Pre-commercial procurement: regulatory effectiveness?

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CHAPTER 2. Institutional and economic backgrounds to the European PCP policies in the 21st century – revival of the demand-side policy in support of innovation

2.1 Introduction

By 2000, political consensus held that innovation is the key to Europe's advancement in the face of competitive pressure from emerging economies and in the face of global threats of a different kind (climate change, shortage of natural resources, ageing etc.). This was acknowledged in 2000 by the European Council during its meeting in Lisbon. Since 2000, EU and national policy-makers have considered (combinations of) policy instruments that would incentivize private actors to bring those types of innovations to the market that are capable to adequately face the above mentioned challenges.

In this context, demand-side policy instruments were rediscovered by the policy-makers as important tools to achieve more, faster and socially desirable innovation. Particularly public procurement was brought to the fore. In 2005, the Commission decided to exploit the potential of public procurement as source for investment in additional R&D efforts in order to contribute to the political goals outlined in Lisbon.[258] This eventually led to the adoption of the PCP Communication in 2007.

As already mentioned in Chapter 1, the PCP Communication focuses on legal compliance with the state aid rules and legal compliance with the fundamental principles of the Treaty regarding the Functioning of the European Union (TFEU). No guidance is provided on the economic pre-conditions that justify the use of PCP or plead against its application, and neither are practices explained that would increase PCP's effectiveness. Nevertheless, the policy decision to include PCP within the EU innovation policy toolbox is based on a number of economic assumptions regarding the role of government intervention in support of innovation and the role of public R&D funding from the demand-side to incentivize private companies to increase their investments in desirable R&D projects.

This chapter describes first the policy processes that preceded the adoption of the PCP. It outlines the political support and the relevant public policy actions adopted in this context by the different EU institutions which have a say in the innovation policy arena: the European Council (which gives the political impetus and support for certain action to stimulate innovation), the European Commission (which translates the European Council´s guidance into concrete activities) and the European Parliament (which has a say as co-legislator, in case legislation needs to be adopted).

[258] Commission, 'Implementing the Community Lisbon Programme: More Research and Innovation - Investing for Growth and Employment: A Common Approach' 8, COM(2005) 488 final.

In the second part of this chapter, the economic assumptions that lie at the basis of the PCP policy are listed. Subsequently, this chapter analyses whether the economic assumptions and the policy expectations resonate with the economic theories and studies on public economic-policy intervention(s) in the form envisaged by PCP (namely public funding of R&D with involvement and purchasing prospects from the side of the end-customer/user).

The economic theories and studies used in this chapter are those employed by EU institutions when deciding on their policies. This chapter also identifies, by looking at these theories and studies, under which economic conditions PCP can be expected to be effective and in which situations PCP can be expected to be counterproductive and should better not be employed.

2.2 Policy background to PCP, an institutional approach

2.2.1 Introduction

This section discusses both the policy steps that precede the adoption of PCP and the policy actions that have been subsequently adopted in order to boost the implementation of PCPs in practice.

It describes the European Council political support for the development of public policy in support of increased investments in R&D (section 2.2.2). It subsequently describes the actions undertaken by the European Commission to design and subsequently encourage the deployment of pre-commercial procurement (section 2.2.3). The description of the policy background continues with an outline of the European Parliament's endorsement of PCP (section 2.2.4) and ends with concluding remarks (section 2.2.5).

2.2.2 European Council's guidance

In 2000, the European Council[259] laid the basis for the current policy expectations related to PCP. The European Council gave in the 'Lisbon Strategy' the political impetus to renew EU's objectives in the face of the challenges brought by economic globalization (such as increased competition from developing countries, climate change, ageing, scarcity of natural resources etc.). The European Council set the ambitious goal for Europe to become the most competitive and dynamic economy in the world within a decade. To reach this goal, increased research and technology intensive production of goods and services and improved innovative capabilities for European businesses were considered necessary requirements.

[259] The European Council is the organ which gives the political impetus to the Union's economic, social and environmental action. It is formed of the heads of the Member States.

In the Lisbon Strategy, the European Council expressed its view that both (i) coordinating research efforts at EU level and (ii) ensuring a substantial demand for the resulting innovations would diminish inefficiencies in the European innovation policy.[260] Moreover, the European Council stressed the importance of redirecting public expenditure towards research and development, innovation and towards information technologies.

In Lisbon 2000, the European Council concurrently decided to introduce the concept of 'open method of coordination' (OMC). OMC is a decentralized approach which entails that the European Council provides annual political guidance on the policy measures which are necessary to achieve the Lisbon agenda in employment, innovation, economic reform and social cohesion. Based on the conclusions of the European Council, the European Commission drafts European guidelines on the needed actions, with specific timetables. The implementation of the actions identified by the European Commission is left to the Member States.

Yet the European Commission monitors the implementation by each Member State against quantitative and qualitative indicators and benchmarks. It draws up annual reports on the progress made in each area. For the comparative assessment of the research and innovation performance of the 27 Member States and the relative strengths and weaknesses of their research and innovation systems, the Commission uses the innovation indicators of the Innovation Union Scoreboard. These Scoreboards are used as justification for policy choices.

This method leaves the European Commission with no direct enforcement mechanisms, yet it allows for evidence-based arguments to persuade and leverage peer pressure.

Since 2000, the European Council re-endorsed and fine-tuned the Lisbon Strategy on innovation each and every year. Different measures meant to create favourable conditions for businesses to invest in R&D and innovation were proposed. Hereafter, I will highlight European Council's most important decisions related to increasing the amount of public investments in R&D and to increasing the efficiency of public policy in incentivizing increased private R&D investments.

In 2001 in Göteborg, the European Council added an environmental dimension to the Lisbon Strategy and underlined the importance of triggering increased private investments in the

[260] Expert Group on 'Knowledge for Growth', 'Globalisation of R&D: linking better the European economy to 'foreign' sources of knowledge and making EU a more attractive place for R&D investment (2006) <http://ec.europa.eu/invest-in-research/pdf/download_en/foray_report.pdf> accessed 12 December 2012.

development of technological innovation.[261] It also identified priority areas for policy action: climate change, transport, public health and natural resources.[262]

Another important step was taken in 2002 during the Barcelona European Council, when it was agreed that investment in R&D and innovation in the Union should be increased to 3% of the GDP by 2010, of which two-thirds should come from the private sector.[263] The Barcelona European Council laid a particular emphasis on priority areas in frontier technologies such as life sciences and biotechnology, considered instrumental for closing the gap between the EU and its major competitors. It also added the energy sector to the priority list.[264]

In 2003, the Spring European Council[265] reiterated that innovation is an insufficiently tapped source of growth for the EU. Increased public and private investments in R&D and innovation are the key to increasing the competitiveness of EU businesses and enhance growth. The 2003 Council mentioned improved access to finance among the various policy actions needed to incentivize businesses to increase their R&D investments and recognized the important role defence R&D procurement has in promoting leading-edge technologies.[266] The 2003 European Council also indicated that environmental innovations must be treated as a priority in EU's public research and innovation strategy.[267] In 2004, the European Council remarked that the EU had not booked sufficient progress towards reaching the 3% investment target, but reiterated its political commitment therefore. It also called upon Member States to use among a variety of measures, targeted public R&D investments in order to enhance greater private investments in R&D.[268]

In 2005, the European Council explicitly added public procurement to the array of innovation policy instruments needed to deploy innovative products and services and particularly eco-technologies.[269] This happened against the background of a negative mid-term evaluation of the achievement of the Lisbon Strategy targets for 2010.[270] This addition was triggered by the request of the French, German and UK governments to surge the use of public procurement

[261] Presidency Conclusions, 'Goteborg European Council, 15 and 16 June 2001', paras19-21 <http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/00200-r1.en1.pdf> accessed 26 March 2013.
[262] Presidency Conclusions June 2001 para 27.
[263] Presidency Conclusions, 'Barcelona European Council 15-16 March 2002' paras 47-8 <http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/ec/71025.pdf> accessed 26 March 2013.
[264] Presidency Conclusions March 2002 para 12.
[265] Presidency Conclusions, 'Brussels European Council of 20 and 21 March 2003' 14-526 <http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/75136.pdf> accessed at 27 July 2011.
[266] Ibid 4.
[267] Ibid 25.
[268] Presidency Conclusions, Brussels European Council 25-26 March 2004' 2 <http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/79696.pdf> accessed 11 April 2013.
[269] Presidency conclusions, 'Brussels European Council, 22 and 23 March 2005' paras 13, 19 <http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/84335.pdf> accessed 27 June 2011.
[270] Spring European Council, ´Working together for growth and jobs, A new start for the Lisbon Strategy´ COM(2005) 24 final.

in support of innovation.[271] Investments in eco-technologies in the energy and transport sectors were considered particularly suitable to be stimulated through public procurement.[272]

The European Council renewed each year its support for the commitments made in Lisbon towards investment in innovation and R&D in areas of European strategic interest, such as the energy sector (energy efficiency, sustainable energies and low emission technologies),[273] waste management and climate (technologies for environmentally safe carbon capture and sequestration and for new fossil-fuel power plant),[274] construction, food and drink, energy-efficient water-technologies, transport, recycling and waste water.[275]

In 2007, at the dawn of the economic crisis, the European Council signaled the need to make public spending on R&D and innovation effective and to increase the rate of R&D transformation into innovative products and services.[276] In 2008, after the economic crisis had hit Europe, the Spring European Council made clear that the long-term global challenges got bigger and that innovation was more than ever needed to deal with these challenges, especially in the context of restricted financial resources. Based on the 2007 Innovation Union Scoreboard, which concluded that EU's performance is significantly weaker than competing economies in areas such as availability of early stage venture capital and public R&D expenditure,[277] the *European* Council reinforced the commitment to invest more, but also more effectively, in research, creativity, innovation and to achieve the 3% R&D investment target. Public procurement was again mentioned as one of the instruments capable to contribute to deployment of desired innovations.[278]

The European Council of 2009 called on the Commission to consider in its proposal for a post-2010 Lisbon Strategy, among others, the need to step up and improve the quality of investment in research.[279]

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[271] French, German, UK Governments (2004)'Towards and Innovative Europe. A paper by the French, German and UK Governments' (2004) <http://www.hm-treasury.gov.uk/media/C0B/BF/towards_innov_europe_200204.pdf> accessed 26 March 2013.
[272] Ibid (n12) 6..
[273] Presidency Conclusions, 'Brussels European Council, 23/24 March 2006' para 22, 34 <http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/89013.pdf> accessed 28 July 2011.
[274] Presidency conclusions, 'Brussels European Council, 8/9 March 2007' 11-2 <http://register.consilium.europa.eu/pdf/en/07/st07/st07224-re01.en07.pdf> accessed 28 July 2011.
[275] Presidency conclusions, 'Brussels European Council, 13/14 March 2008' <http://register.consilium.europa.eu/pdf/en/08/st07/st07652-re01.en08.pdf> accessed 28 July 2011.
[276] Presidency Conclusions March 2007 3, 6.
[277] The EU-US gap in public R&D expenditure was reportedly increasing and the GDP share of early-stage venture capital in the US was still more than 50% higher in the US as compared to the EU. See 'European Innovation Scoreboard 2007 – Comparative Analysis of Innovation Performance' (2008) 16-7, Pro Inno Europe Paper N.6 http://ec.europa.eu/enterprise/policies/innovation/files/proinno/eis-2007_en.pdf> accessed 11 April 2013.
[278] Presidency Conclusions 2008.
[279] Presidency Conclusions, 'Brussels European Council 19/20 March 2009' paras 15-6 <http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/106809.pdf> accessed 11 April 2013.

In 2010, the European Council endorsed the new Europe 2020 Strategy and reconfirmed its political commitment to the same R&D investment target of 3% of GDP, which had been set within the framework of the Lisbon Strategy.[280]

The European Council of February 2011[281] underlined the importance of creating synergies and coherence between actions undertaken by the EU and the Member States in fostering private R&D investments and commercialization of innovations with societal benefits. Concurrently, the Council acknowledged the importance to lift remaining obstacles to the cross-border operation of venture capital and to this end, it invited the Commission to explore the feasibility of a Small Business Innovation Research Scheme.[282]

The European Council of March 2012 praised the Commission for being on time with its measures to improve the conditions for innovation in the EU. This reflected the fact that all six legislative proposals announced in the new innovation strategy[283] were adopted by the Commission in 2011.[284] Concurrently, the European Council acknowledged for the first time the need to put demand-led innovation at the core of Europe's research and development policy and expressly mentioned the need to make more efficient use of pre-commercial procurement.[285]

In conclusion, the European Council provided since 2000 broad guidance on the policy action needed to improve EU's innovative capabilities and transform Europe into the most competitive and dynamic economy in the world. It underlined the need for an integrated and coordinated approach between EU's and Member States' actions in support of research and innovation. Among the various conditions needed to leverage private investments in research and innovation, the European Council mentioned the need to increase not only the amount but also the efficiency of public R&D investments. It also explicitly pointed at the need for public authorities to purchase those innovations which present social benefits.

Following the successful lead of competing economies such as the US, the European Council proposed to increase public R&D and innovation investments up to 1% of the GDP. The European Commission was asked to guide Member States and monitor the amount and impact of their investments. The aim was to deploy public R&D investments in such a way as to leverage increased private R&D and innovation investments up to an additional 2% of

[280] Presidency Conclusions, 'European Council 17 June 2010' 11 <http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/115346.pdf> accessed 11 April 2013, N. CO EUR 9/CONCL 2.
[281] Presidency conclusions, 'Brussels European Council, 4 February 2011' 7-9 <http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/119175.pdf> accessed 26 March 2013.
[282] Presidency Conclusions February 2011 8.
[283] Such as Horizon 2020, new Cohesion policy, reform of public procurement legislation, a new regime for venture capital, standardisation package and legislative proposals for unitary patent protection.
[284] Presidency, Brussels European Council 1-2 March 2012' <http://europa.eu/rapid/press-release_DOC-12-4_en.htm> accessed 26 March 2013.
[285] Presidency Conclusions March 2012 para 18.

GDP. The Innovation Union Scoreboards was designated to monitor the achievement of these targets.

Public procurement of R&D (or pre-commercial procurement) was not mentioned as a distinct policy instrument before 2012. However, the guidance offered before 2012 left sufficient leeway for the European Commission to promote and finance public procurement of R&D. The express reference to pre-commercial procurement in 2012 seems to indicate further increased political support for the deployment of pre-commercial procurement as distinct innovation policy instrument.

2.2.3 European Commission's actions

2.2.3.1 Actions to promote public procurement as innovation policy instrument

Since 2000, the European Commission gave concrete form to the political guidance offered by the European Council. In 2002, it started to pay attention to the potential of public procurement as an important instrument to stimulate private actors to invest in R&D and innovation. The Commission underlined in a number of communications the importance of public procurement as funding source particularly for some industries (such as transport, communications and defence) as well as the need to overcome fragmentation of EU procurement markets in areas where scale is necessary to incentivize innovators to take risks and invest in R&D.[286] In 2003, the Commission included public demand in its Research Investment Action Plan, as an instrument to raise R&D expenditure to the 3% Barcelona target.[287]

Besides explicitly identifying public procurement as a suitable policy instrument to leverage private R&D investments, the Commission introduced new possibilities to procure innovative products into the 2004 Procurement Directives, by creating an equal footing for formal standards and functional specifications, and by introducing the competitive dialogue.[288] Subsequently, the European Commission provided clarity regarding the possibilities to procure innovative solutions in compliance with the legal framework.[289]

The Commission concluded that public procurement may incentivize private investment in R&D, based on a number of funded studies (outlined below). The commissioned studies underlined the importance of customers' needs and risk-taking attitudes in influencing private

[286] Commission, 'More research for Europe, Towards 3% of GDP' 14 COM(2002) 499 final.
[287] Commission, 'Investing in research: an action plan for Europe' COM(2003) 226 final/2.
[288] Arts 23 and 29 Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts, OJ L 134/114.
[289] Wilkinson R. et al, 'Public procurement for research and innovation' (2005) <http://ec.europa.eu/invest-in-research/pdf/download_en/edited_report_18112005_on_public_procurement_for_research_and_innovation.pdf> accessed 26 March 2013.

firms' decisions to invest in R&D and innovation, and warned that the lack of focus on public technology procurement constituted a missed opportunity towards achieving the 3% target. Experts advised the European Commission, among others, to set targets for Member States regarding public procurement of R&D and to stimulate the establishment of analogues to the US SBIR.[290] The same conclusions were validated by yearly EU surveys among private actors. These surveys repeatedly reported that businesses who had the opportunity to offer innovations in publicly tendered contracts, were the most likely to increase their innovation budgets. At the same time, public procurement tenders reportedly did not offer sufficient opportunities to bid innovative solutions, while in the few cases where they did, large companies had a higher chance to sell such innovative solutions.[291]

Some of the most representative studies contracted by the Commission on this topic were the Kok Report which pointed out the possibility to use public procurement to offer lead markets to innovative products[292] and the Wilkinson Report which re-confirmed the need for demand-side innovation policy.[293] But the Aho Group Report, which was commissioned by the EU leaders in the aftermath of their Spring Summit in 2006[294] provided the most important input for the EU broad-based innovation strategy formulated by the European Commission in the same year.[295] The Aho Group underlined that the demand-side was concomitantly the most promising and the most under-represented approach in the EU innovation policy. The Group argued for 4 priority actions: creating innovation friendly markets, strengthening R&D resources, increasing structural mobility and fostering a culture that celebrates innovation. The EU Council endorsed the conclusions of the Aho Group and the possibility of using public procurement to stimulate demand for innovation was reiterated at the Ministerial Meeting organized during the Finnish Presidency in 2006.[296]

The EU broad-based innovation strategy adopted by the European Commission In September 2006, proposed to improve access to finance in support of innovation, to create an innovation friendly regulatory environment and to create demand for innovation as well as to reinforce the activities of institutions relevant for innovation, including the links between

[290] Gheorghiou et al., 'Raising EU R&D Intensity: Improving the Effectiveness of Public Support Mechanisms for Private Sector Research and Development: Direct Measures' (2003) < http://ec.europa.eu/invest-in-research/pdf/download_en/report_directmeasures.pdf> > accessed 26 March 2013; Business Decisions Limited, 'The Power of Customers to Drive Innovation' (2003) <ftp://ftp.cordis.europa.eu/pub/innovation-policy/studies/studies_the_power_of_customers_to_drive_innovation.pdf> accessed 26 March 2013.

[291] Gallup Organization, 'Innobarometer 2009 Analytical Report' (2009) 59 <http://www.proinno-europe.eu/sites/default/files/Innobarometer_2009.pdf> accessed 26 March 2013; Commission, 'Monitoring Industrial Research: the 2005 EU Survey on R&D Investment Trends in 10 Sectors' <http://iri.jrc.es/> accessed 26 March 2013;

[292] W. Kok et al., 'Facing the Challenge. The Lisbon Strategy for Growth and Employment'(2004) <http://ec.europa.eu/research/evaluations/pdf/archive/fp6-evidence-base/evaluation_studies_and_reports/evaluation_studies_and_reports_2004/the_lisbon_strategy_for_growth_and_employment__report_from_the_high_level_group.pdf> accessed 26 March 2013.

293 Wilkinson Report.

[294] Aho, E., Cornu, J., Georghiou, L. and Subira, A. 'Creating an Innovative Europe' (2006) (Aho Report) <http://ec.europa.eu/invest-in-research/action/2006_ahogroup_en.htm> accessed 26 March 2013.

[295] The 2006 innovation strategy is the predecessor to the current EU innovation policy (Innovation Union Flagship).

[296] Jakob Edler, Luke Georghiou, 'Public Procurement and innovation – Resurrecting the demand side', *Research Policy* 36 (2007) 958.

research institutions and industry.[297] Amongst the instruments to achieve these goals, public procurement was singled out. By purchasing innovation, the public sector may stimulate the dissemination of innovations onto the private market through the power of example, while at the same time improving the quality and productivity of the public services. The Commission considered that, in order to achieve a significant impact, the focus should lie on the purchase of innovative products that have the potential to improve public service and for which the public sector is an important customer (such as ICT). Moreover, the need to stimulate all forms of innovation (technological, organizational and innovation in services) was underscored.[298]

The Commission contracted subsequently a broad study to review the focus on innovation in the public procurement practice in EU countries. On the basis of this study, the Commission drafted in the spring of 2007 the Handbook on Public Procurement for Innovation, to provide legal certainty on the possibilities offered by the procurement directives to procure innovative products.[299]

The Commission had thus by 2007 formulated guidance for Member States to uptake demand-side measures within their innovation policies, improved the legal framework for public procurement and increased legal certainty around the room for procurement of innovative products within the EU Procurement Directives. The guidance was by then focused on the procurement of commercially available innovative products, not on the procurement of R&D services.

