felice, G., (2008), Endogenous growth and changing sectoral composition in advanced economies, *Structural Change and Economic Dynamics* 19, 109–131.

Bruno, G. S. F., (2005), Approximating the bias of the LSDV estimator for dynamic unbalanced panel data models, *Economic Letters*, 87, 361-366.

Corrado, C.A., Hulten, C.R., Sichel, D.E. (2006), Intangible capital and U.S. economic growth*, Review of Income and Wealth* 55, 661-685**.**

Caves, R.E. (2007), *Multinational Enterprise and Economic Analysis*, Cambridge University Press, Cambridge III edition

David, P. A. (1975), *Technological Choice, Innovation and Economic Growth*. Cambridge: Cambridge University Press.

Devezas, T. (2010), Crises, depressions and expansions: Global analysis and secular trends, *Technological Forecasting and Social Change* 77, 739–761.

Dopfer, K. (2012), The origins of meso economics. Schumpeter's legacy and beyond, *Journal of Evolutionary Economics* 22, 133-160.

Dunning J.H. (2008), *Multinational Enterprise and the Global Economy*, Edward Elgar, Cheltenham, II edition.

Figini, P., Görg, H. (2011), Does foreign direct investment affect wage inequality? An empirical investigation, *The World Economy* 34, 1455-1475.

Freel, M. (2006), Patterns of Technological Innovation in Knowledge-Intensive Business Services, *Industry and Innovation*, 13, 335-358.

Gatti, D.D., et al. (2012), Mobility constraints, productivity trends, and extended crises. *Journal of Economic Behavior and Organization*, doi:10.1016/j.jebo.2012.03.011

Griffith, R., Redding, S. and J. Van Reenen (2004), Mapping The Two Faces of R&D: Productivity Growth in a Panel of OECD Countries, *The Review of Economics and Statistics*, 86, 883–895.

Griliches, Z. (1979), Issues in assessing the contribution of Research and Development to productivity growth, *The Bell Journal of Economics*, 10, 92-116.

Griliches, Z. and J. Mairesse, (1998), Production functions: The search for identification, Chapter 6, in S. Strom (ed.), *Econometrics and Economic Theory in the 20th Century,* Cambridge: Cambridge University Press.

Helpman, E. (2006), Trade, FDI and the organization of firms, *Journal of Economic Literature*, 44, 589‑630.

Hicks, J.R. (1932), *The Theory of Wages*, Macmillan, London.

Geuna, A. (1999), *The Economics of Knowledge Production*, Edward Elgar, Cheltenham.

Guellec, D., van Pottelsberghe de la Potterie, B. (2001), R&D and productivity growth: Panel data analysis of 16 OECD countries, *OECD Economic Studies 33, 103-126.*

Hausman, J. A. (1978), Specification Tests in Econometrics, *Econometrica*, 46, 1251–1271.

Kang, S.J., Lee, H. (2011), Foreign direct investments and de-industrialization, *The World Economy* 34, 313-329.

Kuznets, S. (1965), *Economic Growth and Structure*, Heineman, London.

Krugman, P. (2009), *The Return of Depression Economics and the Crisis of 2008*, W.W. Norton Company, New York.

Lee, E., Vivarelli, M. (eds.) (2004), *Understanding Globalization. Employment and Poverty Reduction,* New York: Palgrave Macmillan.

Machlup, F. (1982), *Knowledge: Its Creation, Distribution, and Economic Significance*, Vols.1–3, Princeton, NJ: Princeton University Press.

Maddison, A. (2007), Fluctuations in the momentum of growth within the capitalist epoch, *Cliometrica* 1, 145–175.

Mairesse, J. and P. Mohnen (1990), Recherche-Développement et productivité : Un survol de la littérature économétrique, *Economie et statistique*, 237, 99 – 108.

Maroto-Sánchez, A., Cuadrado-Roura, J.R., (2009), Is growth of services an obstacle to productivity growth? A comparative analysis, *Structural Change and Economic Dynamics* 20, 254–265.

Modelski, T. Devezas, W.R. Thompson (eds.) (2008), *Globalization as Evolutionary Processes*, Routledge, Abingdon.

Muller, E., D. Doloreux (2009), What we should know about knowledge-intensive business services, *Technology in Society*, 31, 64–72.

Nickell, S. (1981), Biases in dynamic models with fixed effects. *Econometrica*, 49, 1417-1426.

Nickell, S., Redding, S., Swaffield, J. (2008), The uneven pace of deindustrialization in the OECD, *The World Economy* 31, 1154-1184.

North, D. (2005), *Understanding the Process of Economic Change*, Princeton University Press, 2005.

Olley, S. and A. Pakes (1996), The Dynamics of Productivity in the Telecommunications Equipment Industry, *Econometrica*, 64(6), 1263-1297.

O'Mahony, M. and M. P. Timmer (2009), Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database, *Economic Journal*, 119(538), 374-403.

Rivera-Batiz, L. and P. Romer (1991), International trade with endogenous technological change, *European Economic Review* 35, 971–1001.

Ruttan, V.W., (1997), Induced innovation evolutionary theory and path dependence: Sources of technical change, *Economic Journal* 107, 1520-1529.

Ruttan, V.W., (2001), *Technology Growth and Development. An Induced Innovation Perspective*, Oxford University Press, Oxford.

Samuelson, P. (1965), A theory of induced innovation along Kennedy, Weiszacker lines, *Review of Economics and Statistics* 47, 343-56.

Samuelson, P. (1948), International trade and the equalization of factor prices, *Economic Journal* 58, 163-184.

