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Mixed Modes of Innovation: An Empiric Approach to Capturing Firms' Innovation Behaviour

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MIXED MODES OF INNOVATION: AN EMPIRIC APPROACH TO CAPTURING FIRMS' INNOVATION BEHAVIOUR

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MIXED MODES OF INNOVATION: AN EMPIRIC APPROACH TO CAPTURING FIRMS' INNOVATION BEHAVIOUR[1]

Marion Frenz and Ray Lambert[2]

ABSTRACT

This study uses exploratory data analysis techniques to develop typologies of innovation modes or strategies for groups of firms. Analysing micro-level survey data from 18 countries we identify five innovation modes: *(i) IP/technology innovating* which contains at its core IPRs, and in many countries this is complemented by in-house R&D and new-to-market activities; *(ii) marketing based innovating* which includes forms of product innovation, leaning towards new-to-firm imitating, with marketing expenditures for the introduction of innovations; *(iii) process modernising* which links process innovations with equipment spending and training; *(iv) wider innovating* with combinations of management and business strategy changes, including new sales and distribution methods; and (v) *networked innovating* involving bought-in R&D or licences and formal collaboration and leaning towards accessing information from universities.

The coherence and relevance of the innovation modes is tested by using them as explanatory factors in equations explaining economic performance. In most countries one or more innovation modes are positively associated with labour productivity. However, there is no consistent cross-country pattern as to which modes show significant associations with productivity. Even if common innovation patterns have been identified, there is no 'single' mode or form of innovation across countries that underlies the overall impact of innovation and there appear to be major national differences in patterns of competitive and comparative advantage with respect to levels of productivity as well as growth in turnover and employment. Importantly, sectoral innovation orientations are embedded in national systems, as well as exhibiting a degree of convergence at sectoral level.

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LES MODES MIXTES D'INNOVATION : UNE APPROCHE EMPIRIQUE DES COMPORTEMENTS D'INNOVATION DES FIRMES [3]

Marion Frenz et Ray Lambert[4]

RÉSUMÉ

Cette étude établit des typologies des modes ou stratégies d'innovation pour les groupes d'entreprises au moyen de techniques d'analyse exploratoire des données. Une analyse de micro-données issues d'enquêtes réalisées dans 18 pays a permis de dégager cinq modes d'innovation : (i) l'innovation axée sur la PI/technologie, centrée sur les DPI, complétés dans de nombreux pays par de la R-D interne et des activités d'introduction de produits inédits sur le marché ; (ii) « l'innovation de commercialisation » qui comprend certaines formes d'innovation de produits, se rapprochant de l'imitation inédite pour l'entreprise, avec une dépense de commercialisation pour l'introduction des innovations ; (iii) « la modernisation de procédé » dans laquelle les innovations de procédé sont liées à l'investissement d'équipement et à la formation ; (iv) « l'innovation large », qui peut combiner des changements au niveaux de stratégie de management et des stratégies commerciales, notamment l'instauration de nouvelles méthodes de vente et de distribution ; et (v) « l'innovation en réseau » qui repose sur la R-D externalisée ou l'achat de licences et la collaboration formelle, tendant vers l'acquisition d'informations aux universités.

Pour tester la cohérence et la pertinence de ces modes d'innovation, nous les avons utilisés comme facteurs explicatifs dans des équations de performance économique. Dans la plupart des pays, un ou deux modes d'innovation sont positivement associés à la productivité du travail. Toutefois, on ne constate pas que certains modes spécifiques soient clairement associés à la productivité dans tous les pays. Même si des profils d'innovation communs sont apparus, il n'existe pas un mode ou une forme d'innovation qui détermine l'impact global de l'innovation, et on constate d'importants écarts dans la manière dont l'avantage concurrentiel et comparatif influe sur le niveau de productivité et la croissance du chiffre d'affaires. Les orientations sectorielles de l'innovation sont profondément ancrées dans les systèmes d'innovation nationaux, et on constate une certaine convergence au niveau sectoriel.

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3. Ce travail s'inscrit dans le cadre du Projet de l'OCDE sur les Micro-données sur l'Innovation (phase 2) et a bénéficié du soutien de l'OCDE, en particulier celui d'Alessandra Colecchia, de Vladimir López-Bassols et de Pierre Therrien. Deux ateliers méthodologiques nous ont permis de développer les programmes Stata, dont l'écriture a été centralisée et qui ont été mis en œuvre au niveau national par Martin Berger (Autriche) ; David Hansell et Jason Russo (Australie) ; Jeoffrey Malek Mansour (Belgique) ; Pierre Therrien (Canada et Chili) ; Martin Srholec (pour la République tchèque et les données Eurostat CIS pour l'Allemagne et l'Italie) ; Carter Bloch (Danemark) ; Jaan Masso (Estonie) ; Thorvald Finnbjornsson (Islande) ; Helena Connellan et Ian Hughes (Irlande) ; Seok-Hyeon Kim (Corée) ; Anna-Leena Asikainen (Luxembourg) ; Thomas van Kooten (Pays-Bas) ; William Blankley et Irma Wilkinson (Afrique du Sud) ; Pilar Rico Castro (Espagne). Nous leur exprimons notre gratitude à tous.