In 2007, the Commission went a step further and decided to bring policy-makers from different Member States together to deploy in a coordinated manner demand-side policies and disseminate the resulting best practice. This was the aim of the Lead Market Initiative ('LMI'). The LMI identified and employed a set of demand-based measures such as public procurement networks, standardization and regulation, in support of particular technologies and sectors (eHealth, protective textiles, sustainable construction, recycling, bio-based products and renewable energies). These concrete demand-side instruments were meant to complement supply-side instruments already being employed in these areas. In addition, Member States involved in the LMI were supported in the development of public procurement policies favorable to innovation.[300]

Following the adoption of demand-side instruments by several Member States in their

[297] Council, 'Council Conclusions on a Broad-Based Innovation Strategy: Strategic Priorities for Innovation Action at the EU level' (2006) 2 <http://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/intm/91989.pdf> accessed 26 March 2013.
[298] Commission, 'Putting knowledge into practice: A broad-based innovation strategy for the EU' 11 COM(2006) 502 final.
[299] J. Edler et al., 'Innovation and Public Procurement. Review of Issues at Stake' (2006) <ftp://ftp.cordis.lu/pub/innovation-policy/studies/full_study.pdf> accessed 26 March 2013.
[300] OMC-Net ERA-PRISM, <http://www.eraprism.eu/> accessed 26 March 2013.

innovation policies, the Commission contracted in 2011 a study to investigate the trends and challenges in demand-side innovation policies in Europe. The study concluded that there was a tendency in the EU Member State to focus on public procurement and pre-commercial procurement in their innovation policies, but that it was *'still too early to say whether demand-side type of activities meet the expectations'*.[301] The study signalled the importance of 'intelligent learning' as compared to 'policy copying' as well as the importance of experimentation with demand-side policies, before their positive effects are proven. Based on these results, the EU commissioned the first systematic conceptualisation of an evaluation of demand-side policy (described in section 2.3.2 below).[302]

Another recently commissioned report warns for the necessary improvement in the *quality* of the spending on R&D and innovation in order to close the innovation gap between Europe and its major competitors. According to this study, two issues that need further exploration are the demand-side policy and the innovation of services. The report also underlines that a successful innovation policy requires supranational coordination and governance.[303] Among other solutions, the Report pleads for *'the use of pre-commercial and early-commercialization procurement'* and for extended competences of the European Commission, beyond sharing practices and granting funds.[304]

2.2.3.2 Actions to promote PCP within the EU innovation policy

Until 2005, the European Commission had focused mainly on the use of commercial public procurement as a demand-side instrument to encourage private actors to invest more in R&D. The procurement of innovative products (whether new to the market or to the public purchaser) was expected to give private actors the trust that follow-up innovations would find a market in the public sector. This would potentially nudge them towards assuming more risks and investing more in R&D.

In 2005, the European Commission decided to add a new dimension to the use of public procurement as innovation policy instrument. In a Communication of 2005 the Commission announced its intention *'to raise awareness of the benefits of re-orienting public procurement towards stimulating research'*.[305] In 2006, the European Commission put together a group of

[301] Technopolis, 'Trends and Challenges in Demand-side Innovation Policies in Europe' (2011) <http://ec.europa.eu/enterprise/newsroom/cf/_getdocument.cfm?doc_id=7011> accessed 26 March 2013.
[302] J. Edler, L. Georghiou, K. Blind and E. Uyarra, 'Evaluating the demand side: New challenges for evaluation' *Research Evaluation* 21 (2012) 33–47.
[303] Ernst&Young and Centre for European Policy, 'Next generation innovation policy, The future of EU innovation policy to support market growth' (2011) 14 <http://www.google.nl/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=3&ved=0CEMQFjAC&url=http%3A%2F%2Fwww.siliconrepublic.com%2Fdownload%2Ffs%2Fdoc%2Freports%2Finnovation-20report-lr.pdf&ei=uj4NUb7ECcHs0gXftIDABw&usg=AFQjCNE20kBwzEgEf_ryTG90zL4vBk6ODA&sig2=j0Xz_TvF_v3KJFyUYCvWyw> accessed 2 February 2013.
[304] Ernst&Young study (2011) 17.
[305] COM (2005) 488 final 8.

experts who committed themselves to investigate whether there was a need in the EU to stimulate R&D activities in the ICT sector through demand-side policies.[306]

The ICT sector was singled out as a dynamic and innovative sector that is responsive to public demand, that is of common European interest and that can generate spill-over effects and enable innovative capabilities into other sectors of the economy.[307] It was also considered that the competitive advantages Europe held in certain ICT markets, could be leveraged, if private and public R&D investments were increased to levels comparable to those of competing economies such as the US.[308] Although the scope of PCP was later broadened beyond its initial focus, ICT remains an important target area for PCP as it is considered to hold the capacity to provide revolutionary solutions for the sustainable economy of the future,[309] but needs public steering towards environmentally friendly choices.[310] In the context of the economic slowdown since 2008, innovative ICT solutions were also seen as a source of potential efficiency gains and cost cuts related to energy and the environment in the public sector.[311]

The expert group reported that PCP is a suitable instrument to pull innovative solutions from the R&D phase into the commercialization phase in the ICT sector as well as elsewhere.[312] The conclusion reached by the experts motivated the Commission to support the implementation of PCP as innovation policy instrument.[313]

The PCP Expert Group mentioned several reasons why use of public procurement of R&D was considered necessary.

1. Firstly, Europe's major competitor, the United States (US) succeeded more often to pull technological R&D into the commercialisation phase.[314] The European experts attributed this success to (i) the strategic use of procurement procedures for R&D (design contests with considerable prizes, the SBIR competitions for high-tech solutions,

[306] National IST Research Directors Forum Working Group on Public Procurement in support of ICT Research and Innovation 'Pre-commercial Procurement of Innovation: A Missing Link in the European Innovation Cycle' (PCP Expert Group) (2006) <ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/pcp/precommercial-procurement-of-innovation_en.pdf>, accessed 12 November 2012.
[307] ISTAG, 'Shaping Europe's Future through ICT" (2006) <http://www.cordis.lu/ist/istag.htm> accessed 26 January 2012. Aho Report; 'The EU Economy Yearly Review' 70 <http://ec.europa.eu/economy_finance/publications/publ_page8701_en.htm> accessed 12 December 2012
[308] Commission, 'A Strategy for ICT R&D and Innovation in Europe: Raising the Game' 3 COM(2009) 116 final. The Commission underlines the world leadership Europe holds in ICT application markets such as telemedicine and medical equipment, in automotive and aerospace electronics, and in embedded ICT. See also Joint Research Centre, 'Mapping R&D Investment by the European ICT Business Sector' (2008) (JRC Report) <http://ftp.jrc.es/EURdoc/JRC45723_RR.pdf> accessed 26 March 2013.
[309] The ICT sector generates more than a fifth of all patents in Europe. See JRC Report.
[310] In 2009, the ICT sector and ICT products were considered responsible for about 2% of global GHG emissions and this harmful contribution was expected to grow quickly. See also OECD, 'Measuring the Relationship between ICT and the Environment' (2009) <http://www.oecd.org/sti/43539507.pdf> accessed 26 March 2013.
[311] For example, by making significant savings in energy possible, in sectors such as transport, buildings and in manufacturing, ICT technologies are expected to help reduce 20% of the CO2 emissions in Europe by 2020. See Commission, 'A European Economic Recovery Plan' COM (2008) 800 final. See also COM(2009)116.
[312] PCP Expert Group 4.
[313] These reasons could also be valid for the deployment of PCP in other sectors.
[314] PCP Expert Group 9.

value engineering, risk and IPR sharing in R&D procurement etc.) and to (ii) the restriction of procurement of R&D to domestic suppliers. The US deployed these instruments in well-defined areas in which they aspired to gain international competitiveness. Through these actions the US succeeded to offer a strong home market to their domestic suppliers. This strengthened their competitive capabilities on the global market.

2. Secondly, the EU spent 20 times less (2,5 Bn euro) compared to the US federal government agencies (49 Bn dollar)[315] on demand of R&D. This investment gap was most obvious in public procurement of R&D (and not in other financial instruments such as R&D subsidies, loans or fiscal measures).
3. Thirdly, due to the increasing opening of the Internal Market, the practice in the EU Member States to share the risks of R&D between state monopolies and private suppliers disappeared and left European companies without an important source of funding for risky R&D projects.[316]
4. Fourthly, the private market in the EU had not stepped in to fill the funding gap. In the case of projects focused on the public market, this was due to the limited upside commercialisation potential.[317] This situation was mainly observed in the case of products destined to meet intrinsic needs of the public organisation, but it was also present in cooperative procurement (when the innovative product addresses needs of both the public sector and the private customer) and in catalytic procurement (when the innovative product is destined to meet extrinsic needs to the procuring organization). Consequently, the experts concluded that the private market failed to fund risky R&D in general and R&D oriented towards solutions to public needs, in particular. Such market failures justified, according to the experts, the intervention of the government. [318]
5. Fifthly, the supply-side instruments such as subsidies, were considered insufficient to stimulate the creation of ICT solutions for the public sector. Unlike subsidies, procurement of R&D was not meant to co-finance firms to carry out R&D in line with company plans, but to steer R&D towards the needs of the public sector.[319]
6. Sixthly, the experts concluded that, in the context of increased global competition, the underutilization of pre-commercial public procurement as an instrument for boosting research and innovation in ICT, as well as the fragmented national public

[315] PCP Expert Group 10.
[316] PCP Expert Group 5.
[317] According to the PCP Expert Group 24, before deciding to invest in R&D projects, companies calculate the value of the different investment options as a function of time of the upside commercialisation potential and the downside risk that the project will not be well received in the market. Products destined to the public market have a limited upside commercialisation potential due to the smaller size of the public market and to the risk aversion of public procurers.
[318] PCP Expert Group 24.
[319] PCP Expert Group18.

policy objectives were Europe's most important weaknesses compared to its competitors.[320]

The PCP Expert Group recommended a concerted European approach to the procurement of R&D which involves pooling together resources, demand and competencies of contracting authorities and which allows competition from all GPA countries, provided that the research centre of the company is situated in the EU. According to the experts, this approach had the advantage to lower for each contracting authority the risks of participating in procurements of R&D and to ensure more efficient spending of public money. From an EU perspective, a transparent and competitive procedure would increase interoperability and coherence of solutions in different Member States and would strengthen the Internal market with all its related benefits for EU citizens.[321]

The experts' conclusion that procurement of R&D in the EU was desirable was based on a comparison with the set of instruments in the US innovation policy. The experts did not question the effectiveness of government intervention in support of innovation. Moreover, no evaluation methodology of the impact of PCP was suggested[322] and no need was signalled to check on a case-by-case basis whether PCP is a suitable instrument and is capable of bringing more benefits than harm in the context of competitive markets. The policy recommendation to implement PCPs was in concert with the desire of both the policy-makers and the expert group to explore whether PCP could reproduce the success of the US SBIR and '*bring tangible benefits to society and economy*'.[323]

The PCP Expert Group concluded that PCP could be a suitable instrument to develop ICT solutions for recognized European challenges and recommended priority areas for its deployment: healthcare, social inclusion, e-government, security and transportation. Within these areas, the PCP Expert Group provided examples of broad topics which contain suitable challenges for cross-border collaborative PCPs.[324] In the health area, the following specific topics are mentioned: electronic patient records supported by smart electronic health cards and e-prescriptions based on health information exchange networks. Within the area of social inclusion, the Study mentions the following topics: ambient assisted living for elderly, children, etc., design for all workplaces, total conversation communication technologies, multi-platform information society access for groups at risk of exclusion e.g. in remote or deprived areas. In the area of e-government the following topics are considered to present

[320] PCP Expert Group 11.
[321] PCP Expert Group 6.
[322] Only recently, there has been increased attention for more measurement methodologies of the impact of demand-side policies. These may provide solid proof on the impact of PCP in the EU and may offer suggestions for improvements in its implementation. See Edler et al (2012) 21.
[323] PCP Communication 3.
[324] PCP Expert Group.

suitable challenges for cross-border collaborative PCP procedures: digital identities, workflows for inter-administration business processes (distributed secure software tools) and interactive multi-channel multimedia government to consumer/business architectures. In the security and transportation areas, PCP could be used to solve challenges within the following topics: border security, risk management systems e.g. for large scale bioterrorism attacks, attacks on utility resources etc., automatic inspection in electronic customs/taxation systems, traffic control systems for freight (for secure cargo tracking and managing freight movements), integration of traffic control systems over different transport modes, communication between car and road infrastructure, advanced driver assistance systems ADAS, automatic emergency call from vehicles.

The European Commission embraced the policy recommendations of the PCP Expert Group in the PCP Communication and in the accompanying PCP Staff Working Document.[325]

Subsequently, the European Commission set in its 2009 ICT Strategy the target to triple the use of pre-commercial procurement in ICT by 2020 and announced upcoming actions to incentivize cross-border implementations of PCP.[326] At the same time, the Commission underlined that socially desirable technologies, such as environmental technologies, should be given priority.[327]

In order to achieve the above mentioned target, the Commission started in 2009 to fund under different funding programmes (in RFEC, FP7 and CIP programmes)[328] the establishment of networks of public authorities. The Commission made more than EUR 1,2 million available. These networks were intended to raise awareness on the PCP instrument, to facilitate exchanges of experiences and to eventually facilitate cross-border collaborations for implementation of pre-commercial procurement procedures.

In 2010 it became clear that the goals and targets formulated within the framework of the Lisbon Strategy had not been reached. The data published by the European Commission in the Innovation Union Scoreboards between 2001-2010 confirmed that the gap between Europe on the one side, and the United States and Japan on the other side, has consistently been widening along several dimensions of innovation. At the same time, the BRIC

[325] Commission, 'Pre-commercial Procurement: Driving innovation to ensure sustainable high quality public services in Europe' (PCP Communication) COM (2007) 799 final.
[326] Commission, 'Communication setting a Strategy for ICT R&D and Innovation' COM (2009) 116 final 6, 11.
[327] COM (2009) 116 final.
[328] RFEC is the Regions for Economic Change programme is a European Commission initiative for the 2007-2013 period aiming at funding good regional practices with a particular focus on innovation. See <http://ec.europa.eu/regional_policy/cooperate/regions_for_economic_change/index_en.cfm> accessed 15 April 2013. FP7 (Framework Programme 7) is EU's programme aimed at funding research and covering the period 2007 to 2013. See <http://europa.eu/legislation_summaries/energy/european_energy_policy/i23022_en.htm> accessed 15 April 2013. CIP (Competitiveness and Innovation Framework Programme) is EU's funding framework for innovation activities, with a focus on small and medium-sized enterprises (SMEs). CIP runs from 2007 to 2013 as well. See http://ec.europa.eu/cip/> accessed 15 April 2013.

economies (Brazil, Russia, India and China) were quickly catching up and may overtake the EU in the next few years in terms of key indicators of innovation performance, such as education, patents and investment in R&D. [329] Moreover, despite the fact that Europe features similar levels of public R&D spending on GDP to the US, Japan and China, the difference is substantial in private spending. The effect is less innovation brought to the market.[330]

In response to this negative evaluation, the Commission adopted the new innovation strategy as one of the seven flagships (Innovation Union Flagship)[331] which form the general strategy for the development of Europe up to 2020.[332] The Innovation Union Flagship considers demand-side instruments such as standardisation, public procurement and regulation crucial. The fact that the current low level of investment in R&D in Europe (below 2% of GDP) compared to the US (2.6% of the GDP) and Japan (3.4% of the GDP) is mainly due to lower levels of private investment, led the Commission to conclude that the public investment in R&D in Europe does not trigger the desired incentive effect. As a solution the Commission proposes to improve the impact and composition of public research spending. It also proposes to improve the conditions for private sector R&D in the EU.[333] The new Strategy maintains the focus on the great challenges Europe is facing in the fields of climate change, energy and resource efficiency, health and demographic change.

PCP is expressly up-taken in the new Strategy as innovation policy instrument. The Commission announces the initiative to support Member States to set aside dedicated budgets for PCPs. The use of PCP is considered to contribute to the creation of procurement markets for innovation of at least €10 billion a year across the EU.[334] The Strategy makes clear that PCPs are suitable when used for innovations which at the same time improve the efficiency and quality of public services, while addressing the major societal challenges. According to the 2020 Innovation Union Flagship Initiative, suitable areas where PCP can play a role are the six Lead market Initiative areas (e-Health, sustainable construction, protective textiles, bio-based products, recycling and renewable energies) or the areas identified for European Innovation Partnerships (energy security, transport, climate change and resource efficiency, health and ageing, environmentally-friendly production methods and land management).

It is interesting to notice that the Innovation Union Flagship specifically refers to direct PCPs (and not to catalytic PCPs). It is unclear whether this means that the European Commission

[329] UNU-MERIT, 'Innovation Union Scoreboard 2010 The Innovation Union's performance scoreboard for Research and Innovation' 20 (2011), <http://ec.europa.eu/research/innovation-union/pdf/iu-scoreboard-2010_en.pdf> accessed 26 March 2013.
[330] Ibid.
[331] Commission, 'Europe 2020 Flagship Initiative: Innovation Union' COM(2010) 546 final.
[332] Commission, 'Europe 2020, A strategy for smart, sustainable and inclusive growth' COM(2010) 2020 final.
[333] COM(2010) 2020 final 14.
[334] COM(2010) 546 final commitment no. 17.

considers PCP exclusively suitable when used for intrinsic/operational needs of contracting authorities.[335] The European Commission announces its intention to provide guidance and support mechanisms to contracting authorities and to stimulate joint procurements.[336]

The Innovation Union Flagship of 2010 also introduces the new concept of European Innovation Partnerships (not to be understood as synonimous with the 'Innovation Partnership' procedure introduced through the new draft Procurement Directives). European Innovation Partnerships are a complex combination of supply- and demand-side instruments which should mobilise key actors at both national and EU levels to develop and bring on the market innovations with potential social benefits. From the scant and vague description of the European Innovation Partnership, it could be concluded that its aim is to coordinate and integrate the existing instruments and existing initiatives beyond the existing Joint Technology Instruments (JTIs). The Partnerships would therefore act across the whole research and innovation chain (from R&D efforts to demonstration and pilots, all the way to the market). PCP is one of the available instruments to be used within the Partnerships. The Commission intends to launch innovation partnerships in key areas which represent major societal challenges: energy security, transport, climate change and resource efficiency, health and ageing, environmentally-friendly production methods and land management.[337]

Besides the "Innovation Union Flagship Initiative",[338] other flagships announce Commission's actions related to PCP, flagships such as "Industrial Policy",[339] and "Digital agenda"[340] as well as the communication "Regional Policy contributing to smart growth".[341] The PCP-related actions are: co-finance between 2011-2013 five PCP projects involving contracting authorities from different Member States, employ PCP to create a vibrant Single Market for innovative goods and services, encourage Member States (through guidance and improved legal framework for cross-border collaboration in procurements) to include pre-commercial type of procurement into their procurement budgets.

As already mentioned in the previous section, the European Council of February 2011[342] endorsed the innovation strategy proposed by the Commission and invited the Commission to explore the feasibility of a Small Business Innovation Research Scheme. A recent study on

[335] The question arises whether the 'public services' concept should be broadly interpreted to cover public policy objectives whose achievement does not involve any changes in the purchasing behaviour of the contracting authorities, but does require such changes in the behaviour of private end-customers/users.
[336] COM(2010) 546 final 17.
[337] COM(2010) 546 final 25.
[338] COM(2010) 546 final.
[339] Commission, 'An Integrated Industrial Policy for the Globalisation Era' COM(2010) 614 final.
[340] Commission, 'A Digital Agenda for Europe' COM(2010) 245 final.
[341] COM(2010) 245 final key action 9 states that the Commission will try to leverage more private investment through the strategic use of pre-commercial procurement.
[342] Presidency conclusions February 2011.

the feasibility of a Small Business Innovation Research Scheme has been finalised in 2012.[343] Based on interviews with contracting authorities and policy-makers accross Europe, the study argues that EU suport is key in coordination of cross-border procurement projects, in learning activities and in drafting procurement specifications, while defining the needs and assessing the bids should be left to the Member States. The topic of the procurement initiatives could both fall within the broad common-EU policy objectives, as well as be driven by the concrete needs of the contracting authorities.