Schumpeter, J.A. (1939), *Business Cycles*, McGraw-Hill, New York.

Schumpeter, J. A. (1947), The creative response in economic history. *Journal of Economic History* 7,149-159.

Solow, R. M., (1957), Technical change and the aggregate production function, *Review of Economics and Statistics*, 39, 312-320.

Stephan, P. (2011), *How Economics Shapes Science*, Cambridge: Harvard University Press.

Stiglitz, J.E. (2010), *Freefall: America, Free Markets and the Sinking of the World Economy*, W.W. Norton Company, New York.

Wood, A. (1994), *North–south trade, Employment, and Inequality: Changing Fortunes in a Skill-driven World*. Oxford: Clarendon Press.

Wu, De-Min (1973), Alternative Tests of Independence between Stochastic Regressors and Disturbances, *Econometrica*, 41, 733-750.

Zeira, J. (1998), Workers, machines and economic growth, *Quarterly Journal of Economics*, 113, 1091-1113.

Figure 1. Hours worked in developed countries (manufacturing and KIBS)

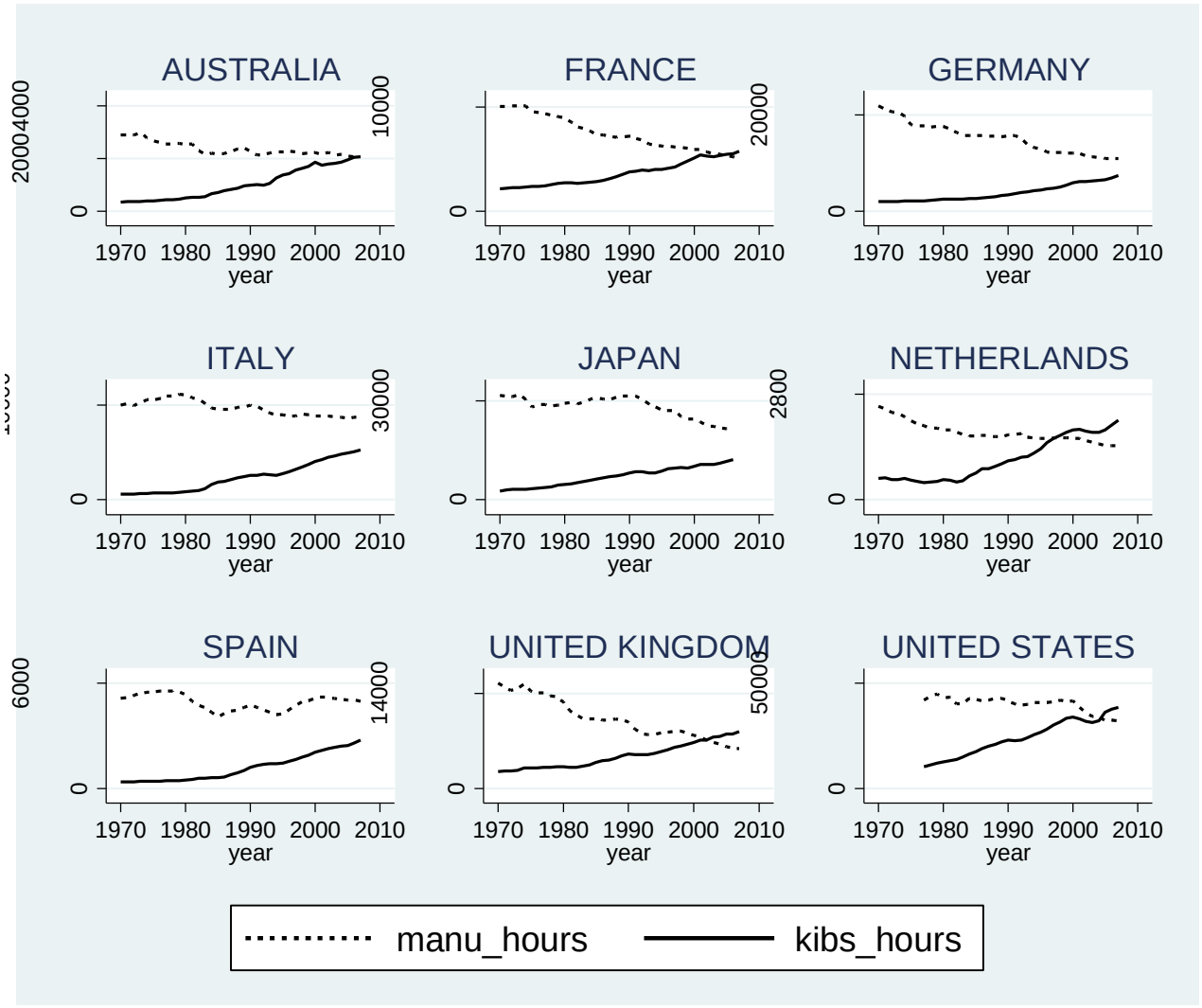


Figure 2. KIBS share of employment and R&D intensity

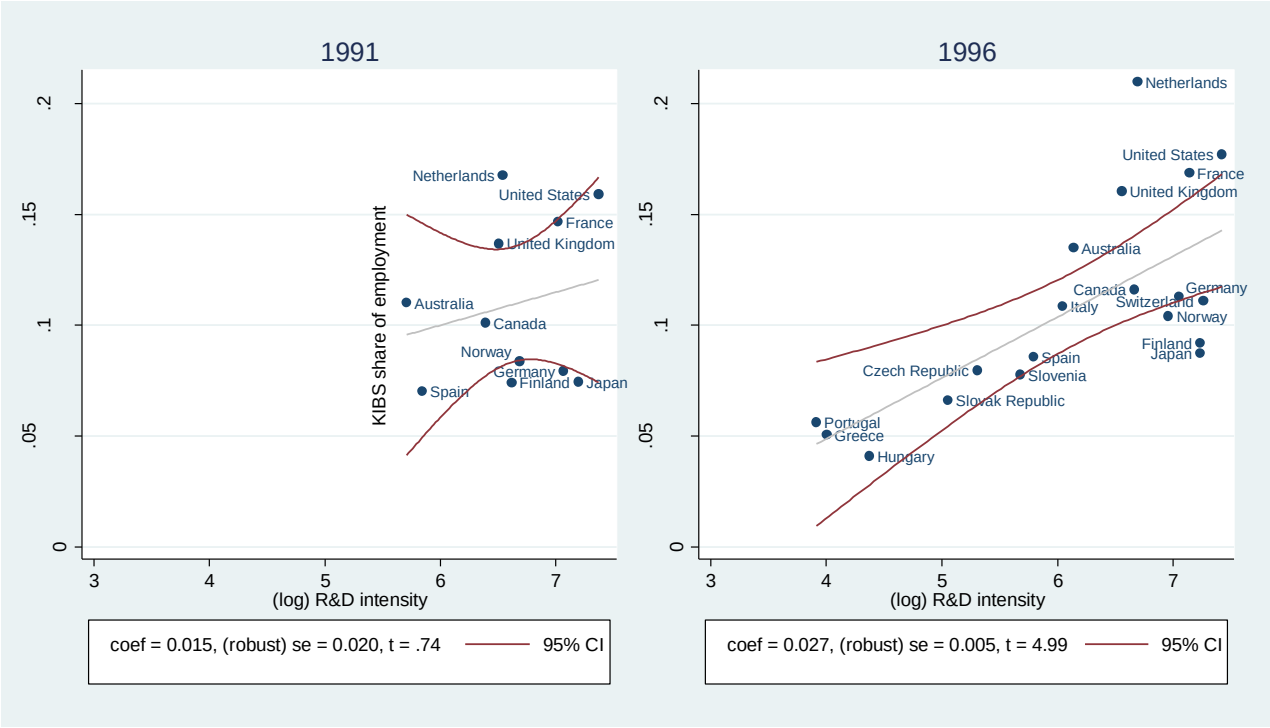


Figure 3. KIBS share of employment and R&D intensity

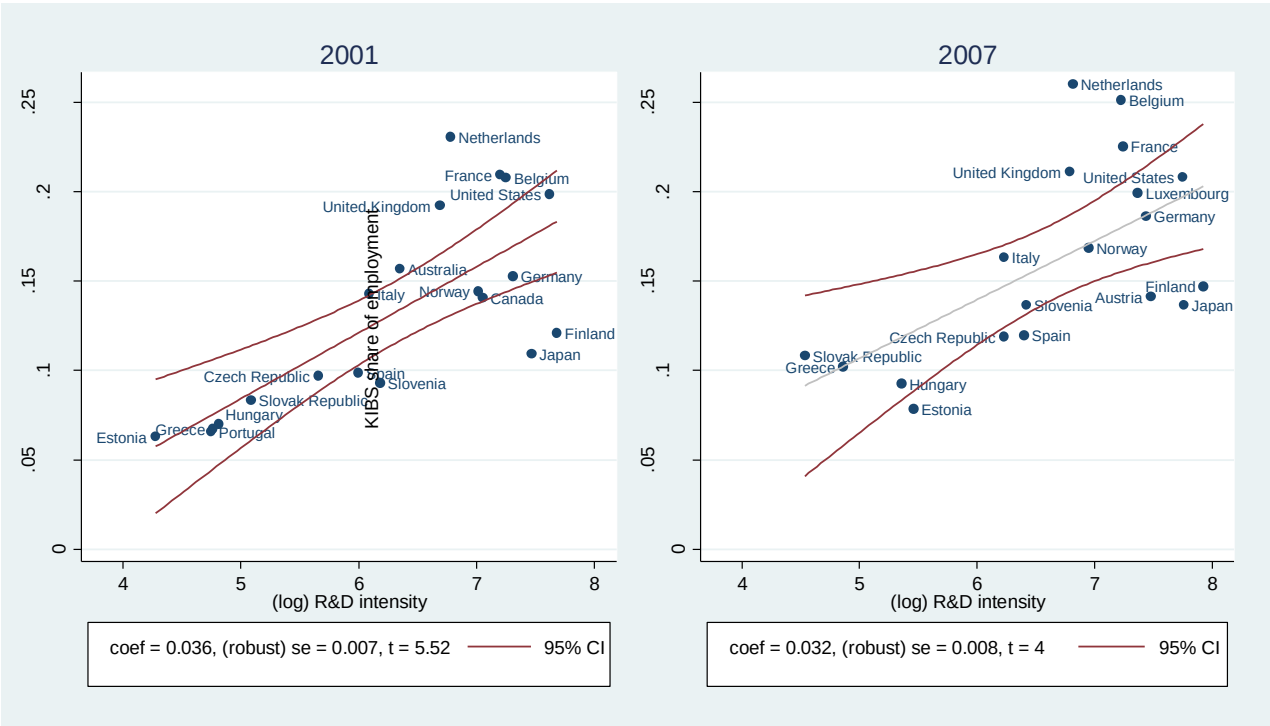


Figure 4. Capital intensity in advanced countries (manufacturing and KIBS)