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MIXED MODES OF INNOVATION: AN EMPIRIC APPROACH TO CAPTURING FIRMS' INNOVATION BEHAVIOUR

1. Introduction: strategic modalities in the innovation system

Innovation plays an important role in shaping the growth and competitiveness of firms, industries and regions. Reflecting further on the outcomes of innovation, accumulated analytical results suggest that a combination of technological and non-technological innovation activities is especially pertinent to performance. Firms that engage in both product and process type innovation and, at the same time, introduce organisational and marketing changes outperform firms that concentrate on one or the other activity underpinning growth at the macro level (von Tunzelmann, 1995).

This paper adopts a recently emerging approach of identifying innovation modes. Mixed modes of innovation explicitly refer to a set, or bundle of, activities which are done together by a firm to develop and market a new good or service, or to improve on production, delivery and business processes (Arundel and Hollanders, 2005, 2011; Battisti and Stoneman, 2010; Frenz and Lambert, 2009; Hollenstein, 2003; Jensen *et al.*, 2007; Leiponen and Dreijer, 2007, Srholec and Verspagen, 2008).

Mixed modes of innovation are developed by exploring – via factor analyses – micro-level innovation surveys. Modes of innovation and their impact on performance are compared across 18 countries and within three selected sectors in the 18 countries. The modes are used to provide insights into the nature of the underlying innovation systems and the relevance of national and sectoral contexts.

The contributions of this work lies in a) the identification of 'core' innovation modes that are found – in varying connotations – in (almost) all countries; b) examining – via regression analysis – the role that different modes play in firm performance and growth; and c) analysing the extent to which there is convergence of modes within selected sectors across countries.

This study builds on and extends previous analysis reported in *Innovation in Firms: a Micro-economic Perspective* (OECD, 2009) by increasing the number of participating countries, expanding on the measures feeding into the analysis (specifically aspects of networked and open innovation additionally to non-technological aspects of innovation) and by introducing improvements to the methodology. The sectoral analysis, impact on growth and emphasis on systemic relationships are new and complement earlier results presented in OECD (2009). We use a systematic and co-ordinated approach to analysing micro-level data held in individual statistical offices of member countries: the Stata codes are centrally written and run by the participants on their firm level datasets.

The objectives of this study were set as:

- Test the consistency of the innovation modes over time;
- Incorporate the role of national innovation systems in innovation modes, through adding 'systems variables' on knowledge flows to the modes;
- Investigate the relative specialisation in modes of innovation across regions and industries;

- Estimate the relative effects on levels and change in productivity and growth in employment and turnover.

Consistency over time was tested by repeating the routines reported in OECD (2009) with later datasets for several of the participating countries. The results showed that very similar parameter values were obtained from the factor analyses that specify the modes. This result suggests that:

- Innovation surveys tend to capture structural rather than transitory characteristics of innovation behaviour; and
- That the estimated modes are robust, *i.e.* that they have specified and quantified some underlying strategic orientations.

The remainder of this paper turns to presenting the methodology and outcomes of the analysis for the Phase 2 specific aspects. It is written to be a self-contained account, including an introduction to the principles of the modelling strategy and the precedent literature to which we now turn.

2. Mixed modes of innovation: a new approach

In this section we first discuss the growing literature on mixed modes of innovation. We then introduce the framework for analysis, drawing out the policy related research questions that are addressed in the empirical part of the report.

2.1. Mixed modes of innovation

What is meant by innovation, and how it should be measured, is not universally understood. We are – often implicitly – working with different and perhaps at times even competing typologies of innovation. Within the conceptual framework of the *Oslo Manual* (OECD/ESTAT, 2005), some common meaning exists with respect to product and process innovations, with various caveats such as the degree of novelty and creativity; but, the set of activities which falls under the umbrella term 'innovations' is much wider including new forms of design, organisational and management concepts, collaborative arrangements, searching for ideas, and marketing activities.