The new Public Procurement Directives represent the most recent initiative of the Commission to modernize the public procurement rules.[344] The most important changes supposed to encourage the innovation supportive practices regard the simplification of the grounds for application of the competitive dialogue procedure and the competitive procedure with negotiation and the legal guidance on the applicable rules in case of cross-border procurements. The new proposed directives introduce also the procedure of Innovation Partnerships, which is meant to stimulate contracting authorities to engage in procurements of R&D. For a critical analysis of the legislative choices regarding this instrument and its relation to PCP, see Chapter 5.

Since 2011, the Commission has also made funding available for consortia of contracting authorities from different Member States which decide to conduct PCPs for the development of innovative solutions on topics of common European interest. The funding is available for up to 100% of the preparation, management and coordination costs of joint PCPs, plus 50% of the development cost of the new solutions within the PCP.[345] The targeted areas are health, ageing well, photonics. But funding has also been made available for PCP proposals addressing any area of public interest.[346] The Commission's support for PCP is further discussed in Chapter 4.

In conclusion, the Commission engaged since 2005 to stimulate public authorities to act as demanding customers of highly innovative solutions. In the Commission's view, demanding public authorities could steer private innovative efforts towards desirable innovations and could incentivize increased private R&D investments. To this end, the European Commission drafted the PCP Communication. Initially, it hoped that the case for PCP was so compelling that contracting authorities throughout the EU would recognize its importance and would

[343] John Rigby, Patries Boekholt, Abby Semple, Jasper Deuten, Ramona Apostol, Stephan Corvers, Jakob Edler, 'Feasibility study on future EU support to public procurement of innovative solutions: Obtaining Evidence for a Full Scheme' (2012) <http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/files/meeting-procurement-feb2012/study-eu-support-public-procurement-innovative-solutions_en.pdf> accessed 2 February 2013.
[344] Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC.
[345] See http://cordis.europa.eu/fp7/ict/pcp/calls_en.html
[346] See http://ec.europa.eu/research/participants/portal/page/cooperation;efp7_SESSION_ID=ljVtPHbpQQd9SsJ9YvDT86W8lCZy4LnVT7pppv1NkCDcT6nVRMBm!733177337?callIdentifier=FP7-ICT-2011-8

widely implement it. When this proved not to be the case, the European Commission first funded the set-up of networks and subsequently funded the organization of collaborative cross-border PCPs. Furthermore, PCP features strongly in the new innovation strategy for 2020. The Commission even investigates the possibilities to extend its competences for deploying PCP, beyond providing guidance and funding.

2.2.4 European Parliament's support

The European Parliament has also engaged in the debate around PCP. In a resolution of 2007, it identified pre-commercial procurement as an '*untapped opportunity in Europe to use public needs as a driver for innovation*' and encouraged Member States to use PCP to develop innovative solutions for specific problems of public interest.[347]

In a later report of 2009, the Parliament endorsed the adopted PCP Communication and the Commission's efforts to fund exchanges of good practices and training on pre-commercial procurement, but expressed concerns that pre-commercial procurement remained little understood by SMEs and largely underutilized by public authorities particularly at the regional and local levels.[348] It called on the European Commission to take further steps to encourage public authorities to deploy this instrument through financial incentives, improved guidance and the set-up of a European pilot project.[349] The report also underscored the role of the Commission and of the Member States in identifying and prioritizing medium and long-term public challenges that could be tackled through PCP.[350] It also stressed the importance of the EU Technology Platforms and of continuous knowledge transfer between technologically innovative universities, institutes and contracting authorities for the successful deployment of PCPs.[351]

In 2010, the European Parliament's Committee on Industry, Research and Energy on Innovation Union[352] reiterated its support for PCP and urged Member States to strategically use public procurement in order to develop innovative, sustainable and eco-efficient solutions to important public challenges. It reiterated its call to the Commission to review the opportunities for pre-commercial procurement within the current legislative proposals, to financially incentivize regional and local public authorities to engage in PCPs and to draft

[347] European Parliament, 'Resolution of 20 June 2007 on specific problems in the transposition and implementation of public procurement legislation and its relation to the Lisbon Agenda' 2006/2084(INI).
[348] European Parliament, 'Report on pre-commercial procurement: driving innovation to ensure sustainable high- quality public services in Europe' 2008/2139(INI) (European Parliament Report (2008)) paras 6, 29.
[349] European Parliament Report (2008) paras 33-6.
[350] European Parliament Report (2008) para21.
[351] European Parliament Report (2008) 7.
[352] European Parliament, 'Report on Innovation Union - Transforming Europe for a Post-Crisis World' 2010/2245(INI) (European Parliament Report (2010)).

best-practice guidelines and training programmes to developed the skills needed to deploy PCPs.[353]

In another more recent resolution, the European Parliament expressed again its support for PCP and listed the important objectives PCP may potentially achieve: creating new markets for innovative and green technologies, improving the quality and effectiveness of public services and creating competitive advantages for small European businesses.[354]

In conclusion, the Parliament has joined the group of EU institutions that support PCP. The Parliament simply reiterates support for the already undertaken initiatives. However, its political support offers the Commission the additional justification to stimulate the use of PCP.

2.2.5 Summing-up policy support for PCP

The EU is trying to catalyze a technological revolution in order to cope with the numerous and enormous challenges of the not so far-away future. Increased R&D investments were identified as a necessary pre-condition. At the same time, the EU noticed that despite similar amounts of public R&D investments, it is less successful than the US in incentivizing private actors to scale up their own R&D investments. The EU policy-makers sought the explanation for these different levels of private R&D investment into the US SBIR-type of measures. As a consequence, they decided to explore whether pre-commercial public procurement could be beneficial to the EU economy. Pre-commercial procurement has not found its way into legislation, but has been anchored in public policy. All main EU institutions (European Council, European Commission and the European parliament) have expressed their support for PCP. PCP is viewed by the EU policy-makers as a suitable instrument (i) to increase both public and private investments in R&D, (ii) to steer private R&D efforts towards innovative solutions for important and complex public problems and (iii) to indirectly enhance the innovative capabilities of (small) European businesses.

The initial focus on the implementation of PCP procedures in the ICT sector was justified by the beneficial effects the ICT sector has on economic growth and social welfare and by the innovative and dynamic character of this sector, which makes it responsive to innovation policy measures. Moreover, Europe holds competitive advantages in global ICT markets and increased private and public R&D investments have the potential to boost these advantages.

Subsequently, the Commission broadened the scope of PCP into all areas wherein the government plays an important role in funding R&D, such as transport and defence, as well as in the field of environmental technologies. Most recently, the focus has broadened

[353] European Parliament Report (2010) para 140.
[354] European Parliament, 'Resolution of 9 March 2011 on an industrial policy for the globalised era' 2010/2095(INI).

towards solutions to the major societal challenges: climate change, energy and resource efficiency, health and demographic change.

In the most recent innovation policy for 2020, the EU proposes to adopt a comprehensive approach to innovation policy.[355] PCP and commercial procurement are two important instruments within the innovation policy toolbox. According to the 2020 Innovation Union Flagship Initiative, suitable areas where PCP can play a role are: e-Health, sustainable construction, protective textiles, bio-based products, recycling and renewable energies, energy security, transport, climate change and resource efficiency, health and ageing, environmentally-friendly production methods and land management.

The main EU institutions have expressed their expectations that the application of the PCP can contribute to the achievement of the EU innovation goals in the above mentioned sectors. The expectations from the performance of PCP are thus high.

These policy expectations are based on research papers commissioned by the EU with a handful of experts. It is difficult to conclude whether these studies are objective or rather serve the purpose of confirming the political decisions which they underpin. In addition, the question arises whether the policy deployment follows the recommendations of these studies regarding the pre-conditions for efficient implementation of PCP.

In the next section, I will outline the evolution of the economic approach that underlines the current EU innovation policy and I will compare the PCP approach against relevant economic studies beyond those commissioned by the EU.

2.3 The economic foundations of PCP

2.3.1 Introduction

In the previous section I have outlined the policy process which led to the broad support for the implementation of PCP in the EU. The policy documents promoting PCP do not pay attention to the economic preconditions for the efficient implementation of PCP. They leave it to contracting authorities to make important value-judgments regarding such efficient implementation. However, policy documents explain the rationale behind the support for PCP.

According to the PCP Communication and to the preceding PCP Expert Group, innovation can bring tangible benefits to the society and to the economy and increased R&D

[355] COM(2010) 546.

investments represent the path towards innovation.[356] However, Europe copes with a situation of underinvestment in R&D and with underperformance in converting new inventions into new products and jobs.[357] The privatization process driven by the creation of the European Internal market has created a funding gap, particularly for risky R&D projects. This gap has not been filled by the European private financial market.[358] This negatively influences the economic performance of Europe and the perspective of finding solutions to important collective problems such as climate change, qualitative and affordable health care in the face of an ageing population, security threats etc.[359]

PCP is considered to be a policy instrument that can address the above mentioned shortcomings. When used strategically, public procurement of R&D would drive forward innovations that address public/collective needs and would concomitantly improve the competitive position of EU businesses in the global market.[360]

Based on the above, I can conclude that several economic assumptions underlie the policy choices for PCP. The most important are:

1. Innovation leads to (social) welfare;
2. R&D investment is a necessary pre-condition of innovation;
3. Venture capitalists underinvest in risky R&D projects;
4. Public needs can influence firms' strategies for creativity and innovation;
5. PCPs is a suitable instrument to develop technological, as well as services innovations.

In this section I will compare these economic assumptions against the most authoritative economic theories and studies. I will analyse a broad array of economic theories and studies, encompassing but going beyond those embraced by the European Commission. Based on this analysis, I will identify criteria for the effective application of the PCP procedure and delineate those situations when PCP is not a suitable instrument.

Before doing that, I will reflect on the problematic nature of the economic methodologies used to measure the impacts of public intervention on innovation or to predict the influence of certain conditions/factors on innovation (sub-section 2.3.2 below).

[356] PCP Communication 3.
[357] PCP Communication 4.
[358] PCP Expert Group 5, 24.
[359] PCP Communication 5.
[360] PCP Communication 3.

I will subsequently test in 2.3.3, the first two assumptions against relevant economic theories. To this end, I will outline the evolution of the economic thought regarding the role of innovation in the economy and the role of (private and public) R&D investment among the various determinants of innovation. I will also elaborate the economic rationale advanced by different economic theories, for public intervention in the innovation area.

In section 2.3.4, I will analyse the economic theories regarding the role of venture capital markets in support of innovation and I will reflect on the role of the government as risk-taking venture capitalist.

In section 2.3.5, I will compare the fourth assumption that public needs can influence firms' strategies for creativity and innovation against the economic theories on the role of demand in the innovation process. I will conclude on the pre-conditions for effectively employing public demand in support of innovation. In this section, I will also highlight the divergent approach as compared to the supply-side EU policy in the area of R&D subsidies.

In section 2.3.6, I will outline the restrictive EU intervention in supporting R&D directed towards services innovations and I will provide an overview of the limited economic theories on the dynamics of the innovation process in services. This will shed light on the relevance of PCP for services innovation.

Finally, I will conclude in section 2.4 on the pre-requisites for a successful implementation of PCP.

As this is primarily a legal research, I will not provide a critical analysis of the concerned economic literature, but purely an overview of some of the most important economic theories and empirical studies. The analysis is largely limited to economic literature on innovative technologies and covers only to a limited extent economic theories on innovation in services.

2.3.2 Innovation policy as decision-making under uncertainty

The challenge to provide the policy-makers with a sound analytical framework to predict whether an envisaged policy does more good than harm has not (yet) been met by economics.[361] Economics are limited in predicting or even determining in hindsight with scientific exactness whether a certain public policy has triggered technological evolution,[362] for the reasons presented below.

[361] Geoffrey A. Manne and Joshua D. Wright, '*Regulating Innovation: Competition Policy and Patent Law under Uncertainty*' (CUP 2009) 10-11.
[362] Eric D. Beinhocker '*The Origin of Wealth, Evolution, Complexity and the Radical Remaking of Economics*' (Harvard Business School Press 2006); Nassim Nicholas Taleb, '*The Black Swan The Impact of the Highly Improbable*' (2nd ed Random House Trade 2010).

The ideal measurement method is to identify the likely evolution of a certain industry in the absence of the public innovation policy and to determine whether the industry would have innovated as rapidly and in the same way.[363] For obvious practical reasons, this is an impossible approach to apply.

A method considered manageable by economists, is to compare the evolution and innovative efforts of an industry following the public intervention against the *expectations* of how the respective public policy would impact/(create incentives for) innovation.[364] To this end, economists use a series of indicators to measure/determine the effects (or outputs) of certain policies on innovation, such as changes in the innovation strategies, number of patents, number of patent citations, sales, firm growth, R&D expenditure etc. There are numerous problems in using such indicators and I will enumerate some of the most important of these below.[365]

Firstly, it is difficult to find pure indicators, which establish exclusively the effects on innovation of the public policy under study, and do not (partly) capture the effect of other types of public interventions.

Secondly, factors such as R&D spending regard an input to the innovation process, not an output of innovation while the knowledge spill-overs are impossible to measure. When economists seek to measure the benefits of public R&D spending on the increase in productivity of the private beneficiary, these appear to be lower than the equivalent benefits of private R&D spending and sometimes economists do not find any measurable effect at all. Scotchmer finds the cause of this, in the lack of suitable markers to measure the social value of the outputs of public R&D funding.[366]

Thirdly, patents are problematic, for being only weakly related to actual innovation performance. Not all innovations are patented and not all patents regard qualitative innovations (or R&D), or the (social) value of an invention may be greater than the value of a patent indicates.[367]

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[363] Jonathan B. Baker, 'Beyond Schumpeter vs. Arrow: How Antitrust Fosters Innovation' (2007) Washington College of Law < http://ssrn.com/abstract=962261> accessed 12 December 2012.
[364] Baker (2007).
[365] A comprehensive outline of the limitations of economic measurements is offered by C. Freeman and L. Soete in 'Developing science, technology and innovation indicators: what we can learn from the past' (2007), UNU-MERIT Working Paper Series 2007-001 <http://arno.unimaas.nl/show.cgi?fid=6680> accessed 26 March 2013.
[366] Suzanne Scotchmer, '*Innovation and Incentives'* (Massachusetts Institute of Technology 2004) 282.
[367] Richard J.Gilbert, 'Competition and Innovation' (2007)17 http://escholarship.org/uc/item/9xh5p5p9> accessed 26 March 2013; Gianmarco I.P. Ottaviano, Dino Pinelli and Carole Juliette Maignan, ' Economic Growth , Innovation, Cultural Diversity What are we all talking about? A critical survey of the state-of-the-art' (2003)FEEM Working Paper No.12.2003, 18-9 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=389042> accessed 26 March 2013.

Fourthly, the problem with using the national gross domestic product (GDP) as indicator is that the positive effects of innovative products may show long after their introduction.[368] Moreover, GDP as an indicator does not sufficiently reflect the value of investment in R&D, as innovation may in many cases lower the price or may not create value for the private actor at all (particularly when the innovation is made publicly available).[369]

Regarding the capability to predict the best policy choices, Lipsey remarks that '*there does not exist a unique set of formally determined, optimum public policies with respect to technological change*'.[370] By looking at the technological evolution throughout the history of mankind, Lipsey concludes that the economic development of the Western part of the world should in large proportion be attributed to historical accidents and not to intentional public intervention. In the Western world, pluralism and separation of powers (science from religion) were major factors in stimulating the advancement of the society, together with the re-discovery of the Greek science, at a moment when it could escape the censorship of religion. He underlines in this context the important role of independent knowledge institutions which provided an '*effective memory*', essential for '*cumulative scientific advances*'.

As a consequence, when attempting to trigger technological change through public policy, Lipsey proposes to use a '*mixture of theory, measurement and subjective judgment*'.[371] Due to the limitation of science to predict whether and which type of intervention is the most effective, other economists consider that the use of political decision and participatory decision-making (which involves large parts of the population and those most affected by the consequences of a certain policy) offer as good of an option as any.[372]

Taleb[373] finds that the current economic models used to predict economic outcomes are inherently flawed for being based on limited samples of past information, insufficient to capture rare events (such as the 2008 financial crisis) that can trigger extreme/catastrophic impacts. The economic models tend to qualify such rare events (so-called Black Swans) as improbable, although they can be envisaged. Taleb warns for the danger in relying decision-making on such economic models and draws the attention to the potential extreme impact that large variations in random economic variables may have in the context of the global society characterized by increased interdependencies and nonlinearity.

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[368] Susanto Basu, John G. Fernald, Nicholas Oulton & Sylaja Srinivasan, 'The Case of the Missing Productivity Growth: Or, Does Information Technology Explain Why Productivity Accelerated in the US but Not the UK?' (2003) NBER Working Paper No. 10010 <http://www.nber.org/chapters/c11441.pdf> accessed 26 March 2013.
[369] Scotchmer (2004) 269.
[370] Richard G. Lipsey, 'Technological Transformation, Intellectual Property Rights and Second Best Theory' 4 *Review of Economic Research on Copyright Issues* (2007) 5-28.
[371] Lipsey (2007) 25.
[372] C. Freeman, '*The Economics of Industrial Innovation*' (Frances Pinter Publishers Limited 1982) 216-20. Rod Coombs, Paolo Saviotti and Vivien Walsh, *'Economics and Technological Change'* (Rowman& Littlefield 1987) 30.
[373] Taleb (2010).

Taleb develops the *'theory of the fourth quadrant'*, an area characterized by high uncertainty and extreme variations in certain atypical variables (which are rare and have an exponential impact on the end outcome), as well as by potential complex payoffs (whether positive or negative). Instead of trying to predict the probability of occurrence of Black Swans, Taleb advices to rather focus on precautionary measures in the eventuality of such events. He particularly advices to avoid decision-making driven by short-term profit, and he supports the idea to build-in necessary redundancy (as opposed to optimization/efficiency).

Taleb's argument is not new. Already in 1945, Frederick von Hayek, the Austrian policy philosopher reflected on decision-making under uncertainty.[374] He argued that no policy-maker can possibly possess the necessary knowledge on the political, social, technological and economic variables which can potentially influence the working of their policies in the real world, particularly on a long-term. However, this does not absolve the policy-maker (legislator) from evaluating the costs of the policy or its long-term value. Hayek criticised mathematical economics, which over-simplified things by often not taking into consideration the equally important *'knowledge of people, of local conditions, and of special circumstances'*. In his view, economics often disregard change in some variables and overly rely on *'statistical aggregates, which show a very much greater stability than the movement of the detail'*. Hayek used his observations as an argument against the central planning of an economy and as a praise of the price mechanism as one available conveyor of necessary relevant knowledge, which although not completely understandable or controllable, performs better than any known alternatives.

However, his reflections underline the limited predictive capabilities of economic models and the limited capacity of a human to process enormous amounts of information in decision-making (even if all the necessary information would be available). He concluded that economic theories can only provide *'very general statements or "pattern predictions"'*, but no predictions of individual events.[375] While economists/statisticians can observe certain regularities in investments, price levels etc, such regularities do not always apply, while economics cannot name the preconditions for such regularities. Theorems of macrotheory are certainly valuable in order to generate predictions in the presence of insufficient information. But they are not more than assumptions which may be proven wrong.[376]

Complexity economist Beinhocker eloquently summarizes it:

'The economy is too complex, too nonlinear, too dynamic, and too sensitive to the twists and turns of chance to be amenable to prediction over anything but the very shortest of terms.

[374] Frederick von Hayek, 'The Use of Knowledge in Society' 4 (1945) *American Economic Review* 35, 519-530.
[375] F.A. Hayek, 'Competition as a Discovery procedure', (translation) 5 (2002) *The Quarterly Journal of Austrian Economics* 11-12.
[376] Hayek (2002) 11-2.