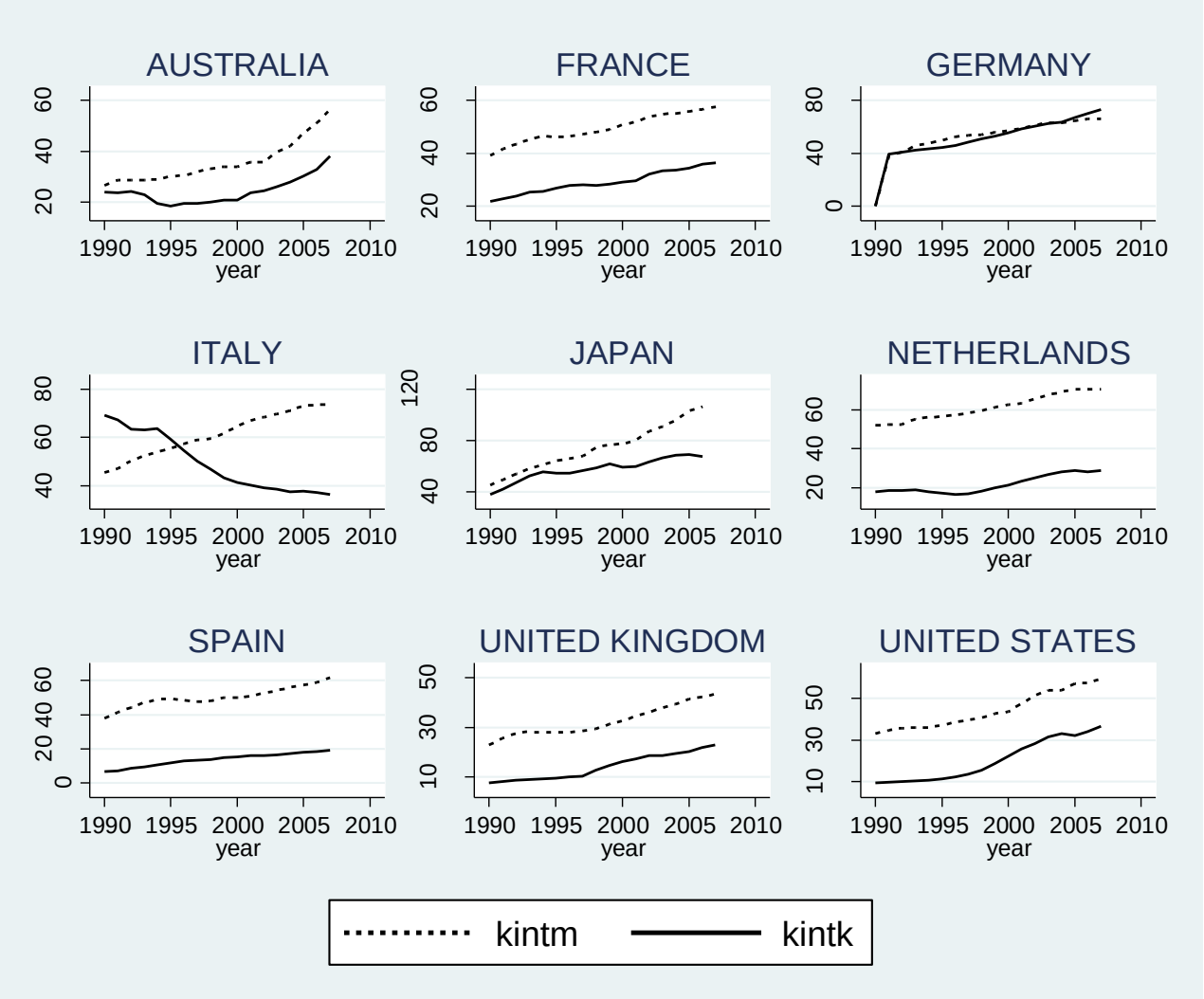


Table 1: the evolution of capital intensity within KIBS and manufacturing sectors

Countries	subperiod: 1990-2000			subperiod: 2000-2007		
	capital intensity		ratio	capital intensity		ratio
	KIBS	Manufacturing	(1)/(2)	KIBS	Manufacturing	(1)/(2)
Australia	21.27	30.14	0.71	27.97	42.78	0.65
Denmark	23.00	38.41	0.60	39.51	55.03	0.71
France	25.74	45.33	0.57	33.02	54.59	0.60
Germany	40.81	43.75	0.94	63.94	62.62	1.02
Italy	58.11	54.29	1.09	38.59	70.17	0.55
Japan	52.04	61.70	0.85	64.73	91.58	0.71
Netherlands	18.28	56.12	0.33	26.49	67.40	0.39
Spain	10.96	46.24	0.23	17.22	55.12	0.31
Sweden	14.02	29.01	0.48	33.49	57.59	0.58
United Kingdom	10.04	27.83	0.36	19.50	38.48	0.51
United States	11.99	37.40	0.32	30.40	53.07	0.57
All countries	26.02	42.75	0.59	35.57	58.57	0.60