Existing (one-dimensional) typologies are being challenged by new approaches to developing innovation typologies which explicitly focus on the multidimensional facets or aspects of innovation strategies/routines. This approach is, therefore, related to the evolutionary perspective proposed by Nelson and Winter (1982) that emphasises 'routines' as the relevant unit of analysis (albeit with an emphasis on innovation routines). In this paper we refer to the typologies as mixed modes of innovation. Similar terms used throughout the literature are innovation strategies, practices or routines. An example of an innovation mode is what we refer to as 'process modernising' by which firms develop a new production process, or service delivery method, coupled with spending on equipment and training of staff to use that equipment. Firms typically employ more than one mode in strategic combinations.

Table 1 provides a (non-exhaustive) overview of different studies identifying innovation modes. The table gives information on the name and number of different modes, broad methodology, measures feeding into the modes and datasets from which the modes are generated.

Table 1. Overview of different studies identifying innovation modes

Innovation modes	Methodology	Measures feeding into modes	Data	Study
Mode 1: 'Science-based high-tech firms ' Mode 2: 'IT-oriented network-integrated developers' Mode 3: 'Market-oriented incremental innovators' Mode 4: 'Cost-oriented process innovators' Mode 5: 'Low-profile innovators'	Exploratory	Inputs and outputs, linkages	Swiss Innovation Survey 1999 Private services sectors	Hollenstein (2003)
Mode 1: 'Strategic innovators' Mode 2: 'Intermittent innovators' Mode 3: 'Technology modifiers' Mode 4: Technology adopters'	Prescriptive	Technological inputs and outputs	Eurostat NewCronos (largely Eurostat CIS3 data)	Arundel and Hollanders (2005)
Mode 1: 'Science, Technology and Innovation' Mode 2: 'Doing, Using, Interacting'	Prescriptive	Inputs, organisational	2001 Danish DISKO Survey	Jensen, Johnson, Lorenz, Lundvall (2007)
Mode 1: 'Science-based' Mode 2: 'Specialised suppliers' Mode 3: 'Supplier-dominated' Mode 4: 'Research-intensive'	Exploratory	Inputs and outputs, Linkages, organisational	Survey of SMEs in the Netherlands 2003	de Jong, Marsili (2006)
Mode 1: ' Science-based' Mode 2: 'Supplier-dominated' Mode 3: 'Production intensive' Mode 4: 'Market driven'	Exploratory	Mainly inputs, linkages	CIS2 for Denmark and Finland	Leiponen and Drejer (2007)
Mode 1: 'Research' Mode 2: 'User' Mode 3: 'External' Mode 4: 'Production'	Exploratory	All CIS variables available	Eurostat CIS3	Srholec and Verspagen (2008)
Mode 1: 'New-to-market innovating' Mode 2: 'Marketing-based imitating' Mode 3: 'Process modernising' Mode 4: 'Wider innovating'	Exploratory	Inputs and outputs	Innovation surveys of 9 OECD countries	Frenz and Lambert (2009)
Mode 1: 'Organizational innovations' Mode 2:' Technological innovations'	Exploratory	Mainly outputs	UK CIS4	Battisti and Stoneman (2010)

The number of modes, and their interpretation, as indicated by the summary names given to the modes, vary due to differences across studies with respect to the following three areas: a) the methodology; b) the measures feeding into the modes; and c) the datasets analysed. In the following a) to c) are discussed in light of the design of the current study.

We first turn our discussion to (a) explorative or prescriptive approaches to generating typologies of innovation modes. Arundel and Hollanders (2005), Arundel *et al.* (2007) and Jensen *et al.* (2007) define *a priori* modes of innovation informed by theory and qualitative empirical evidence. While Jensen *et al.* place specific emphasis on organisational designs and practices, Arundel and Hollanders confine their

study – due to limitations in internationally comparable data – to technological activities resulting in a narrow definition of modes. The more frequently used approach, and indeed the approach adopted in this study, is to not rely on a preconceived idea of what activities are done together by firms and thus form a coherent subset, but to 'let the data speak'. Explorative techniques are used to identify which activities form a specific innovation routine. Typically data reduction techniques (factor and cluster analyses) are applied to the survey data. This paper also relies on an explorative methodology where the data informs the concepts.

This leads onto point (b) above – individual measures feeding into the analysis in different studies – that influences the modes reported. Even where an explorative approach is used, reported innovation modes differ, because different variables feed into the analysis. With respect to this, Srholec and Verspagen's (2008) work stands out, because they explicitly do not select measures feeding into the analysis but use the breadth of variables in the harmonized CIS3 questionnaire. Battisti and Stoneman (2010), on the other hand, almost exclusively rely on output measures – product, process managerial and organisational innovations. The first point that arises is, therefore, if inputs and outputs into the innovation process should be included. There are two further differences across the studies: the extent to which non-technological activities are covered by the modes; and the extent to which linkages, innovation as an interactive process, are covered by the modes. We discuss each in turn.