Even if we were as rational as possible and had all the information we could want, the computational complexity of the economy is such that the future would happen before we would have time to predict it'.[377]

Behavioural economists confirm that individuals perform poorly at computing large amounts of information, while they are good at interpreting ambiguous information and at learning.[378] These theories are backed by psychologists who demonstrate that rational models for decision-making (such as logics or statistics) are in situations of uncertainty (when not all the determinants of a certain outcome can be known or calculated) less reliable than simple heuristics.[379] They confirm the view that the application of rational models to situations characterised by imperfect information may lead to disaster, as even small deviations from the model conditions may have an impact.[380] Although the theory is not as developed as to identify the generic conditions under which heuristics always work better than rational models, Gigerenzer suggests that beyond a certain point, more information may be harmful to making a correct decision. Beyond this point, experience plays a crucial role in selecting the proper heuristics from the adaptive toolbox of an individual (such as recognition heuristic, fluency heuristic, hiatus heuristics etc.).[381]

Complexity economists suggest another solution to policy-making in the context of insufficient information and uncertainty. They argue that public policy should focus on supporting institutions and societies to adapt quicker to changing complex situations (through infrastructure, network etc.), while leaving the selection of the successful innovations to the market forces.[382] Moreover, public policy should focus on setting ambitious goals and defining a portofolio of alternative trajectories/policies to work towards those goals. This entails though that the government should be prepared to *'experiment, collect feedback and change course, none of which is ever politically easy'*.[383] Scotchmer adds that, because results of R&D projects are inherently uncertain, assessments of the success and efficiency of public investments schemes in R&D should not be focused on the failed projects or comparison to better ideas developed after the investment decision. According to her, it is important to use mechanisms that can lead to good decision-making and to adopt a failure-tolerant approach.[384]

[377] Beinhocker (2006) 323.
[378] Amos Tversky and Daniel Kahneman, 'Judgement Under Uncertainty: Heuristics and Biases' 185 (1974) Science 4157.
[379] Gerd Gigerenzer and Wolfgang Gaissmaier, 'Heuristic Decision Making' 62 (2011) Annu. Rev. Psychol. 451. Heuristics can be defined as 'a strategy that ignores part of the information, with the goal of making decisions more quickly, frugally, and/or accurately than more complex methods'.
[380] Gigerenzer (2011) 451–2. Paul Davidson, *'The Keynes Solution'* (Palgrave Macmillan 2009) 35-43.
[381] Gigerenzer (2011) 450.
[382] Beinhocker (2006) 426.
[383] Beinhocker (2006) 324, 334.
[384] Scotchmer (2004) 56-7.

Solutions for decision-making in case of uncertainty are also provided by the precautionary principle, which has made its way into many international agreements, particularly in the field of environmental protection.[385] The precautionary principle advices the adoption of precautionary measures in case of uncertainty or risks with irreversible or catastrophic consequences. Uncertainty in the context of the precautionary principle entails that the outcome can be envisaged with a certain degree of plausibility, but it cannot be attributed any probabilities. In the case of risks, the outcomes can be identified and probabilities can be assigned.[386] The precautionary principle in its stronger forms, entails a low threshold for the plausibility of an uncertain outcome.[387]

The adopted precautionary action should be sufficient to protect flexibility of decision-making in the future, when more knowledge on the harm becomes available and should reflect the magnitude of the *irreversible* or *catastrophic* harm if precautionary action is not taken. However, action should be based on a cost-benefit analysis of the various options (including inaction).[388]

Economists also agree that it is not possible to take precautions against all uncertain outcomes or risks, as these are present in almost any human activity and precautionary measures may themselves create new uncertainty or new risks.[389] Whenever precautionary measures may create new uncertainty with catastrophic or irreversible outcomes, the precautionary measures should not be taken in the first place (such as a preventive war on terrorism that may increase terrorism).[390]

Actions adopted within the framework of innovation policy can often be regarded as precautionary measures intended to address uncertain outcomes or risks with catastrophic and/or irreversible consequences (such as climate change, loss of resources etc.). However, innovation policy may create itself new uncertainty or risks. For example, public intervention in the form of funding of R&D from the demand side (such as envisaged by PCP) may, on the one side, solve the problem of insufficient funding of innovative firms, but may on the other side, deter rather than encourage competitive investments in R&D (when public funding of R&D strengthens the market position of a certain undertaking and reduces the profit perspectives for other undertakings and implicitly their incentives to invest in R&D). Public R&D funding may also encourage inefficient companies and distort competition (by enhancing

[385] See for example, the 1992 Rio Declaration or the United Nations Framework Convention on Climate Change. One common definition sounds as follows: *'Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'*.
[386] Cass R. Sunstein, 'Irreversible and Catastrophic' (2005) John M. Olin Law & Economics Working Paper No. 242, 37 <http://www.law.uchicago.edu/files/files/242.crs_.catastrophic.pdf> accessed 26 March 2013.
[387] Sunstein (2005) 9.
[388] Sunstein (2005) 55.
[389] Sunstein (2005) 12.
[390] Sunstein (2005) 55.

the market power of some companies which will discourage their competitors to invest in R&D themselves) and may divert needed funds from real needs (when their impact on stimulating private actors to become more entrepreneurial and invest more in R&D is low or non-existent). These outcomes are uncertain, but their consequences can hardly be qualified as catastrophic or irreversible. Therefore, there is no ground to argue that innovation policy should not be undertaken, particularly because the striven objective justifies action.

In conclusion, innovation policy-making is a form of decision-making under uncertainty. It cannot rely on economic mathematical models for answers, due to the fact that these do not and cannot compute all relevant information. Economists propose to employ experience and learning besides available information and to retain needed redundancy as well as avoid distortions to judgments by short-term pay-offs.

2.3.3 Economic approach to public innovation policy

The fact that economic models are not capable to determine with scientific exactness what triggers innovation poses difficulties to policy-makers. In this section, I will analyse what relevant lessons can be drawn by the policy-maker from the current economic knowledge on the role of public R&D funding.

This section will also test the first two economic assumptions mentioned in section 2.3.1:

- innovation leads to (social) welfare;
- R&D investment is a necessary pre-condition of innovation;

To this end, I will describe how the economic thought on the role and on the determinants of innovation evolved with a particular focus on R&D investments. I will also highlight the economic thinking on the role of government R&D investments in support of innovation. In the second part, I will describe the economic rationale advanced by different economic theories, to justify public intervention in the innovation area.

2.3.3.1 Evolution of economic thought

Already in 1776 economist Adam Smith[391] observed that innovation contributes to wealth creation (or economic growth). He saw innovation as exogenous, an external random phenomenon that is not determined by economic factors and cannot be predicted more accurately than weather. It was in 1934 that a more in-depth economic theory was developed by Schumpeter regarding the role of innovation in the economic system, based

[391] Adam Smith, *'An Inquiry into the Nature and Causes of the Wealth of Nations'* (5th edition Methuen & Co., Ltd 1904) para I.1.9, <http://www.econlib.org/library/Smith/smWN.html> accessed 27 August 2012.

on a historical analysis of large, sweeping changes that fundamentally restructure industries and markets.

He concluded that innovation had a dual role: creating new wealth-generating structures and destroying the old ones.[392] He saw economy as an equilibrium system. He considered that introduction of an innovation in a static economy creates a disequilibrium. This starts as a period of prosperity but changes gradually into a recession, as the economy adapts to the changed situation, the innovation weakens and the forces of competition and self-interest trigger increased production. This second wave of changes turns into a period of depression when inefficiencies and false expectations transform into unfavourable expectations. Depression is however accompanied by two favourable effects: the wide spread of the benefits of the innovation and the elimination of inefficient enterprises. Among the negative effects is that wages and prices, production and consumption fall far beyond the equilibrium values. A period of recovery follows under the effects of the forces of equilibrium (these are forces in the market which absorb the destructive effects triggered by innovation and adapt to them), which eventually leads to a new equilibrium.[393] Later, he admitted that other causes besides innovation may trigger the cyclicality of the economy.[394]

Schumpeter saw innovation as endogenous to the economic system and considered the entrepreneur to be its main driver. Moreover, he saw innovation as evolutionary. In Schumpeter's view, the evolutionary character is related to the selection of the viable innovations through competition and the cumulative character of knowledge which leads to innovation (innovations being often the result of efforts of many inventors and developers).

As classical economist, Schumpeter believed that *'technical progress is a simple time trend'* that cannot be influenced by intentional action such as government intervention.[395] He believed that non-intervention was more advantageous on a long term for the level and speed of performance.[396] Schumpeter also did not believe there was a linear process between invention and innovation. He thought that *'innovation is possible without anything we could identify as invention and invention does not necessarily induce innovation'*.[397]

In an article of 1957, the Nobel Prize winner economist Robert Solow added the mathematical dimension to Schumpeter's theory on innovation and renewed interest in the

[392] Joseph Schumpeter, *'Capitalism, Socialism and Democracy'* (4th edition, Unwin University Books 1954) 83.
[393] Joseph Schumpeter, *'Business Cycles: a Theoretical, Historical and Statistical Analysis of the Capitalist Process'* (McGraw-Hill 1939).
[394] Schumpeter (1939); Robert Loring Allen, *'Opening doors: the life and work of Joseph Schumpeter'* (vol 1, Transaction Publishers 1991) 71-87.
[395] Chris Freeman and Luc Soete, *'The Economics of Industrial Innovation'* (3rd ed, MIT Press 2000) 325.
[396] Reference found in Erik Gortz, 'Public and private expenditure and the Faroese business cycle' 236, in Gunnar Eliasson, Nils Karlson (eds) *'The limits of government, Policy Competence and Economic growth'* (Transaction Publishers 2001).
[397] J. Schumpeter (1939) 84.

economic study of innovation.[398] He considered that growth was a function of physical capital and human labour and he believed that shifts in the function were caused by technological change.[399] He argued thus that technological progress is the key driver of growth. However, he considered technical progress to be an exogenous variable (as a time trend similar to population growth) to which the economy continuously adjusts and is driven in a state of dynamic equilibrium. His theory became known as the exogenous growth theory.

Schumpeter and Solow concluded on the important role innovation plays in the economy, but were not preoccupied with the origins of innovation. W. Ruper Maclaurin was the first economist who studied how innovation processes take place. He developed in the 1940s the linear model of innovation at Massachusetts Institute of Technology.[400] According to his model, the innovation process can be divided into the following subsequent phases: basic science, invention, innovation, finance, acceptance/diffusion.[401]

The linear model of innovation was generally accepted at the time and was mainly based on the belief that massive public investments in R&D during and after the Second World War had led to breakthrough innovations.[402] Moreover, the belief that basic science (or basic research) was the source of inventions and discoveries was driven by the observation that throughout history, innovation efforts had increasingly concentrated in specialized public or private research and development laboratories. These specialized R&D efforts were made necessary by the increased complexity of technology and by its increased amount of scientific content.[403]

In the 1960s, Friedmann´s and Arrow's neo-classical theories[404] gained tremendous prestige and the costs and benefits of public R&D investments were increasingly being scrutinized.[405] Neo-classical theories argued that the market mechanism, although often wasteful and inefficient in the choice of the winning innovation, had been a viable mode of bringing

[398] Beinhocker (2006) 40-1. Robert Solow, *'A Contribution to the Theory of Economic Growth'*, (1956) 70 *Q.J. ECON*. 65; Robert Solow, 'Technical Change and the Aggregate Production Function', (1957) *The Review of Economics and Statistics*, 39, 312-20, 320.
[399] Output (Y) is a function of the quantity of physical capital (K) and human labour (L): Y= F (K,L).
[400] Benoit Godin, '"Innovation Studies": The Invention of a Specialty (Part II)' Project on the Intellectual History of Innovation Working Paper No.8 (2010) 6.
[401] Maclaurin, W. R. (1953), The Sequence from Invention to Innovation and its Relation to Economic Growth, *Quarterly Journal of Economics*, 67 (1): 97-111.
[402] According to Freeman, the massive public investments in R&D during and after the WWII brought breakthrough innovations.
[403] Scientific content can be defined as the body of learning which is a necessary precondition of future innovations. This is a departure from initial innovative processes which were exclusively associated with the persons involved in the production. Freeman & Soete 2000 (n113); C. Freeman and L. Soete, 'Developing Science, technology and innovation indicators: what can we learn from the past' (2007) United Nations University Working Paper Series, n. 2007-001,10 <http://litbang.bantenprov.go.id/2012/wp-content/uploads/gravity_forms/26-88014c92d2ae36634af6fe9f3e6a4b4d/2012/10/Developing-science-Technology-and-Innovation-indicators-Freeman.pdf> accessed 26 March 2013.
[404] Milton Friedmann, *'Capitalism and Freedom'* (The University of Chicago Press 1962). Kenneth Arrow, 'Economic Welfare and the Allocation of Resources for Inventions' 619 in R.R. Nelson (ed.), '*The Rate and Direction of Inventive Activity'* (NJ: Princeton University Press 1962).
[405] Freeman (1982) 15.

remarkable technological advances[406] and that the government should intervene only in case of market failures through investment in basic research, education and infrastructure. Market failures occurred when the results of research (and particularly of basic/fundamental research) could only be appropriated to a limited extent. In such cases, neo-classical economists believed that a free market underinvests in invention (or creation of new knowledge).[407] Moreover, neo-classics argued that only scientists have the necessary information to make correct decisions in which research to invest and public funding should not restrict in any way their choice of the R&D project.[408]

During the same period, different US Federal agencies commissioned studies to measure the role of basic research as source of innovation and reached diverging conclusions.[409] These studies took into consideration other drivers of innovation besides investments in R&D. Demand of customers was advanced as an important driver. This was interpreted to mean that investment by the government in applied research may lead to more innovation than investments in basic research.[410]

The linear model of innovation was thus being increasingly questioned. This also happened under the influence of Schmookler's book 'Invention and Economic Growth', in which he argues that market demand (or extent of the market potential) is the most important driver of the inventive activity.[411] In the 1990s economists paid more attention to the role of users and market demand in driving innovation. These theories are discussed in section 2.3.4.

OECD also contributed to the debate. Studies on what factors contribute to a strong technological base of the more advanced economies, concluded that other factors besides scientific and technological capabilities were crucial: capital availability, management, competence, attitudes, entrepreneurship, marketing skills, labour relations, education and culture.[412]

As a consequence, public innovation policy moved from an initial exclusive focus on increasing national R&D capabilities towards a more integrated approach which recognizes

[406] R.R. Nelson, 'Capitalism as an engine of progress' (1990) 19 Research Policy 195.
[407] Arrow (1962) 615, 623-4. Under conditions of uncertainty which govern the results of innovation, the amount of public investment and its efficiency are difficult to determine. To mitigate these problems, he advocated the use of past performance in the selection of research performing firms as well as other contractual incentives, in the award of public R&D contracts which focus on costs, rather than end-results.
[408] M. Polanyi, 'The Republic of Science' (1962) 1 *Minerva* 54-72.
[409] Based on an analysis of major weapon technologies, the report commissioned by the US Department of Defense concluded that only 0,3% of the innovations derived from basic research. Another report of the US National Science Foundation concluded on the basis of 5 technological innovation that in 70% of the cases, basic research was the direct source of the innovation. Charles W. Sherwin and Raymond S. Isenson, 'Project Hindsight' 156 *Science* (1967). IIT Research Institute, 'Technology in Retrospect and Critical Events in Science (TRACES)', (Washington 1968) Quoted from Benoit Godin, 'Measurement and Statistics on Science and Technology: 1920 to the Present' (Routledge 2005).
[410] Benoit Godin and Joseph P. Lane, '"Pushes and Pulls": The Hi(story) of the Demand Pull Model of Innovation', Project on the Intellectual History of Innovation, Working Paper No.13 (2013) 8-9.
[411] J. Schmookler, *'Invention and Economic Growth'* (Harvard University Press 1966).
[412] OECD, 'Gaps in Technology: General Report' (Paris 1968); OECD, 'Gaps in Technology: Comparisons Between Countries in Education, R&D, Technological Innovation, International Economic Exchanges' (Paris 1970) 23

the influence of the whole economic environment on technical change, and supports the innovation process beyond the R&D stage.[413]

In the 1970s, innovation groups were set-up in the US and Europe to systematically study how innovation emerges. The most prominent representative of such groups in Europe is Chris Freeman who led the Science Policy Research Unit (SPRU) at University of Sussex for sixteen years. At SPRU, the economic theory of systems of innovation was developed.

Freeman argued that neither R&D, nor market demand is the main driving factor behind innovation activity. He believed that innovation was a 'coupling process' between supply (technological knowledge) and demand, that takes place in an evolving environment with imperfect information where uncertainty prevails and '*chance plays a much greater role in competitive survival and in growth than it is comfortable to admit*'.[414]

Later, the theory was refined and innovation was depicted as a non-linear process that is influenced by interdependent interactions between firms and other organizations. The emphasis was laid on the role of institutions (such as firms, public laboratories, universities, financial institutions, government bodies etc.) in a national innovation system. Systems of innovation were defined as '*the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies*'.[415] Innovation is thus not only influenced by the independent elements of the systems, but also by the relations between these elements.[416]

The innovation system economists also paid attention to the role of public policy. In their view, innovation policy should be more detailed and comprehensive than required by neo-classics. They argued that 'system failures' explain the suboptimal results in innovation and advocated a broader justification for government intervention than under the 'market failure' approach. Innovation policy should be about facilitating interactions and identifying technological opportunities.[417] They also underlined the narrow and vertical focus of public institutions involved in stimulating innovation and their fragmented approach.[418]

In terms of choices of areas for public support, Freeman proposes to prioritize public support based on the contribution of science and technology to social welfare.[419] A few years later (in 1982), Freeman argued that as a consequence of the increased knowledge on the drivers

[413] Freeman (1982) 193-8.
[414] Christopher Freeman, 'The Determinants of Innovation' *Futures* June (1979) 213.
[415] C. Freeman, 'The "national system of innovation" in historical perspective' 19 Cambridge Journal of Economics 1995.
[416] Charles Edquist, Leif Hommen, 'Systems of innovation: theory and policy for the demand side' *Technology In Society* 21 (1999) 66.
[417] Freeman (1982).
418 J. Edler, S. Kuhlmann, R. Smits,'New Governance for Innovation, The Need for Horizontal and Systemic Policy Co-ordination', Report on a Workshop held at the occasion of the 30th anniversary of the Fraunhofer Institute for Systems and Innovation Research (2002) 5.
[419] Freeman (1974) 307.

of innovation, public innovation policies shifted in focus from enhancing the competitive advantage of the national firms and achieving economic growth towards improving the quality of innovations and '*contribut[ing] to social welfare, conceived in a wider sense*'.[420]

Economic historian Godin identifies the industrialist Carty in 1924, followed by the policy-maker V. Bush in 1945 to be among the first ones who supported the idea that public funding of basic research (science) was supposed to bring social benefits. They believed that public funding of basic research was '*the seed of future great inventions which will increase the comfort and convenience and alleviate the sufferings of mankind*'.[421] In the 1960-70s, there was increasing attention to the social impact of technology.[422] However, social innovation as reaction/adjustment to the undesired effects of technical innovations, intended to meet social/public needs has become of more interest to researchers and particularly to policy-makers in the twenty-first century.[423]

In the 1980s, neo-classics have started to show interest in the black box of innovation. Paul Romer was the first neo-classical economist to model innovation as an endogenous factor to the economy and he put the basis of the endogenous growth theory.[424] He attributed the source of growth not to the entrepreneur, but to the nature of the technology. Technology has a cumulative, accelerating feature. The more knowledge is accumulated, the higher are the payoffs. This was coined as the 'increasing return' phenomenon. The endogenous growth theory also found support in the perceived success of massive public spending in R&D in the aircraft, nuclear, space and security sectors during and after the Second World War. Public R&D spending was considered the source of remarkable innovations,[425] as well as the source of broader economic growth.[426]

In 1986, Stanford mechanical engineering professor Kline and Stanford economy professor Rosenberg theorized the chain-linked model of innovation. The chain-linked model suggests that innovation is triggered by either research or the existence of a potential market and goes through the following stages: invent and/or produce analytic design, detailed design and test, redesign and produce and distribute and market. Important feedback loops are created between these stages.[427] When science does not provide the necessary knowledge,

[420] Freeman (1982) 198-201.
[421] Quoted from Benoit Godin, '*The Making of Science, Technology and Innovation Policy: Conceptual Frameworks as Narratives, 1945-2005*' (Montreal 2009) 18.
[422] Quoted from Benoit Godin, 'Social Innovation: Utopias of Innovation from c.1830 to the Present' Project on the Intellectual History of Innovation Working Paper No. 11 (2012); E.G. Mesthene, '*Foreword*', in R.S. Rosenbloom, R. S., and R. Marris (eds.), *'Social innovation in the City: New Enterprises for Community Development'* (Harvard University Press 1969); OECD, 'Science, Growth and Society' (OECD Publications Service 1972).
[423] Godin (2012) 36-7.
[424] P. M. Romer, 'Endogenous Technological Change' 98 *Journal of Political Economy* (1990).
[425] During the Second World War, government funded R&D successfully led to the development of weapons and of medical treatment for infectious diseases. Nelson (1990) 209.
[426] Davidson (2009) 13-8.
[427] Stephen J. Kline and Nathan Rosenberg, 'An Overview of Innovation', in Ralph Landau and Nathan Rosemberg (eds), *'The Positive Sum*

an innovator starts with a repetitive process of trial and error of several combinations of existing knowledge. This process follows the following steps: the first best estimate of a workable design, build it, test it, incorporate learning, redesign, retest, incorporate learning and so on. This process is costly and justifies continuous investment in basic research.[428]