Table 2. Capital intensity and KIBS employment

VARIABLES	(1) n=1 j=0	(2) n=1 j=0	(3) n=1 j=0	(4) n=1 j=1	(5) n=1 j=1	(6) n=1 j=1	(7) n=4 j=0	(8) n=4 j=1
Δ_n ln $KIBS_{it-j}$	-0.303***	-0.293***	-0.215***	-0.150***	-0.134**	-0.148**	-0.238***	-0.225*
	(0.051)	(0.051)	(0.033)	(0.049)	(0.053)	(0.055)	(0.078)	(0.105)
Δ_n ln RD_{it-j}		-0.051**	-0.044***		-0.076***	-0.068***	-0.121***	-0.162***
		(0.017)	(0.014)		(0.024)	(0.020)	(0.036)	(0.047)
Δ_n ln w_{it-j}			-0.106*			0.062	-0.019	0.031
			(0.050)			(0.049)	(0.127)	(0.093)
$OPEN_{it-j}$			-0.001***			-0.001***	-0.002*	-0.002*
			(0.000)			(0.000)	(0.001)	(0.001)
time dummies	yes	yes	yes	yes	yes	yes	yes	yes
Constant	0.056***	0.059***	0.108***	0.055***	0.061***	0.116***	0.244***	0.227***
	(0.006)	(0.005)	(0.009)	(0.009)	(0.009)	(0.020)	(0.053)	(0.072)
Observations	245	227	226	241	222	222	48	47
R-squared	0.633	0.687	0.769	0.466	0.549	0.651	0.691	0.679
Number of id	15	15	15	15	15	15	15	15

The dependent variable in all models is the growth rate of capital intensity K. The period of observation is 1990-2007: time dummies are included in all models. All models are estimated through Fixed Effects estimators, controlling for heteroskedasticity. In all specifications the Hausman test rejected the consistency of (GLS) Random Effects estimators. In columns (1), (2) and (3) the yearly growth rate of capital intensity is regressed on the contemporaneous yearly growth rates of the independent variables. In column (4), (5) and (6) the yearly growth rates of the independent variables are 1-year lagged. In column (7) the 4-years growth rate of capital intensity is regressed against the contemporaneous 4-years growth rates of the independent variables. In column (8) the 4-years growth rates of the independent variables are 1-year lagged. In columns (7) and (8) only the years 1995, 1999, 2003, 2007 are included. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3. Growth rate (%) of non-ICT Capital Services: advanced countries

time	Denmark	Finland	France	Germany	Italy	Netherlands	Sweden	United Kingdom	Canada	United States	Australia	Japan
1990	2,93	4,62	3,41	2,77	3,39	2,58	4,64	3,35	3,89	1,91	4,36	5,76
1991	2,32	2,03	3,22	3,36	3,22	2,54	2,70	2,57	2,84	1,50	3,15	5,70
1992	1,74	0,06	2,78	3,22	2,70	2,19	0,59	2,09	2,02	1,16	2,61	4,96
1993	0,81	-0,89	2,15	2,04	1,48	1,70	-0,18	1,90	1,38	1,34	2,66	3,90
1994	0,69	-2,33	1,85	1,24	0,72	1,36	-0,16	1,68	1,41	1,78	2,96	2,59
1995	1,39	-2,50	1,87	1,17	1,23	1,62	1,06	1,48	1,79	2,14	3,32	1,93
1996	1,76	-0,96	1,77	1,07	1,64	2,09	1,99	1,66	1,80	2,34	3,39	2,04
1997	1,88	0,40	1,71	1,04	1,66	2,32	2,18	2,24	2,58	2,50	3,65	1,95
1998	2,43	1,28	1,93	1,20	1,91	2,48	2,24	3,10	3,40	2,78	3,97	1,51
1999	2,33	1,47	2,37	1,36	2,28	2,79	2,62	3,42	3,61	2,99	3,89	1,07
2000	2,19	1,45	2,84	1,57	2,51	2,79	2,78	2,75	3,72	3,03	3,61	0,98
2001	2,34	2,04	3,04	1,39	2,64	2,33	2,73	2,34	3,36	2,68	3,35	0,89
2002	1,86	1,91	2,83	0,71	2,78	1,70	2,38	2,35	2,81	1,97	3,48	0,56
2003	1,32	1,11	2,52	0,38	2,53	1,24	2,17	2,20	2,55	1,49	4,68	0,32
2004	1,03	0,66	2,40	0,46	2,16	0,91	2,31	2,03	2,64	1,49	5,71	0,40
2005	0,76	0,56	2,52	0,54	2,01	0,70	2,45	1,99	3,01	1,81	5,72	0,69
2006	1,28	0,53	2,66	0,79	1,96	1,03	2,72	2,13	3,55	2,18	5,63	0,86
2007	2,08	1,12	2,84	1,28	2,06	1,58	3,20	2,69	3,43	2,24	5,62	0,78
90-07	**1,73**	**0,70**	**2,48**	**1,42**	**2,16**	**1,88**	**2,13**	**2,33**	**2,77**	**2,07**	**3,99**	**2,05**

Source: The Conference Board *Total Economy Database*™

Table 4. Growth rate (%) of non-ICT Capital Services: industrializing countries

time	China	India	Indonesia	Malaysia	South Korea	Taiwan	Thailand	Singapore	Brazil
1990	5,47	5,24	6,34	6,18	12,00	10,44	11,98	9,28	2,02
1991	5,84	4,75	7,39	9,60	12,65	9,78	13,20	8,39	1,54
1992	7,41	4,44	7,88	10,64	11,45	10,27	12,12	6,57	1,30
1993	9,69	4,46	7,29	11,22	9,76	10,19	11,10	7,44	1,43
1994	10,83	4,87	7,21	12,90	10,09	9,53	10,81	6,95	1,65
1995	10,56	6,30	7,87	13,92	11,19	9,40	11,22	6,01	2,14
1996	10,48	6,11	8,70	13,21	10,94	8,92	11,24	6,50	2,57
1997	9,93	5,48	9,20	12,36	8,36	8,72	8,18	7,18	2,73
1998	9,22	5,36	6,86	6,67	4,18	8,65	2,23	4,74	2,79
1999	8,42	5,46	3,45	0,61	2,68	7,76	-1,26	2,91	2,15
2000	7,81	5,56	3,00	1,95	4,12	7,49	-0,14	5,21	1,82
2001	7,98	5,20	3,80	3,13	4,75	5,49	0,97	4,37	2,04
2002	8,56	5,17	4,00	2,88	4,80	3,03	1,10	1,65	1,84
2003	9,67	5,25	3,81	2,52	5,20	2,63	1,72	-0,92	1,32
2004	10,37	5,84	4,16	1,96	4,92	3,79	2,71	-1,20	1,30
2005	10,51	6,68	5,03	2,32	4,90	4,85	3,54	0,73	1,64
2006	10,74	7,41	5,14	2,83	4,93	4,32	3,83	1,55	2,06
2007	10,72	8,32	5,16	3,32	5,04	4,03	3,60	3,07	3,18
90-07	**9,12**	**5,66**	**5,91**	**6,57**	**7,33**	**7,18**	**6,01**	**4,47**	**1,97**