The same view of innovation models is shared by complexity economist Brian Arthur. He explains that innovations occur sometimes when the scientific phenomena are not understood (for example, the bicycle was invented when the physical laws of equilibrium were not understood); other innovations emerge as applications of the scientific knowledge (for example the synthetic dyestuffs industry that emerged in Germany at the end of the 19th century as a direct result of knowledge advances in organic industry[429]). Moreover, in the context of increasingly complex technologies, science and technologies co-evolve. Arthur uses the concept of 'combinatorial evolution' to capture the idea that technologies are often made of numerous sub-technologies that emerge from existing knowledge, while new knowledge is also created during the development process. Certain major innovations require decades of sequential innovations (little fixes and advancements) before they can compete with incumbent competitors.[430]

By now economists have not succeeded to empirically prove that R&D investments are essential to growth.[431] However, economists broadly embraced the idea that R&D is one of the key determinants of economic growth.[432] OECD has also confirmed there is a correlation between amount of investment in R&D and the economic performance of nations.[433] It was also the OECD who admitted that attempting '*to attribute so much economic growth to technical advance, so much to capital formation, and so much to increased educational attainments of the work force, is like trying to distribute the credit for the flavour of a cake between the butter, the eggs and the sugar. All are essential and complementary ingredients.*'[434]

This has in recent history led to calls for 'knowledge economies' such as the EU (which rely on innovation to drive growth) to invest more than 2 percent of GDP annually in R&D, in order to

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Strategy – Harnessing Technology for Economic Growth' (National Academy Press 1986) 286.
[428] Kline & Rosenberg (1986) 296.
[429] For a detailed account of the emergence of these innovations, see Johann Peter Murmann, 'Knowledge and Competitive Advantage in the Synthetic Dye Industry:1850-1914 : The Coevolution of Firms, Technology and National Institutions in Great Britain, Germany, and the United States' 4 Enterprise Society (2000).
[430] Brian Arthur, *'The Nature of Technology - what it is and how it evolves'* (Free Press 2010) 157-9.
[431] Godin (2009) 91, 94.
[432] Hulya Ulku, 'R&D, Innovation, and Economic Growth: An Empirical Analysis' (2004), IMF Working Paper, No.185, 4-5 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=879010##> accessed 26 March 2013; Rachel Griffith, Stephen Redding, John van Reenen, 'Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Industries' (2000) The Institute for Fiscal Studies Working Paper 02/00 <http://eprints.ucl.ac.uk/4074/1/4074.pdf> accessed 26 March 2013.
[433] OECD, 'Technology and the Economy: the Key Relationships' (Paris 1992); OECD, 'Science and Technology Policy Outlook' (Paris 1992); OECD, 'Technology and Industrial Performance' (Paris 1996).
[434] Godin (2009) 96; OECD, 'The New Economy: Beyond the Hype' (OECD 2001) 4.

increase the stock of new knowledge and ensure a sufficient flow of innovations.[435] This is the rationale behind the call of the European Council in Barcelona to reach the 3% of GDP investment in R&D (out of which 2% should come from the private market).[436]

Economists conclude thus that innovation (technological advance) leads to economic growth and that R&D investments constitute an essential, but not sufficient condition to support innovation. Other economic factors (such as institutions and networks) are also indispensable. Due to the complexity of the economic factors that co-impact innovation processes, designing the right mixture of measures and implementing such a broad, overall encompassing public innovation policy remains a challenge.

In the 21st century, the increased recognition of the complexity of the economy and of the limitations of economics in measuring or predicting the effects of public intervention on the decisions of firms to innovate, has led to new approaches to innovation policy.

Complexity economists provide such an approach.[437] They argue that economy is a complex adaptive system with many dynamically interacting parts and networks, within which the micro-level interactions of the parts leads to macro-level patterns of behavior. The evolution 'algorithm' (differentiate, select, amplify) explains the growing order and complexity of the economic system and of the innovation process.[438] Unlike the neo-classics, complexity economists do not assume economy is an orderly system made of perfectly rational individuals tending towards equilibrium, but a complex system, impacted by numerous random factors (such as individual capabilities, circumstances at birth, twists of fate etc.) and made of imperfect individuals who '*use inductive rules of thumb to make decisions*' and '*are subject to errors and biases*', but also capable to adapt to changing circumstances.[439]

Complexity economists advice to employ public policy as an experimental endeavor.[440] The experimental public policy should focus on *´fostering entrepreneurship in the discovery and exploitation of (ever-changing) opportunities´*, by creating knowledge and making it available and by making information about opportunities available.

Another approach proposed by Edler et. al in the context of demand-side instruments is to develop evaluation metrics and methodologies which are capable to capture the integrated effects of a whole set of policy instruments and to adopt an integrated approach

[435] Shahid Yusuf, 'From Creativity to Innovation' (2007) World Bank Policy Research Working Paper 4262, 10-1 <http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2007/06/21/000016406_20070621101544/Rendered/PDF/wps4262.pdf> accessed 26 March 2013.
[436] Presidency Conclusions March 2002.
[437] Brian Arthur, Eric Beinhocker are such complexity theorists.
[438] Beinhocker (2006) 11-2, 17-8.
[439] Beinhocker (2006) 97.
[440] Hasan Bakhshi, Alan Freeman and Jason Potts, 'State of Uncertainty - Innovation policy through experimentation' (2011) NESTA Provocation 14 <http://www.nesta.org.uk/library/documents/Provocation_14_State_of_Uncertainty_v7.pdf> accessed 27 March 2013,

to all the stages of set-up, implementation, assessment and fine-tuning of demand-side policies. Hence, the policies should be formulated as programmes with bounded goals, timescale and budget, and should be accompanied by a logic model that compares the goals and the employed activities to achieve these goals against the outputs, and outcomes.[441]

At the set-up stage, this means that the policy should be formulated only after policy-makers have acquired sound knowledge of the current state-of-the-art in the targeted sector, has imagined future scenarios regarding technological trajectory and diffusion patterns and has identified which incentives move the key actor groups. This could be done through systematic consultation with relevant stakeholders, such as potential customers, intermediary actors etc. In other words, the policies should only be implemented in markets where the measures would achieve the strongest impact (e.g. highly innovative markets, responsive to customers' needs, strong technological base in Europe, depend on public policy intervention etc.). Such an analysis would also help to establish the baseline (the choice and delineation of the market and the definition of appropriate indicators) against which the impact of the policy can be measured.

Subsequently, the policy-maker should evaluate the appropriateness of the whole policy (the conceptualization stage), through surveys and interviews with (potential) buyers, suppliers and through analysis of the legal texts and tender documents. At the conceptualization stage the problem of non-coordination of inter-related or even conflicting policies should be addressed. This entails that the policy-maker should consider the whole conundrum of policy measures which may have an impact on its objectives, in order to catch their interactive effects and to detect the failures in linking them. Immediate, short-term and long-term goals of the policy should at this stage also be formulated.

The achievement of these goals should be subsequently assessed (the impact assessment stage) at different stages during and after the implementation of the policies. The assessment should, according to the authors, take three types of impacts into consideration: 1) impact on the intermediary actors shaping the market conditions (such as purchasers, standard setting bodies, innovation agencies, regulatory bodies etc.); 2) impact on the behaviour of the innovators; 3) impact on the market development itself (sales incomes, patents, number of producers etc.). Lessons drawn from the assessment exercise should be processed in the design and implementation of the policy as going along (the formation stage).

It is not within the reach of this research project to evaluate whether this type of highly nuanced industrial policy in fact possible. However, regardless of the embraced theoretical

[441] J. Edler et al (2012) 33-47.

argumentation, a withdrawal of public support for innovation in Western countries can hardly be conceived.[442] Examples from the recent history of innovation, which indicate that important scientific and technological discoveries and inventions find their origin in publicly funded projects, have even lead some economists to argue that it is *'a mistake to say that the private sector is the only, or even the main, engine of technological growth'*.[443]

2.3.3.2 Economic justification of public intervention in support of innovation

In the previous section, I outlined the evolution of economic thought on the role innovation plays in the economy and on the role R&D plays among the determinants of innovation. In this section, I will focus on the different economic justifications for public intervention in general and on the accepted economic justifications for public R&D investments in particular. I will compare these economic justifications against the market failures PCP allegedly seeks to address.

Neo-classics argue that public intervention should only be justified when the private market is not capable to achieve a certain public interest and after the causes of this failure are identified. In addition, the government should be convinced that the envisaged form of intervention can lead to a better outcome than the one achieved when left to the market. This can be demonstrated through a societal cost-benefit analysis, which involves an analysis of the causes of the market failure and demonstrates the (social) benefits of the intervention, compared to non-intervention or intervention in another form/field.[444] A public interest is for example present in the case of clean technologies which have the potential to address societal challenges such as global warming[445] or in the case of drugs for neglected tropical diseases.[446]

In the case of innovation, neo-classics argue that the free market (or price) mechanism achieves better efficiency results than centralized economies,[447] but nevertheless, in certain

[442] Scotchmer (2004) argues: 'In the US, for example, R&D performed by industry now comprises a hefty three-fourths of the total. Nevertheless, the R&D performed by universities and the federal government is also substantial. Most industrial R&D is applied, while most R&D in universities is basic research. Even though universities perform only 14 % of R&D, they perform about half of total basic research. Federal government funds 26% of total R&D, including grants to universities, firms, and federally funded research and development centers, which are run by firms and universities but are not owned by them. Only ¼ of the federally funded research takes place intramurally in government laboratories. Even though the federal government funds 26% of R&D, its employees perform only 7% of the total R&D. This is why industry and universities perform much more R&D than they fund. Industry only receives 10% of its R&D budget from the government.'

[443] Such as the packet-switching technology of the Internet, the digital computer, the world-wide web protocols, the technology for inserting foreign genetic material into bacteria, the first bioengineered human protein, human insulin or the human growth hormone. See Scotchmer (2004). See also Marianna Mazzucato, 'The Entrepreneurial State' (Demos 2013).

[444] B. Baarsma, C. Koopmans, J. Theeuwes, 'Beleidseconomie – Een rationele onderbouwing van overheidsingrijpen' (Pallas Publications – Amsterdam University Press, Amsterdam 2010) 39-41. C. Teuling, L. Bovenberg, H. van Dalen, 'De cirkel van goede intenties – De economie van het publieke belang' (Amsterdam University Press 2005).

[445] D.C. Popp, 'R&D Subsidies and Climate Policy: Is there a 'Free Lunch'?' (2006) 77 *Climate Change* 311-41.

[446] Pharmaceutical companies are reluctant to invest in R&D in tropical diseases, due to the risk that the selling-price of the medicine would not cover the investments. See Michael Kremer and Rachel Glennerster, *'Strong Medicine – Creative Incentives for Pharmaceutical Research on Neglected Diseases'* (Princeton University Press 2004).

[447] Ph. Aghiou, N. Bloom, R. Griffith and P. Howitt, 'Competition and Innovativeness: an inverted-U relationship' (2005) *Quarterly journal of Economics* 701-28; J. Boone and E. Van Damme, 'Marktstructuur en innovatie', in B. Jacobs and J.J.M. Theeuwes (red), 'Innovatie in Nederland – De markt draalt en de overhead faalt' 71-92, (Konijnklijke Vereniging voor de Staathuishoudkunde Preadviezen 2004).

cases outcomes are inconsistent with the expectations of the society.[448] This is due to the fact that the price mechanism does not capture social value:[449] 1) when innovations presents the characteristics of a public good; 2) when innovations entail positive externalities;[450] 3) when information asymmetries are present; or 4) when monopolies are formed.[451]

An innovation has the characteristics of a public good if, once disseminated, users cannot be denied further use and cannot be mandated to pay for it. Among the innovation activities, basic research is one of the purest forms of public goods. It requires big investments, while it does not produce an economic advantage on a short term and can often not be appropriated.[452] This particularly the case of fundamental research, without a concrete commercial application in sight.

Innovations may present beneficial spillovers (or positive externalities) which cannot be translated into benefits for the producers or can only partially be exploited due to the short time-span over which the innovation can be appropriated.[453] Environmental innovations for example, present two types of positive externalities which cannot be translated into private return on the R&D investment: knowledge externalities and social/environmental benefits. Due to this, an unaided market will not invest sufficiently in the creation of new knowledge. Economists take the view that knowledge externalities and spillovers are desirable for the emergence of innovation and public intervention in the form of funding can incentivize private actors to invest in R&D and produce sufficient amounts of knowledge.[454]

In the case of information asymmetries, the private investment market fails to engage sufficient funds in highly experimental and uncertain innovations that may potentially yield large economic and social benefits, because it lacks information on the innovative capabilities of the innovator or the private funder and the innovator are not aware of each other's existence.

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448 Such as when innovation contributes to depletion of natural resources instead of enabling their conservation. Robert Cooter, Aaron Edlin, Robert E. Litan, and George L. Priest, 'The Importance of Law in Promoting Innovation and Growth', in The Kauffman Task Force on Law, Innovation and Growth, *'Rules for growth – Promoting Innovation and Growth Through Legal Reform'* (Ewing Marion Kauffman Foundation 2011) 11-2. Yusuf (2007) 3. Stiglitz argues the need for public intervention, justified by the fact that the relation between fluctuations in the economy and fluctuations in innovation goes both ways, and by the fact that the free market left to itself will not always choose the most positive equilibria resulting from the positive feedback between economy and innovation. See Joseph E. Stiglitz, 'Endogenous Growth and Cycles' 121-154, in Yuichi Shionoya and Mark Perlman (eds), *'Innovation in Technology, Industries and Institutions-Studies in Schumpeterian perspective'* (The University of Michigan Press 1994).

449 Richard Gilbert, 'Holding Innovation to an Antitrust Standard', (2007) 3 *Competition Policy International* 2.

450 Externalities are about benefits (and costs) of private economic activity that those who make the relevant decisions do not see as benefits (or costs) to them'. See R.R. Nelson, 'The market economy, and the scientific commons', (2004) 33 *Research Policy* 462.

451 Commission, 'Community Framework for State aid for Research and Development and Innovation' (Framework for State aid for R&D&I) 2006/C 323/01 (Framework for State aid for R&D&I). R. Inman, 'Markets, Governments and the "New" Political Economy', in A.J. Auerbach and M. Feldstein, *'Handbook of Public Economics'* (vol II, Elsevier 1987) 647-777. B. Baarsma et al (2010).

452 G.M. Peter Swann, 'Funding Basic research – when is public finance preferable to attainable 'club goods' solutions?' 335-60, in Aldo Geuna, Ammon J. Salter, W. Edward Steinmueller (eds)*'Science and Innovation– Rethinking the Rationale for Funding and Governance'* (Edward Elgar Pub 2003). Erik Brynjolfsson and Xiaoquan (Michael) Zhang, 'Innovation Incentives for Information Goods' (2006) MIT Sloan School Working Paper 4780-10, 3 <http://seeit.mit.edu/Publications/brynjolfsson-zhang6-14-06.pdf> accessed 27 March 2013.

453 Lipsey (2007) 5-28.

454 Stuart Minor Benjamin and Arti K. Rai, 'Fixing Innovation Policy: A Structural Perspective' (2008) 77 *George Washington Law Review* 12. See also Paul Romer, 'The Origins of Endogenous Growth' (1994) 8 *J. ECON. PERSP.* 3, 20–21.

In the case of monopolist markets, a market failure arises when the monopolist does not have sufficient information on whether the consumers are ready to pay the fixed costs of the production of a certain product. In this case, public intervention in the form of funding of basic research is likely to stimulate the monopolist to invest in innovation. [455]

Some economists also talk of a market failure when competition (or the market selection mechanism) is too rapid and may punish the most innovative firms which undertake risky R&D projects with long-term perspectives, while being inefficient on a short-term. Capital markets intervene in this case, by providing them with the funding necessary to bridge the period until the innovative products come on the market. When capital markets do not function well, most innovative firms may be excluded from the market.456

Other justifications for public intervention which are accepted by neo-classical economics are: the strategic trade policy (which entails public subsidies to national companies active in foreign markets, in order to ensure them a dominant position), and co-ordination (when users get locked-in to an old standard/technology and are not willing to pay the costs of transaction to the new standard).[457]

Neo-classics believe that performing innovative activities and bringing innovative solutions to the market remains principally the role of the private market.[458] Public policy should only be employed to the extent that is needed to correct failures of the private market. [459] Even when the intervention is restricted, the neo-classics warn that correcting market or systemic failures may come with high costs[460] as policy decisions are not always sufficiently informed and unbiased to achieve better results than the private market.[461]

As a consequence, neo-classics argue that public intervention must be used with care and must be quickly transposed into stable rules, as private initiative is stimulated in an environment characterized by legal/political certainty.[462]

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455 Swann (2003) 335-360.
[456] Geroski, P. A., & Mazzucato, M., 'Myopic Selection' (2002) 53 *Metroeconomica* 2, 181-99.
[457] G.M. Peter Swann, 'The economic rationale for a national design policy' (2010) BIS Occasional paper no.2, 10-4 <http://www.dx.org/site/design_exchange/assets/pdf/Economic_Rationale_for_National_Design_Policy_UK.pdf> accessed 27 March 2013.
[458] B. Baarsma et al (2010) 39-40.
459 Because innovation is 'highly cumulative, (…) small changes in initial innovation conditions can have huge future impacts. Benjamin and Rai (2008) 11. In the Faroese Islands of the 1980s, the excessive public intervention through subsidies and demand driven economic growth led to near state bankruptcy. See Erik Gortz, 'Public and private expenditure and the Faroese business cycle' 235 in Gunnar Eliasson, Nils Karlson (eds) *'The limits of government, Policy Competence and Economic growth'* (Transaction Publishers 2001).
460 The public costs of correcting market failures are high because the public intervention will try to bring about private transactions between partners with non-reciprocal interests. See Teuling et al (2005). See also B. Baarsma et al (2010) 39-40.
[461] Hans W. Friederiszick, Lars-Hendrik Roller, and Vincent Verouden, 'European State Aid Control: An Economic Framework' (2005) 637 <http://ec.europa.eu/dgs/competition/economist/esac.pdf> accessed 8 April 2013; Baarsma et al (2010).
462 Teuling et al (2005).

According to the innovation systems theorists, the justification for public intervention should be broader. The following system failures justify government's intervention: infrastructural failures (when the infrastructure for certain desirable economic activities such as universities, labs etc. are too costly to be funded by private actors),[463] institutional failures (when the legal system (IP protection system) or the political and social culture and values do not create a climate supportive towards innovative activities),[464] interaction failures (when strong network ties between the different actors in the national innovation systems lead to ignorance of other important external factors, or when there are no ties between complementary technologies or actors or there are ties between non-complementary actors),[465] transition and capability and learning failures (when firms are not capable to adapt to changes in their environment, such as new technologies)[466].