Source: The Conference Board *Total Economy Database*™

Figure 5: Average Growth rate (%) in non-ICT Capital Services

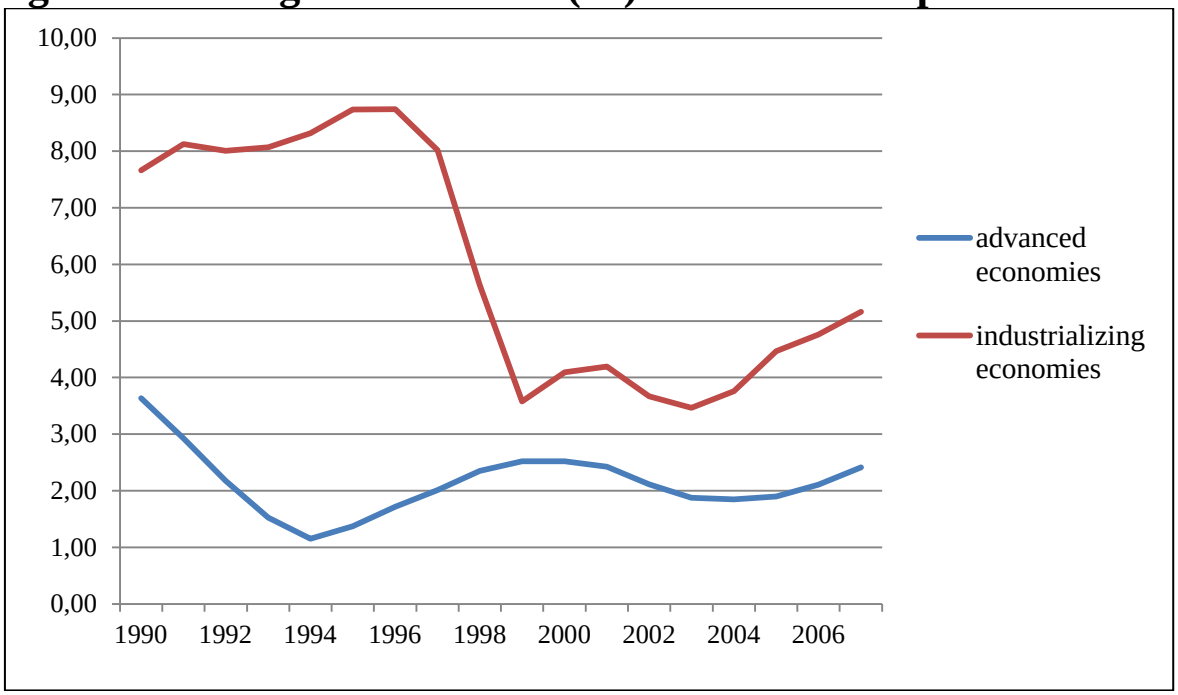


Table 5. The determinants of labour productivity growth

VARIABLES	(1) j=0	(2) j=0	(3) j=0	(4) j=1	(5) j=1	(6) j=1
$\ln(k_{it-j}/k_{it-j-1})$	0.328***	0.297***	0.455***	0.399***	0.379***	0.461***
	(0.074)	(0.064)	(0.081)	(0.068)	(0.059)	(0.065)
ln RD int_{it-j}	0.006	-0.010	-0.016**	0.006	-0.006	-0.012**
	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)
$KIBS_{it-j}$	0.043	-1.187**	-1.198**	0.101	-0.853*	-0.915*
	(0.185)	(0.516)	(0.423)	(0.172)	(0.471)	(0.472)
ln RD int_{it-j}*$KIBS_{it-j}$		0.164***	0.135**		0.127**	0.119**
		(0.054)	(0.051)		(0.053)	(0.051)
$OPEN_{it-j}$			0.105***			0.073**
			(0.033)			(0.027)
constant	-0.046	0.081	0.073	-0.039	0.055	0.064
	(0.043)	(0.059)	(0.055)	(0.045)	(0.050)	(0.047)
Observations	233	233	233	229	229	229
R-squared	0.273	0.294	0.405	0.345	0.358	0.411
Number of id	15	15	15	15	15	15

The dependent variable in all models is the yearly growth rate of labour productivity. The period of observation is 1990-2007: country and time dummies are included in all models. All models are estimated through OLS estimators, controlling for heteroskedasticity. In columns (1), (2) and (3) the yearly growth rate of labour productivity is regressed on the contemporaneous levels and growth rates of the independent variables. In column (4), (5) and (6) the independent variables are 1-year lagged. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6. Endogeneity specification tests.