Other economists suggest that the state is capable to play a more active role on the innovation scene than correcting market failures and creating the right infrastructure and linkages between innovation actors.[467] By investing in early stage, highly uncertain projects, it can drive the innovation process rather than just incentivize it.[468]

According to Mazzucato, the US government invested in forward-looking innovations through its Small Business Innovation Research ('SBIR') programme, and managed to play a leading role in bringing about innovative breakthroughs. US state investment in different types of risky and uncertain research (whether basic or applied research) was there far earlier than private investment.[469] Mazzucato uses as argument two studies, one conducted by Ruttan and another by Block and Keller on the role US state investments has played in the development of technology. Based on a study of state investments in six technology areas (the US 'mass production' system, aviation technologies, space technologies, information technology, internet technologies and nuclear power) Ruttan observes that the US government engaged funds in the most risky and uncertain early research in areas where it spotted a window of technical and commercial opportunity, and continued to oversee the innovation process up to commercialization. Government investment constituted the engine for the creation of these technologies and in certain cases of technologies that require large investments at early stages (such as nuclear power) even the indispensable incentive for their

[463] Edquist C., 'Innovation Policy: a Systemic Approach', in D. Archibugi and B.Å. Lundvall (eds) *'The Globalizing Learning Economy'* (OUP 2001); Smith K., 'Innovation as a Systemic Phenomenon: Rethinking the role of Policy' (2000) 1 *Enterprise and Innovation Management Studies* 1, 73-102.
[464] Carlsson B. and S. Jacobsson, 'In Search of Useful Public Policies: Key Lessons and Issues for Policy Makers' in B. Carlsson (ed) *'Technological Systems and Industrial Dynamics'* (Kluwer Academic Publishers 1997).
[465] Malerba F., R. Nelson, L. Orsenigo and S. Winter, 'History-friendly models of industry evolution: the computer industry' (1999) 8 *Industrial and Corporate Change* 1, 3-40.
[466] Chaminade C. and C. Edquist, 'From Theory to Practice: The Use of the Systems of Innovation Approach for Innovation Policy' in J. Hage and M. Meeus (eds), *'Innovation, Science and Institutional Change'* (OUP 2006).
[467] Mazzucato (2013) 18-9.
[468] Mazzucato (2013) 49.
[469] Mazzucato (2013) 49.

development.[470] Block and Keller confirm that between 1971 and 2006, 77 out of 88 of the most important innovations[471] were in their early stages but also beyond, heavily funded by the federal government.[472]

Some complexity theorists argue that public policy is an exogenous factor that stimulates the emergence of a variety of innovations to be subsequently exposed to the selection process in the marketplace.[473] They see the policy-maker as an adaptive agent, subject to evolution through policy experimentation and policy learning. The more recent approaches in complexity theory, advocate to completely drop the debate on state versus private markets and concentrate on an effective interplay between the two forces to create an effective evolutionary system.[474] An evolutionary systems follows the evolutionary algorithm (differentiate, select, amplify): it involves actors able to adapt to changing circumstances and an evolutionary innovation strategy following many small trajectories and making the choice for the most successful trajectory only when uncertainties are much lower. An evolutionary system also implies tolerance to *'redundancy, overlap and excess capacity'*.[475]

In conclusion, economists disagree on the situations when public intervention in the innovation processes is justified and on the extent to which it should be employed. Both neo-classics and systems of innovation theorists admit that private innovation efforts do not always lead to the desired result. Neo-classics delineate specific circumstances (market failures) under which intervention is justified, while systems of innovation theorists adopt a broader view on the conditions and means of intervention. Complexity theorists advise to drop the debate altogether and focus on the effective interplay between the state and private actor.

In practice, innovation policies in the US and the EU are complex and encompass numerous supporting actions. The EU policy making, for example, moved from a 'grants and subsidies' approach to an 'infrastructure building' approach. Although the market failure justification for policy intervention is still used, the *'policy maker is no longer seen as a surrogate for a perfectly informed social planner correcting imperfect market signals to guide private decisions towards more desirable outcomes'*.[476] Innovation policy action is not always based on an economic calculation of size of a market failure and of costs and benefits of a planned public measure. Often, decisions are based on political considerations. The EU policy approach also differs among different areas, such as is the case of R&D funding. On the one

[470] V. Ruttan, *'Is War Necessary for Economic Growth?: Military procurement and technology development'* (OUP 2006).
[471] They rate the importance of the considered innovations based on R&D Magazine's annual awards.
[472] Block F and Keller M, 'Where do innovations come from?' in F Block and M Keller (eds), State of Innovation: The US government's role in technology development (Columbia: Paradigm 2010).
[473] J. Stan Metcalfe & Luke Georghiou, 'Equilibrium and Evolutionary Foundations of Technology Policy', CRIC Discussion Paper No 3 (September 1997) 7 available at http://www.cric.ac.uk/cric/Pdfs/dp3.pdf accessed 28 December 2013.
[474] Beinhocker (2006)427.
[475] Beinhocker (2006) 339-40.
[476] Metcalfe & Georghiou (1997) 23.

hand, the EU applies strict assessment of the economic conditions to conclude on compliancy of national R&D subsidies. On the other hand, the EU does not attach any economic conditions to the application of public procurement of R&D services. This is further discussed in section 2.3.5.

2.3.4 Public funding of R&D when the venture capitalist fails

The PCP Communication and the preceding PCP Expert Group report outlined the following assumption: PCP is necessary due to underinvestment of private venture capitalists in risky R&D projects.

In this section, I will outline some of the most important economic studies regarding the role of venture capital markets in the innovation process in the US and in the EU. I will highlight the conclusions of these studies regarding the role of public R&D investments to compensate for less well functioning venture capital markets. This will test the above mentioned assumption and will provide guidance to public procurers on the conditions for effective deployment of PCP.

Economists[477] point out that the presence of a large number of new firms is an important prerequisite for innovation. They perform the role of exploratory devices to test the viability of innovations, and put competitive pressure on incumbent firms. They are a source of new knowledge even in case of failure. However, the positive effect on economic growth is not obtained unless a sufficient number of high-growth start-ups emerge from among the new firms. This depends to a large extent upon access of younger innovative firms to finance.[478]

In general, venture capital is attributed the merit of mitigating the problem of access to finance of such young innovative firms and of spurring their growth.[479] Venture capital is considered the most efficient financial institution to operate under conditions of uncertainty and information asymmetries which characterize innovative projects in young firms.[480]

In the US, venture capitalists address the uncertainty and information asymmetry problems through intensive scrutiny of business plans, the existence of a syndication partner who shares the decision that the investment is attractive, staged funding, intensive monitoring of

[477] Erik Stam, 'Entrepreneurship and Innovation Policy' (2008) 34, 40-1, Jena Economic Research Papers 006, <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1115262> accessed 8 April 2013. Matthew Spiegel and Heather Tookes, 'Dynamic Competition, Innovation and Strategic Financing' (2008) 3 <http://www4.gsb.columbia.edu/filemgr?file_id=72705> accessed 8 April 2013.
[478] J.E. Stiglitz and A. Weiß , 'Credit rationing in markets with imperfect information' (1981) 71 *The American Economic Review* 393-410. M. Binks and C.T. Ennew, 'Growing Firms and the Credit Constraint' (1996) 8 *Small Business Economics* 17-25.
[479] D. Engel, 'The Impact of Venture Capital on Firm Growth: An Empirical Investigation' (2002) ZEW Discussion Paper No. 02-02 <ftp://ftp.zew.de/pub/zew-docs/dp/dp0202.pdf> accessed 8 April 2013.
[480] Stefano Caselli, Stefano Gatti, Francesco Perrini, 'Are Venture Capitalists a Catalyst for Innovation, or do they simply exploit it ?' (2006) 6 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=890669> accessed 8 April 2013.

managers (through representation on the board of directors).[481] The existence of an efficient financing system with a mature venture capital market is believed to be the reason for the sustained economic growth in the US in the 1990s.[482]

Based on a study of twenty industries in the US over a period of three decades, Kortum and Lerner conclude that venture capital funded firms acquire a larger number of patents compared to large firms with R&D divisions, or compared to projects financed through private R&D funds.[483] However, Kortum and Lerner point out that venture funding does not have an uniform impact. During 'hot' financial periods, the impact tends to decrease, as venture capitalists tend to overestimate the value of projects and over-invest in similar projects which leads to excessive duplication, or tend to increase the size of their investment, at the cost of reducing their capability to keep control through '*staged capital commitments*'.[484]

Kline and Rosenberg underline that the incentive of venture capital to finance potentially breakthrough innovations is influenced by the level of envisaged costs. The trend of increasing development costs of new products in many high tech sectors, particularly when those involving radical improvements in product performance, combined with the uncertainty and unpredictability of needed efforts, leads to reticence of venture capitalists to invest in such projects.[485]

Mazzucato notices that the incentives of venture capitalists to invest in high risk long-term projects may also be diminished by policies regarding management fees and bonuses for high returns, which determine venture capitalists to focus on shorter term investments (of 3 to 5 years, although they are usually set up for period of 10 years).[486]

According to Chemmanur et al, this issue is less apparent in Corporate Venture Capital ('CVC') in the US.[487] CVC performs better in nurturing innovation in the funded firms than independent venture capitalists due to less concerns with the short-term financial returns of the portfolio projects (as a consequence of the payment structure in the form of a fixed salary with corporate bonuses) as well as due to the unique knowledge of the industry. These features allow the corporate venture capitalist to be more open to experimentation and more tolerant to failure. CVCs appear to generate more innovation productivity (in terms of

[481] Gompers, Paul, and Josh Lerner, *'Capital Market Imperfections in Venture Markets: A Report to the Advanced Technology Program'* (Department of Commerce 1999) 11.
[482] Caselli et al (2006).
[483] S. Kortum and J. Lerner, 'Assessing The Contribution Of Venture Capital To Innovation' 31 (2000) *Rand Journal of Economics* 674-92.
[484] Kortum and Lerner (2000) 686. Gompers and Lerner (1999) 8.
[485] Kline and Rosenberg (1986) 295.
[486] Mazzucato (2013) 41.
[487] These are internal VC funds established by corporations as subsidiaries.

number of patents and citations) from younger, riskier firms, but obtain growth on a long-term.[488]

Tolerance to early failure has also been identified by other studies to be particularly important in spurring innovation productivity in firms exposed to high failure risks (such as ventures born in recession periods, ventures at early development stages and ventures in highly uncertain innovations).[489] Economists argue that technological revolutions are preceded by a period of increased experimentation in the economy, which comes along with inevitable failure of numerous start-ups and destruction of mature firms and which necessitates highly active financial markets, which are willing to fund new firms even if the failure risk is high.[490] In this context, the youngest and most experimental firms are impacted by the financial risks even in times of financial equilibrium and are most vulnerable to financial shocks.[491]

Thus knowledge of the industry, openness to experimentation and tolerance to failure are key attributes that explain the success of venture capital.

Unlike in the US, European venture capital has not been associated with support of innovation, but rather with exploitation of existing technological capabilities of funded firms.[492] Moreover, economists noticed that in conditions of depressed financial markets, the level of venture capital investments at seed and start-up stage tends to fall abruptly in Europe.[493] The lack of early-stage venture capital for young companies in Europe was considered as one of the most important reasons why Europe has fewer young firms as leading innovators in high-tech sectors as compared to the US.[494]

Another aspect increasing the difficulties of young innovative firms in funding innovative undertakings, has been the lack of large public budgets for high-tech R&D such as have been available in the US.[495] According to Auerswald and Branscomb the amount of US government funding just for early stage technology firms, equaled by 2003 the total

[488] Thomas J. Chemmanur, Elena Loutskina, Xuan Tian, 'Corporate Venture Capital, Value Creation, and Innovation' (2012) *Rev. Financ. Stud.* <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1364213> accessed 8 April 2013; Jean-Sebastien Lantza and Jean-Michel Sahut, 'Corporate Venture Capital and Financing Innovation' (2010) 8 *Problems and Perspectives in Management.*
[489] Xuan Tian & Tracy Yue Wang, 'Tolerance for failure and Corporate Innovation' (2011) *Rev. Financ. Stud.* 3 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1399707> accessed 8 April 2013.
[490] Ramana Nanda and Matthew Rhodes-Kropf, 'Financing Risk and Innovation' (2011) 1-2 Working Paper 11-013 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1657937> accessed 8 April 2013.
[491] Nanda and Rhodes-Kropf (2011) 5, 38.
[492] Caselli et al (2006) 22.
[493] In 2002, the level of venture capital investment has fallen from EUR 6,7 billion in 2001 to EUR 4,2 billion. See Independent Expert Group, 'Raising EU R&D Intensity – Improving the Effectiveness of Public Support Mechanisms for Private Sector Research and Development' EUR 20717 (2003) 6.
[494] Veugelers, R. and M. Cincera, 'Europe's missing yollies' (2010) Bruegel Policy Brief 2010/06.
[495] Chris Hendry, 'Commercialising University Research", paper for ESRC Sustainable Technologies Programme' http://www.google.nl/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&ved=0CDQQFjAA&url=http%3A%2F%2Fwww.esrc.ac.uk%2Fmy-esrc%2Fgrants%2FRES-332-25-0003%2Foutputs%2FDownload%2F70d2fe7a-9b21-46d2-aee9-1d106f92f9d4&ei=z7ViUc3XIsjBtAbPwIGgAg&usg=AFQjCNFsdvGVcAD-zkX9QuI6ZcflTxO7dw&sig2=gR-tL1zn4OrY8XbO8jkBDw> accessed 8 April 2013; PCP Expert Group 13.

investments of 'business angels' and was approximately two to eight times larger than private venture capital.[496]

In the US, the government has acted as an entrepreneurial venture capitalist through the Small Business Innovation Research (SBIR) programme and has played a vital role beyond the basic research phase of projects.[497] Mazzucato points out the fact that US SBIR agencies have sometimes invested in highly uncertain, high risk undertakings in fields such as genomics or ICT, long before venture capital funding was available. One important characteristic which has ensured the success of the US SBIR program in stimulating technologies which escaped the attention of the traditional venture investor, was the decentralized institutional set-up, with program managers looking to fulfill very specific technical needs of the Federal agency.[498]

Economists warn that in public venture capital programs such as the SBIR the same pitfalls as in the private venture capital arena may occur. The impact of the additional public funding proves to be low when short-term reward mechanisms lead public managers to choose firms with better prospects of success and already sufficiently funded by venture capitalists.

In conclusion, several lessons can be drawn for the contracting authority and policy-maker from the economic studies analysed in this section.

Firstly, venture capital funding is often oriented towards close to market innovations and overlooks the riskier undertakings even in times of financial bonanza. This entails that public R&D funding should target the most cutting-edge and riskier projects, that require large investments and/or long-term return on investments.

Secondly, small innovative firms and particularly start-ups experience more acutely the difficulties to access private capital for promising but risky R&D projects.

Thirdly, public investment should also focus on firms that have already been funded by VCs but that do not succeed in obtaining follow-on capital.

Fourthly, public R&D funding should concurrently be complemented by measures to increase the efficiency of the private market on a long-term, such as facilitating the deployment of early-stage technologies and providing tax incentives to stimulate entrepreneurship.[499]

[496] P.E. Auerswald and L.M. Branscomb 'Valleys of death and Darwinian seas: financing the invention of innovation transition in the United States' 3-4 (2003) 28 *Journal of Technology Transfer*.
[497] Mazzucato (2013) 41.
[498] Lerner (2002) 17.
[499] Lerner (2002) 17.

Fifthly, the investment decisions should be made by program managers in decentralized agencies, who possess state-of-the art knowledge on the market structure and status of development of innovations.

Finally, a high degree of experimentation and tolerance to risk must be accepted.

2.3.5 The role of public needs/demand in innovation – lessons for public policy

2.3.5.1 Introduction

Until 2000, the EU innovation policy had a strong focus on supply-side instruments, such as R&D subsidies, tax measures etc. The approach has been criticized for its negative effects on demand-driven innovation.[500]

Since 2000, the EU institutions started to contemplate the adoption of complementary demand-side measures. The demand-side innovation policy was defined as '*all public action to induce innovation and/or speed up the diffusion of innovation through: increasing the demand for innovation (i.e. the willingness and ability to buy and use an innovation); defining new functional requirements for products and services and/or improving user involvement in innovation production (user-driven).*'[501]

Among the various demand-side measures, public procurement is the most direct measure.[502] The EU institutions acknowledged since 2000 the need to change the public procurement practices and re-direct public purchases towards new technologies.[503] Public procurement was considered a large source of finance[504] for innovation in those sectors where the government was an important customer.[505] Pre-commercial procurement was given an important role within the demand-side innovation policy.

However, the European Commission adopted a fundamentally different approach to the implementation of the PCP as compared to R&D subsidies.

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[500] A. Gavras, L. Hommen, M. Rolfstam, M. Mavis, N. Vasileiadis, L.S. Cardoso, D. Tsigos, D. Serpanos, 'Procurement as an Innovation Instrument' (2006) 70-2 <http://www.inno-utilities.org/public/Documents/Inno-Utilities-Book.pdf> accessed 28 December 2013; IVA, 'Technical development in deregulated markets: What we can learn from the telecom, energy, railway and defence sectors' (The Royal Swedish Academy of Engineering Sciences 2003).

[501] Jakob Edler, 'Review of Policy Measures to Stimulate Private Demand for Innovation. Concepts and Effects' (2013) 9 <http://www.innovation-policy.org.uk/share/12_Review%20of%20Policy%20Measures%20to%20Stimulate%20Private%20Demand%20for%20Innovation.%20Concepts%20and%20Effects.pdf> accessed 28 December 2013

[502] Other demand-side measures cover financial (subsidies, tax reductions etc.) and non-financial (information campaigns, labels, trainings etc.) support for private demand. See Edler (2013).

[503] COM (2002) 499, 14.

[504] In 2008, EU public procurement amounted to around 2155 billion Euro, equivalent to 17- 18% of EU GDP, out of which approximately 389 billion Euro was covered by the rules set out in the EU Directives on public procurement. See Mario Monti, 'A New Strategy for the Single market at the Service of Europe's Economy and Society' (2010) 76, <http://ec.europa.eu/bepa/pdf/monti_report_final_10_05_2010_en.pdf> accessed 8 April 2013.

[505] COM (2003) 226 final; Independent Expert Group, 'Raising EU R&D Intensity – Improving the Effectiveness of Public Support Mechanisms for Private Sector Research and Development' 20, EUR 20717 (2003).

In the area of R&D subsidies, the EU adopts a straightforward economic approach. R&D subsidies are only considered beneficial when needed to correct a market failure and to the extent it is effective and it is necessary to incentivize the private actor to invest itself (more) in innovative activities. The European Commission has the competence to check whether national R&D funding schemes or individual R&D funding measures are justified. Due to restrictive capacity, the Commission has developed certain conditions to assume suitability of funding measures. These conditions regard types of activities that potentially target market failures, categories of private undertakings particularly affected by market failures, as well as amount and percentage of funding for different type of R&D projects.[506] The EU performs a case-by-case assessment of the compliancy of the measure when the above mentioned conditions are not fulfilled.

The strict supervision by the European Commission of R&D subsidies is justified with the argument that EU Member States are often tempted to provide financial support to domestic firms with strong lobbying and that this may lead to the exclusion from the market or the delayed reward of the most competitive and innovative firms to the detriment of consumers' welfare.[507] The EU State aid rules aim to promote a more integrated European market in which firms compete effectively and are able to benefit of economies of scale.[508]

In contrast to this, the guidance on the implementation of the PCP (the PCP Communication and the accompanying PCP Staff Working Document) does not define economic conditions for its effective deployment. Neither do they define the necessary safeguards to avoid damages to competition. In section 1.7.3, above I argued that the European Commission missed the opportunity to provide a clear conceptual outline of the rationale behind the use of PCP. PCP was labelled as a demand-side innovation policy instrument. However, it is often limited to participation by national companies and does not entail any guarantee or commitment for a subsequent purchase of the resulting innovation by the funding agency.

In this section I will outline the most important economic theories on the role of demand in driving innovation and I will address the fourth PCP assumption that public needs can influence firms' strategies for creativity and innovation. I will subsequently derive pre-conditions for the effective use of public demand as innovation policy instrument.

[506] These conditions are described in section 5.3.5.
[507] For example, aid may negatively impact foreign competition and lead to higher prices for the consumer. Friederiszicket al (2005) 638, 644-5. *See also* COM(2005) 107 final 3.
[508] Midelfart-Knarvik, K. H., and H. G. Overman., 'Delocation and European integration: Is structural spending justified' 35 (2002) *Economic Policy* 325.

2.3.5.2 Demand-side innovation policy instruments

According to Mowery and Rosenberg, modern economic theories regarding the role of demand[509] in the innovation process had emerged in the mid 1960's in the US, when it was considered that federal funding of basic research did not lead to solutions for *'pressing economic and social problems'* and that government needed to steer itself innovative efforts towards such solutions.[510]

However, the idea that funding should be oriented towards addressing societal needs is even older.

The economic historians Godin and Lane trace the first studies on the role of 'needs' back to 1935 and 1939, when J. Huxley, an English evolutionary biologist and J.D. Bernal, an Irish mathematician, argued that science should be oriented towards fulfillment of social needs.[511] Huxley criticized the bias of public funding towards research in the interest of industry to make immediate profit as opposed to long-term beneficial projects to the consumer and the individual citizen.[512] Bernal saw science in a capitalist society working towards destruction, but he believed that science should and could be steered towards playing a powerful role in curing social injustice and meeting real social desires.[513]

These studies referred to the concepts of 'social needs' or 'collective needs'. [514] Social or collective need means a social problem identified by the government or expressed by society collectively through the political process. The core idea of these studies was that the government should turn the above mentioned needs into public goals, and should fund the development of technologies to address these needs.[515]

However, social needs are not the same as the economic term of 'demand'. The second encompasses trade-offs between quantity, price and performance and entails the willingness and ability of customers to buy and use an innovation.

In 1967, another non-economist referred in a paper commissioned by the Center for Business Research at the University of Manchester to the role of needs in the more economic sense. The Australian chemist James Albert Allen concluded that *'the recognition of a need at the*

[509] Demand can be defined as the 'willingness to pay a certain price for the satisfaction of a need or want'. See Edler (2013) 8.
[510] Mowery, D. and Rosenberg, N., 'The Influence of Market Demand upon Innovation: A critical review of some recent empirical studies' 8 (1979) *Research Policy* 105.
[511] Godin and Lane (2013).
[512] Quoted from Nature November 30, 1935, 865.
[513] J.D. Bernal, *'The Social Function of Science'* (The Macmillan Company 1939) 409-10.
[514] Godin and Lane (2013).
[515] A. Brook, 'Raising Education Achievement and Breaking the Cycle of Inequality in the United Kingdom', OECD Economics Department Working Papers No.633 (1971) 15.

distribution end and the prospect of exploiting it is probably the most powerful driving force for the total process [of innovation]'.[516]

However, the landmark economic contributions on the role of market demand (rather than social needs) come from Mowery and Rosenberg (1979), Kline and Rosenberg (1986), von Hippel (1986) and Porter (1990).

In a 1979 study on the role of demand in the innovation process, Mowery and Rosenberg, two Stanford economists, distinguished between the role of demand at different moments in the innovation process. They admitted that demand had a dominant role at the diffusion phase, but criticized the overemphasis of the role of demand in determining the emergence of innovative solutions. The decision of firms to innovate is not always caused by the existence of customers' demand or the likelihood of future demand.

They concluded that market demand, defined as willingness of customers to pay for purchasing innovative solutions, is not always and definitely not the only factor motivating firms in investing efforts in the desired innovations . They argued that additional and at least equally important supply-side conditions were necessary, such as new technological opportunities/capabilities which lower production costs and make it possible to bring to the market the desired innovation.[517] Moreover, they expressed doubts on whether firms have the capabilities to perceive the demand curve for products[518] and observed that the most radical innovations responded the least to market 'needs'.[519]

They concluded that there is an important role for the government to give a decisive impulse to the innovation process in areas in which the market does not generate the necessary incentives or R&D resources to determine the emergence of innovative solutions for urgent social needs. However, public demand will be effective in those areas where the technological basis is ripe as a consequence of nourishment though supply-side measures.[520]

They also signaled the importance of exchanges of information regarding desired products and product characteristics, between users and producers and between non-commercial basic research institutions and private firms and laboratories.[521]

In 1986, Rosenberg teamed up with Stanford mechanical engineering professor Kline and conceptualized the chain-linked innovation models. They concluded that innovation is

[516] James A. Allen, *'Studies in Innovation in the Steel and Chemical Industries'* (University of Manchester Press 1967) 23.
[517] Mowery and Rosenberg (1979)142.
[518] Mowery and Rosenberg (1979) 145.
[519] Mowery and Rosenberg (1979) 143-4.
[520] Mowery and Rosenberg (1979) 149
[521] Mowery and Rosenberg (1979) 149.

triggered by either research or the existence of a potential market.[522] Even when innovation is triggered by basic research, it still needs to be coupled to market needs in order to be commercially successful. Kline and Rosenberg support their argument with a quote from the journal of Thomas Edison, who, after inventing a vote counting machine only to find out later that the Congress was not interested, allegedly said that he would never again spend time on an invention with no sound market prospect.[523]

In the same year, MIT economist von Hippel outlined his 'lead-users' theory.[524] He argued that manufacturers experience significant benefits when they identify the most experienced and leading-edge users ('lead-users') and involve them in the product development process. He defined 'lead-users' as individuals, firms or organisations which present early needs (months or years before they become general needs in the market place) and tend to benefit significantly from obtaining an early solution to these needs. Based on empirical studies in the chemical and computer industries, he concluded that lead-users may contribute to the innovation process not only with sharing data regarding their needs (and future general needs) but also with *'rich insight to working and tested prototypes of the desired novel product, process, or service'* and even with the development of solutions.[525] Lead users will also tend to be early adopters[526] of the innovations, due to the significant benefits they gain from adoption.[527]

Harvard economist Porter studied in 1990 the role demanding and sophisticated markets (as opposed to individual lead-users) play in creating global competitive advantages for local companies. Based on a four-year study of internationally successful industries in ten important trading countries (Denmark, Germany, Italy, Japan, Korea, Singapore, Sweden, Switzerland, the UK and the US), Porter concluded that the quality, and to a lesser extent the size of demand in the markets where firms are located have a significant influence on the innovation rate of the industry and as a consequence on their competitive advantages on a global level.[528] He explained that local markets which give early and clear signals of emerging buyer needs help build a competitive advantage of local firms on foreign markets. The most significant effect is observed when the needs are stringent and the lead market widely embraces the resulting products. In addition, the needs of the local buyers have to *'anticipate or even shape those of other nations'*, which happens when a nation is *'exporting*

[522] Kline & Rosenberg (1986) 286.
[523] Kline & Rosenberg (1986) 278.
[524] Glen L. Urban and Eric von Hippel, 'Lead User Analyses for the Development of New Industrial Products' (1986) <http://web.mit.edu/evhippel/www/papers/Lead%20Users%20Eric%20von%20Hippel%20and%20Glen%20Urban%20-%201988.pdf> accessed 8 April 2013.
[525] Edler (2006) 19.
[526] However, lead users are not the same as early adopters. Lead users feel the need before the product is available on the market, before early adopters.
[527] Von Hippel (1986)
[528] Michael E. Porter, 'Competitive Advantage of Nations' 81 (1990) *Harvard Business Review*.

its values and tastes as well as its products'.[529] He advocated the legitimate role of the government in challenging firms and rewarding the most innovative ones, without falling into the industrial policy pitfalls, such as protecting inefficient companies from foreign competitions.[530]

The theories of von Hippel and Porter inspired Gheorghiou to develop the concept of 'lead markets'.[531] These are markets with multiple or large single users who are willing to adopt innovations early and pay the premium price for them. In addition, a lead market provides *'the more general conditions favourable to innovation such as an efficient and responsive regulatory structure, security for intellectual property etc.'*.[532] Policy action to support the emergence of lead markets includes the use of innovation-oriented public procurement. The European Commission has embraced this approach and has launched several lead-market initiatives, focused on the early uptake of innovations.[533] Moreover, the EU concept of lead-market constitutes a diluted version of the demanding and sophisticated market in Porter's study. Lead-markets entail early adoption of innovations, but do not cover definition of advanced requirements to influence the early R&D decisions of the innovating companies. PCP has thus not been part of these initiatives. The above described studies argue thus that companies are incentivized to engage in innovative activities when sophisticated end-users articulate advanced and stringent needs, and adopt the developed innovation at an early stage and on a sufficiently large scale. Although they do not refer to the involvement of the end-user in *funding* the R&D trajectory, these studies show that for demand to have an impact on the innovative activities of private actors, it needs to entail the involvement of the end-users and a clear prospect of early commercialisation at a sufficiently broad scale.

Other studies that investigate how *public* demand shapes the innovation process, focus on the role of a public agency in financing the R&D stages and on the role of a public agency in adopting the innovation at an early stage.[534]

They warn that the decision of a public agency to support one specific innovation at an early R&D phase should be based on a solid knowledge on the technological trajectory and market trends, in order *'to avoid lock-in to a technology that is premature or for which*

[529] Porter (1990) 82.
[530] Porter (1990) 87.
[531] Luke Georghiou, 'Effective Innovation Policies for Europe – the Missing Demand-Side', in Economic Council Secretariat (eds), *'Globalisation Challenges for Europe'* (18 ed, Prime Ministers Office Publications Finland 2006) 173-194.
[532] Gheorghiou (2006) 13.
[533] http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/#h2-3
[534] Nesta, 'Demand and Innovation How Customer preferences shape the innovation process' (2010) 14 The Work Foundations Working Paper <http://www.nesta.org.uk/library/documents/Working-Paper-Demand-and-Innovation-v7.pdf> accessed 8 April 2013. Edler (2013).

accompanying business infrastructure is not ready'.[535] Otherwise, the public agency should fund parallel development trajectories.[536]

As early-adopter, a public agency can significantly benefit the innovating company in the following ways:

- by paying a premium for the early use of innovations, the public purchaser ensures early revenues for the innovating firm, which allows the firm to develop the technology up to the point when it is competitive compared to established technologies available on the market.[537]

- as early-user, the public purchaser can provide important feedback to innovators, [538]

- as early-user, the public purchaser can provide credibility to small firms by taking away the perception of risk in adopting that new product/service.[539]

In conclusion, economists agree that public demand can effectively be employed to incentivize the emergence of innovations and to redirect private innovation efforts towards such desired innovations. Based on the review of relevant economic literature, Dalpé et al[540] summarize the following cumulative conditions for an efficient use of public procurement at both the R&D stage and at the early-adoption stage:

- It is employed at the early stages in the life cycle of a product and of an industry;

- competition is maintained throughout the whole innovation process;

- the government is itself a technologically advanced end-user of the innovation;

- the government is capable to offer a sufficiently sizeable market for the developed innovation;

- the adaptation of the product to larger markets is not cumbersome.

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[535] Kincsö Izsak & Jakob Edler, 'Trends and Challenges in Demand-Side Innovation Policies in Europe Thematic Report 2011 under Specific Contract for the Integration of INNO Policy Trend Chart with ERAWATCH (2011-2012) 18 (2011) <http://ec.europa.eu/enterprise/newsroom/cf/_getdocument.cfm?doc_id=7011> accessed 2 February 2013.

[536] Luís M B Cabral, Guido Cozzi, Vincenzo Denicolò, Giancarlo Spagnolo and Matteo Zanza, 'Procuring Innovation', CEPR Discussion Paper Series No.5774 <www.cepr.org/pubs/dps/DP5774.asp.asp> accessed 8 April 2013.

[537] OECD (2011) 23; F. Malerba, L.Orsenigo, R.Nelson and S.Winter, 'Public policy and changing boundaries of firms in a history-friendly model of the coevolution of the computer and semiconductor industries' 67 (2008) *Journal of Economic Behavior & Organization*.

[538] In the UK, for example, studies show that in many sectors, a large share of spending on innovation is oriented towards marketing and preparing the market, rather than on understanding the needs and preferences of customers. See DTI, 'Innovation in the UK: Indicators and insights' (2006) DTI occasional paper No.6 <http://www.dti.gov.uk/files/file31569.pdf> accessed 8 April 2013.

[539] Edler and Georghiou (2007) 955.

[540] Dalpé, Robert, DeBresson, Chris & Xiaoping, Hu, 'The public sector as first user of innovations' (1992) 21 *Research Policy* 252.

Using *public* demand to drive innovation in the context of PCP requires thus that the involved public agency is the potential end-user of the developed innovation and has the willingness and ability to purchase and use it if developed to expected levels of performance and price. As shown in section 1.7.3 above, in such a case, there is a clear conceptual delineation between an R&D subsidy and a PCP contract. When PCP is employed to develop an innovation for a social need, there may be no prospective private customers/consumers at the end of the R&D trajectory, willing and able to buy and use the innovative products. In this case, the PCP leads to the granting of a supply-side subsidy.

2.3.5.3 Empirical studies

A number of economic studies analyse concrete cases when public procurement was used as innovation policy instrument, while others rank public procurement as compared to other innovation policy instruments in terms of positive impact on innovation.

One of the most used examples by economists to demonstrate that public demand can compensate for customers' distrust of the reliability of a new product which is objectively superior to the more established competing products, finds itself in the transistors sector.[541] The initial transistors were initially not competitive in terms of quality and price against vacuum tubes. The financial support from the US Department of Defense ('DoD') within the US SBIR for the continuous improvement of the technology, which by mid 1970s had eliminated vacuum tubes from the market. A similar example is that of the jet engines. Although it cannot be argued that the technology would not have emerged without the SBIR funding by the DoD, it is widely accepted that DoD speeded the time to the market of jet engines. Jet engines eventually replaced piston engines in the civil aircraft industry. The same happened in the case of Internet, after DoD required the development of a packet/switch network instead of the existent circuit/switched network.[542]

In Europe, the most well-known example of a successful use of public procurement to steer private R&D efforts towards environmentally friendly solutions in the household appliances sector comes from Sweden. [543] Between 1988-1998, the Swedish Energy Authorities applied catalytic procurement to stimulate technological advancement in the energy sector. More concretely, it coordinated end-users, in the residential, the service, and the industrial sector and technology experts in identifying potential technological improvements in terms of energy efficiency and articulating procurement requirements for such improved products.

[541] Mowery and Rosenberg (1979) 148.
[542] Malerba et al (2008).
[543] Lena Neija, Kerstin A˚strand, 'Outcome indicators for the evaluation of energy policy instruments and technical change' 34 (2006) *Energy Policy* 2662–2676; Neij, L., 'Methods to evaluate market transformation programs - experience of the Swedish market transformation program' 29 (2001) Energy Policy 67–79.

Through a competitive procedure, the best prototype which met the requirements was then selected and awarded.

The program was accompanied by unique combinations of policy instruments for each developed technology, such as subsidies for the installation costs, training of maintenance personnel, information campaigns, labeling. The catalytic procurement program was also characterized by intensive interaction between the actors involved and by an ongoing monitoring and learning process. Thus, failure in the process of technical change was identified at an early stage and action was taken to redesign or terminate the policy intervention.

The economic analysis of the Swedish programme concludes on its success in bringing improvements in technological performance and in some cases cost reduction. The program proved less effective in impacting other outcome indicators such as increasing sales data, market share, changes in manufacturers' assortment, change in knowledge, attitudes and behaviour of important actors. Moreover, not all of the 30 procurements of technologies included in the program scored positively in terms of outcome.

Economists who evaluated the Swedish program admit though the limitation of the available data necessary for the evaluation, such as lack of information on the levels of the outcome indicators before the start of the program. Moreover, by using outcome indicators, the evaluation of the program reflects the impact of all the public instruments used without distinguishing between them.

Other studies assess the prospect of having a public customer at the end of the R&D trajectory impacts the innovative efforts of the industry. Beise and Rennings[544] conclude on the basis of case-studies of fuel-efficient passenger cars and wind energy that legislation (imposing technological performance requirements) combined with anticipation of international demand created the proper conditions for innovation. International demand appears to have a positive impact on innovation efforts in the vaccine industry as well. A study by Smita Arinivas on the evolution of the vaccine industry in India concludes that technical advance is most stimulated by international procurement when the sector is free from accusations of protectionism and when delivery terms are long and the number of competing suppliers is large. Besides demand, prior learning, enhanced by open

[544] Marian Beise & Klaus Rennings, 'Lead markets and regulation: a framework for analyzing the international diffusion of environmental innovations' 52 (2005) *Ecological Economics* 5– 17.

dissemination of technical standards and regulations and the participation of developers and manufacturers in networks, is essential.[545]

Other studies, based on surveys of private firms/innovators reach various conclusions regarding the positive or significant impact of public procurement on innovation. These studies do not distinguish between the type of procurement and do not make clear whether the conclusions are related to the active deployment of public procurement in support of innovation at the specific time or previous to the survey.

For example, based on a survey of Finnish innovators from different sectors, Palmberg[546] concludes that public procurement was the least valuable among different sources of innovation. Miles et al.[547] show that UK firms, out of the seven wider conditions that matter for innovation, rate the intensity of competition and demand for new products and services as the most important after availability of human resources. The study concludes that firms are willing to innovate when innovation delivers them economic and competitive advantages. The extent of these advantages depends on the demand for innovation and the intensity of competition they encounter on the market within which they operate. The stronger and the more clear the demand for innovation in a market, the more willing the firms will be to innovate.[548]

Based on qualitative and quantitative analyses of public demand, Rothwell and Zegveld[549] and Geroski[550] show that on a long-term, public procurement had a more positive impact on innovation than R&D subsidies. Other studies bring evidence that the impact of public procurement on market success of innovations (indicated by turnover from sales of products which are new to the market) is similar in Germany to the impact of university knowledge spilling over to firms, and scores better than regulation and subsidies.[551] The same study indicates that regular procurement rather than defence procurement has a stronger influence and that its impact is most clear on small firms in economically challenged regional markets, with limited financial resources.

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[545] Smita Arinivas, 'Industrial Development and Innovation: Some Lessons from Vaccine Procurement' 34 (2006) *World Development* 1742–1764.
[546] Christopher Palmberg, 'The Sources of Innovation – Looking Beyond Technological Opportunities' 13 (2004) *Econ. Innov. New Techn.* 183–197.
[547] In a functional model of innovation systems the seven conditions which influence innovation are: qualitative public research, openness (of individuals to seek and share knowledge and the existence of physical infrastructure which facilitates effective exchange of knowledge), commercial motivation and entrepreneurship, demand for innovation, a competitive market that facilitates entry, rewards successful innovators and selects out poor performers, access to finance and available and qualitative human resources. See N. Miles, C. Wilkinson, J. Edler, M. Bleda, P. Simmonds and J. Clark, 'The wider conditions for innovation in the UK - How the UK compares to leading innovation nations' (2009) 11-2.
[548] Miles et al (2009)16-17.
[549] Rothwell, R.; Zegveld, W., 'Government regulations and innovation – Industrial Innovation and Public Policy' in Rothwell, R./Zegveld, W. (ed), *'Industrial Innovation and Public Policy'* (Pinter 1981) 116-47.
[550] Geroski (1990) 182-98; Dalpé, R., 'Effects of Government Procurement on Industrial Innovation' 16 (1994) *Technology in Society* 65-83.
[551] Birgit Aschhoff and Wolfgang Sofka, 'Innovation on Demand – Can Public Procurement Drive Market Success?' (2008) ZEW Discussion Paper No. 08-052 <ftp://ftp.zew.de/pub/zew-docs/dp/dp08052.pdf> accessed 8 April 2013.

A more recent survey performed on 10% of the public sector suppliers in the UK, shows that public procurement is the second most important incentive for innovation, following changes in the market demand and preceding internal R&D or private buyers. The survey also concludes that 51,4% of the suppliers who had performed R&D in the previous three years, had increased their R&D expenses as a result of participation in a public award procedure.[552]

The empirical studies support thus the conclusion of the previous subsection that public demand can have an positive impact on innovation.

2.3.6 Services innovation

The 2007 PCP Communication and the accompanying PCP Staff Working Document are not clear on whether PCP is a suitable instrument for the development of innovative services, particularly when they are not built around a(n innovative) technology. On the one hand, the policy documents talk about the role of PCP to assure the development of technological solutions to meet challenging societal needs.[553] On the other hand, they indicate that the result of a PCP can be either an innovative product or an innovative service.[554]

In this section, I will outline the general approach of EU innovation policy to services innovation and I will sketch the main economic theories in this area. Based on this, I will test the fifth assumption that PCP is a suitable instrument to stimulate technological, as well as services innovations.

2.3.6.1 EU policy in support of services innovation

Innovation theories have until recently focused on technologies.[555] And so has EU's innovation policy. But service sectors have increasingly been recognized as important drivers of competitiveness and growth.[556] By 2009, services represented 74,1% of the gross value-added, generated by the EU 27[557] and promised to provide most of the future new jobs and to play an important role in improving the living standards in Europe.[558]

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[552] Luke Gheorghiou, Jakob Edler, Elvira uyarra, Jilian Yeow, e Gheorghiou, Jakob Edler, Elvira uyarra, Jilian Yef" " CChoice, design and assessment, *Technological Forecasting & Social Change* (2013) 7

[553] PCP Communication 4, 9, 10; PCP Staff Working Document 2-3, 10-1.

[554] PCP Communication 2-3, 8; PCP Staff Working Document 3-4, 8.

[555] Service firms were, for instance, included for the first time in the third Community Innovation Survey (CIS-3)capturing innovation performance in 1998-2000. See Commission, 'Challenges for EU support to innovation in services – Fostering new markets and jobs through innovation' 12 SEC(2009) 1195.

[556] Henk L.M. Kox and Luis Rubalcaba, 'Business services and the changing structure of European economic growth' (2007) MPRA Paper No.3750 < http://mpra.ub.uni-muenchen.de/3750/1/MPRA_paper_3750.pdf> accessed 8 April 2013; J.A. Camacho and M. Rodriguez, 'Integration and diffusion of KIS for industry performance' in Rubalcaba, L. and Kox, H. (eds), *'Business Services in European Economic Growth'* (Palgrave/Macmillan 2007) 128-143; M. Tomlinson, 'The contribution of services to the manufacturing industry', in B. Andersen, J. Howells, R. Hull, I. Miles and J. Roberts (eds.), *'Knowledge and innovation in the new service economy'* (Edward Elgar 2000) 36-48; P. Windrum and M. Tomlinson, 'Knowledge-intensive services and international competitiveness: a four country comparison', 11 (1999) *Technology Analysis and Strategic Management* 391-408.