VARIABLES	(1) IV $ln(k_{it}/k_{it-1})$	(2) IV $ln\ RD\ int_{it}$	(3) IV $KIBS_{it}$
$\ln(k_{it}/k_{it-1})$	0.71***	0.41***	0.47***
	(0.11)	(0.067)	(0.073)
ln RD int_{it}	0.00016	-0.046***	-0.0096
	(0.010)	(0.011)	(0.016)
$KIBS_{it}$	-0.54	-2.52***	-0.94
	(0.52)	(0.56)	(1.08)
ln RD int_{it}*$KIBS_{it}$	0.044	0.30***	0.10
	(0.067)	(0.072)	(0.14)
$OPEN_{it}$	0.13***	0.12***	0.10***
	(0.019)	(0.017)	(0.016)
Constant	0.012	0.38***	0.086
	(0.087)	(0.095)	(0.14)
Observations	227	220	228
R-squared	0.506	0.511	0.529
Sargan Test of overidentifying restrictions Chi-sq	17.318	0.308	1.357
p-value	0.000	0.579	0.244
Durin-Wu-Hausman test Chi-sq	9.076	20.221	0.027
p-value	0.00259	0.000	0.870
Time dummies	Y	Y	Y
Country dummies	Y	Y	Y

All models are estimated through IV estimators. The dependent variable is the yearly growth of labour productivity. In column (1) only the growth of capital intensity $\ln(k_{it}/k_{it-1})$ is instrumented with its own lags (one and two-years lags). In column (2) the R&D intensity (ln RD int_{it}) is instrumented with its own lags: in order to achieve a better predictive power of the instruments, only two and three-years lags have been used. In column (3) only the share of employment in KIBS sector ($KIBS_{it}$) is instrumented with its firts two lags. The Sargan test of overidentifying restrictions checks for the goodness of the instruments, while the Durbin-Wu-Hausman tests performs a specification test in which the coefficient of the instrumented variable is confronted with the coefficient obtained through a normal OLS regression. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 7. The determinants of labour productivity growth, instrumental variables

VARIABLES	(1) j=0	(2) j=0	(3) j=1	(4) j=1
$\ln(k_{it-j}/k_{it-j-1})$	0.842***	0.778***	0.618***	0.429***
	(0.146)	(0.156)	(0.095)	(0.084)
ln RD int_{it-j}	-0.009	-0.037**	-0.006	-0.024**
	(0.010)	(0.015)	(0.007)	(0.010)
$KIBS_{it-j}$	-0.181	-2.133***	-0.014	-1.375**
	(0.152)	(0.736)	-0.123	(0.570)
$OPEN_{it-j}$	0.155***	0.156***	0.097***	0.090***
	(0.028)	(0.027)	(0.021)	(0.021)
ln RD int_{it-j}*$KIBS_{it-j}$		0.264***		0.180**
		(0.096)		(0.075)
Constant	0.063	0.267**	0.027	0.166**
	(0.096)	(0.131)	(0.067)	(0.082)
Observations	212	212	212	212
R-squared	0.444	0.440	0.537	0.533
First stage F-test $\ln(k_{it-j}/k_{it-j-1})$	65.911	16.646	16.483	6.462
p-value	0.000	0.000	0.000	0.000
First stage F-test ln RD int_{it-j}	45.096	134.022	121.648	46.667
p-value	0.000	0.000	0.000	0.000
Sargan test of overid	9.157	0.905	0.981	10.259
p-value	0.242	0.989	0.986	0.114

All models are estimated through IV-GMM estimators with heteroskedasticity-robust weight matrix. The dependent variable is the yearly growth of labour productivity. The period of observation is 1990-2007. The set of instruments, common to all equations, is: $\ln(k_{it-2}/k_{it-3})$, $\ln(k_{it-3}/k_{it-4})$, ln RD int_{it-2}, ln RD int_{it-3}, $OPEN_{it-2}$, $OPEN_{it-3}$, $KIBS_{it-2}$, $KIBS_{it-3}$. Time and country dummies are included. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Figure 6. The marginal effect of R&D conditional on KIBS