[557] Eurostat yearbook 2011, 36.

[558] SEC(2009) 1195 final 9, 15.

Despite the perceived importance of services in the EU economy, economists remarked that the present innovation system policies are not well adapted to accommodate the new realities.[559] The EU had only recently taken into consideration the potential of public policies to stimulate innovation in services.[560] The EU funding of R&D in services, although at roughly equal levels with the manufacturing firms, had occurred incidentally and mainly in ICT – related services.[561]

The Council of the EU invited in 2006 the European Commission to analyse the status of innovation in services and to assess the necessity to adjust policy accordingly, in order to take into account non-technological innovation.[562] A study commissioned on the basis of this mandate confirmed that R&D and innovation in services need to be stimulated through public policy.[563] As a consequence, the Commission developed in 2007 a policy framework aiming at better supporting innovation in services,[564] and set-up a Working Group on R&D in Services ('Group') to refine potential policy measures to be included in the innovation strategy for the services sector.[565]

The Group concluded that, due to the heterogeneous nature of services, it is difficult to design a single uniform policy to stimulate R&D in services and that more knowledge is needed to this end.[566] According to the Group, R&D in services is often based on collaborations between disciplines, across sectors and regions and *'it is often affected more by mainstream policies than by those aimed directly at innovation'*.[567]

Based on the Group's recommendations, the Commission concluded in a 2009 Staff Working Document that, although less European service firms have reached the top-50 of global players compared to their American counterparts and although innovative small-, medium- and micro-enterprises ('SMEs')[568] active in knowledge intensive services experience difficulties in accessing private finance, this is not sufficient proof of market or systemic failures to justify

[559] Rubalcaba, Jorge Gallego and Pim Den Hertog, 'The case of market and system failures in services innovation', 30 (2010) *The Service Industries Journal* 549–566; OECD, *'Enhancing the Performance of the Service Sector'* (OECD Publishing 2005).
[560] Expert Group on Innovation in Services, 'Fostering Innovation in Services' (2007) <http://www.gencat.cat/diue/doc/doc_33636404_1.pdf> accessed 28 December 2013; Commission, 'Towards a European strategy in support of innovation in services Challenges and key issues for future actions' SEC(2007) 1059; PRO INNO Europe, 'Challenges for EU support to innovation in services – Fostering new markets and jobs through innovation', SEC(2009) 1195, 9.
[561] SEC(2009) 1195 , 64.
[562] Council, '2769th Competitiveness (Internal Market, Industry and Research) Council Meeting' (2006) point 8.
[563] Reneser Project, 'Research and Development Needs of Business Related Service Firms' (2007) http://www.europe-innova.eu/c/document_library/get_file?folderId=21454&name=DLFE-12859.pdf> accessed 8 April 2013.
[564] SEC(2007) 1059.
[565] Jari Kuusisto, 'R&D in Services – review and case studies, A paper submitted for the CREST R&D in Services Working Group' (February 2008) 30 <http://ec.europa.eu/invest-in-research/pdf/download_en/service_rd080129.pdf> accessed 8 April 2013.
[566] Kuusisto, (2008) 51.
[567] Kuusisto (2008) 52.
[568] SMEs are defined in article 2 of Bijlage I of General Block Exemption Regulation as businesses with maximum 250 employees and an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million.

public intervention. The Commission proposes to build up a better understanding of how innovation takes place in services, before policy tools are developed. [569]

This conclusion is also reflected in the policy approach to R&D subsidies to organizational and process innovation in the State aid area. The Framework for R&D&I imposes separate conditions to aid to process and organisational innovation in services, distinct from the conditions imposed to aid to R&D projects:

- the organizational innovation is related to the use and exploitation of ICT;

- both organisational and process innovation are conducted within a proper R&D project with an identified and qualified project manager and with identified project costs, and entails a clear degree of risk;

- the result of the innovation projects are new or substantially improved compared to the state of the art in its industry;

- the results are in the form of *'a standard, a business model, methodology or concept which can be systematically reproduced, possibly certified and possibly patented';*[570]

- the maximum aid intensity are lower than for traditional R&D technology projects[571] (15% of the cost of the project for large enterprises, 25% for medium enterprises and 35% for small enterprises).

According to the Framework, the separate treatment is justified by the fact that innovative activities in services do not always conform with the definition of R&D, but is *'typically less systematic and stems frequently from customer interaction, market demand, adoption of businesses and organisational models and practices from more innovative sectors or from other sources'*.[572]

In 2011, the European Commission set-up a new advisory group formed of high-profile economists to provide advice on policy options regarding R&D and innovation.[573] In December 2012, the policy recommendations point out to the importance of a supporting policy for innovative services, but at the same time to the gap in knowledge regarding the creation of innovations in services sectors.[574] The experts outline areas of research that need

[569] SEC(2009) 1195, 55, 68-70.
[570] Framework for State aid for R&D&I para 5.5.
[571] Framework for State aid for R&D&I had also extended the definition of R&D to experimental development, which corresponds to the testing phase of the PCP.
[572] Framework for State aid for R&D&I para 5.5.
[573] See http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=expert-groups
[574] Stare Metka & Falz Galluoj, 'Policy Brief N.7 Seizing the opportunities of service innovations' (1-2 December 2012) available at http://ec.europa.eu/research/innovation-union/pdf/expert-groups/i4g-reports/i4g_policy_brief_7_-

to be addressed in order to fill the above mentioned funding gap. They also argue among other, that a revision of public financial schemes in order to make them accommodate services innovations beyond e-services and the use of demand-side instruments such as public procurement are constitute necessary policy measures. It remains to be seen how these recommendations will be reflected into future policy actions undertaken by the European Commission in the area of service innovations.

In conclusion, EU's view on the need to support innovation in services is restrictive. This means that PCP is mainly relevant for technologically demanding solutions. But whenever the minimum conditions for the application of a PCP are fulfilled (particularly the condition that the project activities qualify as R&D services), services innovations could also form the aim of the PCP. The concept of R&D in the PCP area is not limited to activities encompassing (ICT) technologies as it is the case in the R&D policy area.[575] However, activities to develop innovative service solutions will more quickly qualify as R&D services when based on technologies.

2.3.6.2 Economic theories of innovation in services and related empirical studies

As already mentioned, the EU policy choice for limited support to innovation in services is currently based on the fact that theory regarding innovation in service firms is at an early stage.[576] In this section, I will shortly outline the economic literature on the innovation patterns in services.

Some economists consider that a 'one-size-fits-all' innovation cycle applies to all service sectors,[577] while others argue that innovation in services does not have a uniform pattern and that innovation intensity in specific service activities and in specific types of companies may actually be higher than the manufacturing average.[578]

For example, based on empirical data from Spain, Un and Montoro-Sanchez[579] conclude that small- and medium-sized companies (employing fewer than 200 workers) and start-ups have a greater tendency to innovate, both in products (whether in goods or services) and in processes. Moreover, the companies with a greater tendency to implement process

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service_innovation.pdf#view=fit&pagemode=none last accessed 10 October 2013.

[575] The Frascatti Manual remains the leading authority for interpreting the R&D concept.

[576] Services are difficult to define. According to Bryson et al. service functions/activities 'refer to tasks that are being carried out in connection with productive processes and consumption of both goods and services'. J. Bryson, P. Daniels and B. Warf, *'Service Worlds. People, Organisations, Technologies'* (Routledge2004).

[577] Barras concluded that service innovations are characterized by a reverse product cycle (RPC) made of three stages: (1) improved efficiency phase, which means an investment in new technology to increase the efficiency of delivery of existing services; (2) improved quality phase, in which technology is used to improve the quality of services; and, ending the cycle, the stage (3) new products phase, which consists, basically, of the generation of new services. See R. Barras, 'Towards a theory of innovation in services' 15 (1986) *Research Policy* 161-73.

[578] X. Vence and A. Trigo, 'Diversity of innovation patterns in services' 29 (2009) *The Service Industries Journal* 1635–57.

[579] C. Annique Un and Angeles Montoro-Sanchez, 'Public funding for product, process and organizational innovation in service industries' 30 (2010) *The Service Industries Journal* 137.

innovations are those in the financial sector.[580] In contrast, real estate and transport companies prefer not to innovate in services. This conclusion is confirmed by Hollenstein[581] based on the Swiss case. He identifies the causes of the low innovativeness of these services sectors in the weak demand prospects, strong price competition, low appropriability and innovation opportunities, and relatively poor human capital endowment.

Business services[582] more generally are identified by other economists as services which find themselves at the forefront of innovation.[583] Innovation in this sector appears to be the result of combinations of knowledge from different sources (mainly tacit knowledge).[584] Innovation in this sector is positively influenced by intense level of interaction and the high level of interface with clients. The banking, insurance, and other financial services are also sensitive to the innovation coming from suppliers of new technologies and ICT.[585]

The PRO-INNO study[586] came in 2009 to the conclusion that the innovation patterns of knowledge intensive service firms[587] in Europe – which present an R&D intensity above the average of manufacturing companies - are similar to those of manufacturing firms. However, innovation in other services than knowledge intensive ones, is more incremental rather than radical. Compared to the manufacturing sector, less service firms develop internal R&D activities and most new ideas in service companies come from employees and customers.

Other economists advocate that innovation in services should be treated as a completely different field from innovation in manufacturing, thus requiring new theories and instruments of analysis,[588] because the traditional indicators of innovation inputs (levels of R&D expenditures) and innovation outputs (the number of patents) do not reflect the *'hidden parts'* of innovation in services. Innovation in services is often not related to R&D activities and tangible results as defined in the context of technological innovation.[589] Innovation in services

[580] The most important are: online banking, telephone monitoring tools, new or enhanced software or computer networks, application of new methods of risk diversification, optical-electronic document filing, paper-free office management, improved points payment systems, introduction of point-of-sale marketing policy and introduction of new rating or scoring methods.
[581] H. Hollenstein, 'Innovation modes in the Swiss service sector: a cluster analysis based on firm-level data' 32 (2003) *Research Policy* 845-63.
[582] *'Business services cover a broad spectrum of services principally traded in business-to-business transactions. These intermediary services range from software development to temporary-labour agencies, from equipment rental to economic consultancy, and from translation services to accountancy'.* See SEC(2009)1195, 17.
[583] Vence and Trigo (2009).
[584] C. Hipp and H. Grupp, 'Innovation in the service sector: The demand for service-specific innovation measurement concepts and typologies' 34 (2005) *Research Policy* 517–35.
[585] Maria Abreua, Vadim Grinevich, Michael Kitson and Maria Savona, 'Policies to enhance the 'hidden innovation' in services: evidence and lessons from the UK' 30 (2010) *The Service Industries Journal* 115.
[586] SEC(2009)1195 (n275) 9.
[587] Examples of knowledge intensive service activities (KIS) include: research and development (R&D), management consulting, ICT services, human resource management and employment services, legal services (including those related to IPR) accounting, financing, and marketing-related service activities.
[588] Un and Montoro-Sanchez (2010); Barras (1986).
[589] Griliches, Z., 'The Search for R&D Spillovers' 94 (1992) *Scandinavian Journal of Economics* 29-47; Abreua et al (2010); Vence and Trigo (2009).

is instead often determined by users and tacit knowledge rather than by research. Therefore, different measurement indicators are necessary.[590]

Based on empirical data from the UK, Abreua et al[591] remark that organisational innovation is a substantial part of the *'hidden'* dimension of innovation in services, especially in three sectors: financial intermediation, computer services and research and development services. These sectors introduce more major changes in organisation and business structure than either manufacturing or other services. Abreua considers that although there are a number of key drivers of innovation in services, there is no one dominant pattern or model of innovation. The most efficient form of public intervention in support of innovation is to incentivize trainings for high-level skills. This is recommendable for two reasons. Firstly, labour skills are crucial for the innovative capacity of service firms. Secondly, service firms tend to underinvest in training and staff development due to the intensive movement of labour.

The ServPPin study[592] argues that the current prevailing theory for service innovation should be a synthesis between the technological and services theory of innovation, on the background of a converging trend in the manufacturing and services sector in terms of specialization and modularity. Unlike the innovation patterns defined by Schumpeter in which the entrepreneur or the internal R&D labs play a central role, the ServPPIN study remark a trend towards a neo-Schumpeterian innovative pattern in which the central role is occupied by networks of firms.

The Study also provides an overview of the reasons for active and direct public support of services innovation within the framework of public-private networks. The study argues that governments have *'a leading role in initiating and pulling through innovation processes'* in the services sector. This is driven by the privatization of numerous public tasks, the internationalization of economics and politics and the serious social challenges (such as social inequality and environmental threats) that put pressure on the public actor to collaborate with the private sector in finding innovative solutions. Moreover, the public body remains *'the largest service provider in most developed countries'* and most of these services have the characteristic of public goods. This entails that the private sector is not able to provide improvements unilaterally.

Some economists[593] divide the policy tools that may enhance the appropriate environment for innovation in the service sectors between: (i) regulatory-framework-related and (ii) complementary policies. The former group comprises more-normative-oriented policy

[590] SEC(2009)1195, 34-5.
[591] Abreua et al (2010) 99–118.
[592] Andreas Pyka, Benjamin Schön, Paul Windrum, Lars Fuglsang, Koen Frenken, 'Cooperation for Innovation in Services – An Economic Approach to the Theory of Innovation Networks in the Service Industries' (ServPPIN 2009).
[593] Rubalcaba et al (2010).

measures, which range from pro-competition policies to SMEs, support measures and transparency in markets mechanisms, from reinforcement of the appropriability system measures to supporting the creation of a European common market for services.

Among the complementary policy actions the authors recommend to promote service quality and brand recognition for service firms, to encourage results dissemination, to enable collaborative schemes (networks) between both research and industry and users and producers, to enhance access to venture capital and finance from outside the firm. The same authors advocate the important role of standardization in the field of services in order to reduce the asymmetry in information, for the benefit of both provider and user and in order to provide a guarantee of the quality being supplied. The authors see also a role for commercial public procurement of innovative services as a means to reduce uncertainty problems caused by asymmetry of information and to increase through competition the number of active service providers in a market.

In conclusion, most economic studies analysed in this subsection consider that innovation patterns and R&D intensities differ among the various service sectors. Amongst these, knowledge intensive service sectors perform better in terms of R&D intensities than the manufacturing sector. However, innovation activities in many service sectors, and particularly innovation activities in organizational processes, do not qualify as R&D in the traditional sense. This makes established R&D public policies less relevant.

Economists largely agree that the most important drivers of innovation in services are: quality of the human capital (including tacit knowledge), intense levels of interaction with clients and use of innovative (ICT) technologies. Moreover, economists agree that mainstream policies (such as incentives for training of high-level skills etc.) positively impact innovation in services, often more than those policies aimed directly at innovation in services. Among policy measures aimed directly at innovation in services, economists mention: increased access to external finance and commercial public procurement.

PCP as policy instrument is not mentioned in any of the reviewed literature. PCP may however be employed when the minimum conditions for its applicability are fulfilled. However, the condition that only R&D services may be funded through PCP limits the relevance of PCP for the services sector.

2.4 Conclusion

This chapter has described in the first part the policy process which led to the adoption of PCP and the political expectations which built around this instrument. Summarized, the EU

policy-makers expect PCP to incentivize private actors to invest in R&D projects that have the potential to provide ground-breaking solutions to important social problems. In addition, PCP is expected to enhance the innovation capabilities of EU businesses and to grant them a competitive advantage in (new) global markets.

The second part of this chapter tested 5 of the most important economic assumptions that lie at the foundation of PCP, against authoritative economic theories and studies encompassing but going beyond those embraced by the EU innovation policy-makers.

I concluded that there is broad support in economic theory for the first assumption that innovation leads to (social) welfare. Economists also broadly support the second assumption, that R&D investment is a necessary pre-condition of innovation, although it may not be the only or the most important one. Economists differ mostly on the role the government can play as investor in R&D. According to neo-classics, public R&D investments should be justified only in case of a demonstrated failure of the market to invest itself in R&D. According to systems of innovation theorists, public intervention should be approached in a more integrated manner, and should particularly be focused on facilitating interactions between the different public and private institutions that form the systems of innovation.

More recent complexity theories underline that due to the large number of factors that co-impact innovation processes and due to their complex and to a certain extent random patterns of interaction, public innovation policy should be designed as an evolutionary system, open to experimentation, learning and adaptation. In respect of R&D funding, such an evolutionary innovation policy should entail:

- stimulating the emergence of a variety of innovations to be subsequently exposed to the selection process in the marketplace;

- choosing for the most successful innovative trajectory when uncertainties are much lower;

- tolerating redundancy, overlap and excess capacity.

This chapter also tested the assumption that PCP is needed in the EU, due to insufficient investments by venture capitalists in risky R&D projects. Based on a comparative analysis of theories and studies dealing with the role of venture capital in the US and the EU, I concluded that this third assumption is correct. In the US, private venture capital mitigates to a certain extent the difficulties of new innovative firms to access finance for risky R&D projects. However, venture capital is insufficient in the US for potentially high value projects which involve high failure risks, large research and development costs, or long-term return on investment. The shortage of venture capital for risky R&D projects becomes more acute in

times of economic downturn. US public investments in early stage technology firms compensates to a large extent for the funding difficulties of new innovative firms. By 2003, the US government dedicated approximately two to eight times more funds to early stage technology firms than private venture capitalists.

In contrast to the US, EU copes with a far less developed private venture capital market and with low public investments in high risk R&D projects.

This chapter also showed that there is wide support among economists for the fourth assumption, that demand is a key determinant of innovation. Economists distinguish between social or collective needs and demand. Social or collective needs are social problems identified by the government or expressed by society collectively through the political process, while demand is the willingness and ability to buy and use an innovative solution. Based on several landmark economic studies, I concluded that:

- demand may motivate firms to invest in R&D;

- firms are not always able to perceive demand;

- the government has an important role to signal public demand for innovative solutions;

- involvement of the most experienced and leading-edge users (lead-users) in the product development process yields significant benefits to the innovative firm in terms of insight into future demand, testing inputs and even innovative ideas.

- early signaling of advanced and stringent needs together with early and sufficiently wide adoption of the resulting innovation strengthens the competitive position of firms on global markets.

This chapter has also tested the fifth assumption that PCP is a suitable instrument to stimulate technological, as well as services innovations. I pointed out that due to the increasing importance of services for economic growth in Europe and due to the important role of the government as service provider, the EU policy-maker has in recent years investigated the need to support innovation processes in services. Based on outcomes of commissioned studies and expert groups, the European Commission has so far concluded that due to the limited understanding of how innovation emerges in services, a specific public policy cannot be designed. This does not change the fact that whenever innovative activities related to services qualify as R&D, they may form the target of a PCP procedure. This will mainly be the case when the innovation is related to the use of technologies. Thus, PCP remains mainly

relevant for technologically demanding solutions and only to a limited extent for innovation in services.

On the basis of the analysed economic studies and theories, I can summarize the following economic preconditions for the effective implementation of PCP:

1. the public R&D funding targets the most experimental and riskiest R&D projects;

2. the public R&D funding targets small companies, that experience difficulties in obtaining (sufficient amounts of) private capital for experimental/risky R&D projects;

3. a high degree of experimentation and tolerance to failure are accepted;

4. competition is maintained throughout the whole innovation process;

5. the public purchaser is the technologically sophisticated end-user of the envisaged innovation;

6. the public purchaser is willing to pay the premium price for the early use of the developed innovation and is capable to offer a sufficiently sizeable market for the developed innovation;

7. when the public purchaser is not the end-user of the envisaged innovation, it is capable to convey the advanced needs of the private end-users to the innovator and it is capable to adopt additional policy measures to stimulate the early up-take of the developed innovations by the private end-users (the case of the so-called catalytic PCP);

8. the adaptation of the product to larger (foreign/global) markets is not cumbersome;

9. innovative technologies rather than innovative services are targeted;

10. a continuous scrutiny/measurement of the impact of PCP is performed and lessons learnt are codified in guidance.

This chapter sets the scene for the following outline of the differences between the US SBIR, and the PCP procedure and for the discussion on the significance of these differences for the successful deployment of PCP in Chapter 3.