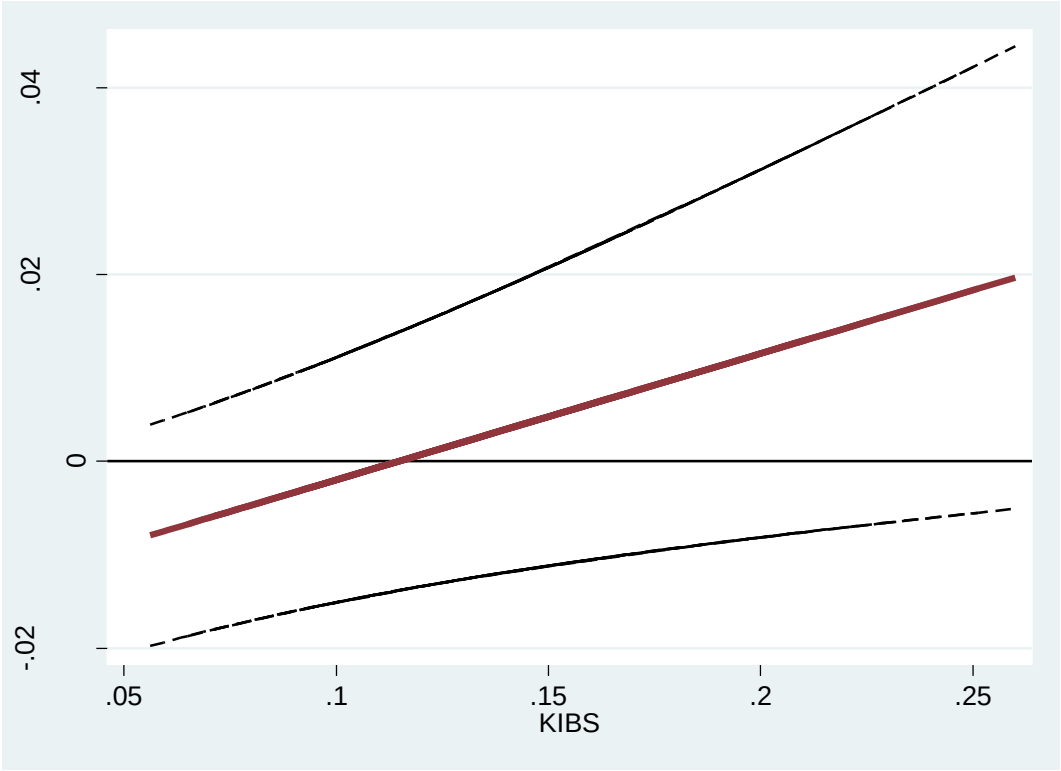
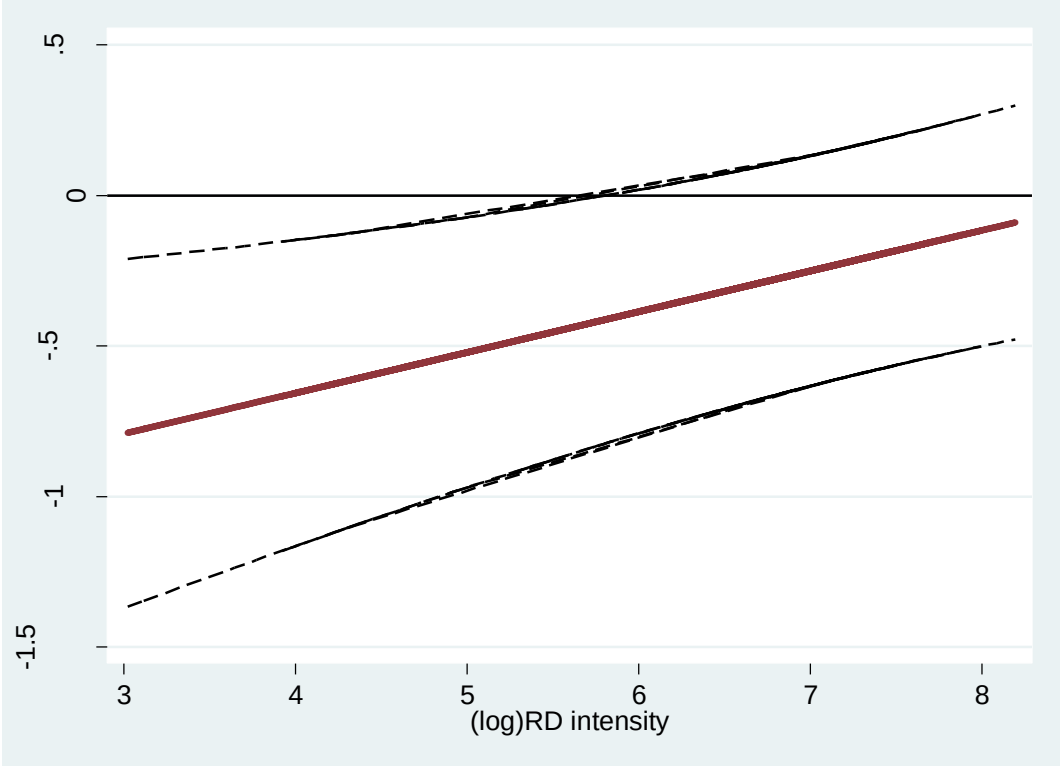


Figure 7. The marginal effect of KIBS conditional on R&D



APPENDIX

TABLE A1.

List of countries included in the OECD STAN/BERD DATABASE (1990-2010)

Australia	Italy
Austria	Japan
Belgium	Luxembourg*
Canada	Netherlands
Czech Republic*	Norway
Estonia*	Portugal
Finland	Slovak republic*
France	Slovenia*
Germany	Spain
Greece*	Switzerland*
Hungary*	United Kingdom
Israel*	United States

countries maked with an asterisk could not be used in the estimation of equations (5) and (13) because of the lack of data on either capital stocks or openness to trade

Table 2A: Descriptive statistics of the panel dataset

Variable		Mean	Standard Deviation			# Obs.	# countries	T
			overall	*between*	*within*			
$KIBS_{it}$	1990-2007	0.140	0.048	0.044	0.024	254	15	16.9
$\Delta_1 KIBS_{it}$	1990-2007	0.042	0.032	0.008	0.031	250	15	16.7
$RD\,\mathrm{int}_{it}$	1990-2007	6.781	0.804	0.787	0.230	246	15	16.4
$\Delta_1 RD_{it}$	1990-2007	0.042	0.069	0.032	0.061	244	15	16.3
$\ln K_{it}$	1990-2007	12.166	0.283	0.308	0.090	258	15	17.2
$\Delta_1 \ln K_{it}$	1990-2007	0.018	0.018	0.010	0.016	255	15	17
$\Delta_n w_{it}$	1990-2007	0.044	0.032	0.016	0.027	265	15	17.7
$OPEN_{it}$	1990-2007	64.34	32.26	32.10	8.69	270	15	18
$KIBS_{it} * RD\,\mathrm{int}_{it}$	1990-2007	0.993	0.375	0.355	0.184	239	15	15.9

Note:T indicates the average number of observations per country