Focusing on inputs or output measures reflects a specific, sequential view of the innovation process and assumes a degree of demarcation between activities that feed into innovation and those aimed at introducing a new or improved production process or product. But there is considerable overlap and blurred boundaries around inputs and outputs in the innovation processes that lead them to be jointly determined, and the majority of studies consider both inputs and outputs together. In this paper, both inputs and outputs into the innovation process feed into the development of mixed modes, with the view that activities happen in parallel reinforcing each other via feedback loops as, for example, described in the chain-linked model of the innovation process (Kline and Rosenberg, 1986).

With respect to the loose distinction the literature makes between technological and non-technological activities, mixed modes of innovation as considered here are based around the relevance of activities linked to technological knowledge, but also non-technological activities. Non-technological activities are reflected in all studies introduced in Table 1, with the exception of Arundel and Hollanders (2005), where the sole focus on technological activities is due to data constraints. Indeed, the increased emphasis on non-technological activities has contributed to the emergence of modes of innovation (*e.g.* Frenz and Lambert, 2009). The relevance of internal resources (*e.g.* Penrose, 1959) to innovation and growth are picked up in most studies, and are connected with the effectiveness of adoption of external ideas (Cohen and Levinthal, 1989, 1990). Internal activities can lean towards technological activities, but also comprise non-technological activities that bear relevance for the innovation process, including organisational and managerial practices, resources devoted to new designs and marketing concepts. While technological activities lean towards invention, non-technological activities lean towards the successful commercialisation of an innovation.

Linkages form part of the modes developed in Hollenstein (2003), de Jong and Marsili (2006), Leiponen and Dreijer (2007), Jensen *et al.* (2007) and Srholec and Verspagen (2008). Measures capturing the relationships with the wider innovation system feed into the modes developed here. Innovation processes are interactive, inside the firm as discussed above, but, and increasingly so, involve the use of outside sources and network configurations (*e.g.* Freeman, 1987; Rothwell, 1992, Kline and Rosenberg, 1986; Chesbrough, 2003). In the context of open innovation linkages, the focus is on bought-in technology and knowledge and internal and external 'routes to market' (Chesbrough, 2003).

Innovation networks emphasise the relevance of collaborations to innovation (*e.g.* Rothwell, 1992). These can be formalised, *e.g.* via strategic alliances, or be informal. Both are captured in the innovation surveys by asking firms to indicate the relevance of different sources of information for innovation. These sources are firms (competitors, suppliers or customers), and research organisations and universities (for an analysis of the relevant variables see for example Laursen and Salter, 2006). More formalised arrangements are captured by asking respondents whether or not they co-operated.

Finally – and with reference to point (c) above – the selection of measures is also influenced by the different datasets, most, but not all, comprise both manufacturing and private services. The questionnaires of the innovation surveys are influenced by the successive revisions of the *Oslo Manual*, which provides international guidelines on innovation data collection. The *Oslo Manual* takes an eclectic and comprehensive approach to theories explaining the innovation process. The older the surveys are, the more likely they are to lean towards technological activities. On the whole, activities related to design and organisational innovations are perhaps least well captured in the datasets used in the studies summarised in Table 1. The latter are captured with reference to the propensity of firms to engage in a specific activity (yes/no questions), while activities leaning towards formal research and development are measured with respect to both, the propensity of firms to engage in an activity and the intensity with which firms engage in an activity. In this paper we explore the propensity of firms to engage in an activity. For technical reasons, and as explained in Section 3, intensity measures do not feed into the mixed modes of innovation at this stage.

Based on the above discussion, Table 2 gives the names of the core modes from the empirical section and summarises the framework developed in this section to identify mixed modes of innovation. This framework guides the data analysis and determines the dimensions of activities feeding into the mixed modes and the broad methodology. In Section 3 we discuss the individual, specific measures and statistical techniques. The results refer to the largest available number of participating countries.

Table 2. Framework for deriving at modes of innovation

Innovation modes	Methodology	Measures feeding into modes	Data
Mode 1: 'IP/technology innovating' Mode 2: 'Marketing based innovating' Mode 3: 'Process modernising' Mode 4: 'Wider innovating' Mode 5: 'Networked innovating'	Exploratory factor analysis used to generate core modes. Comparison across countries, and within sectors across countries.	Inputs and outputs, linkages, organisational, marketing	Micro level data across 18 countries

The methodology adopted for the purpose of identifying different modes of innovation is explorative – factor analysis – to summarise bundles of activities and determine the relevant number of modes. The measures feeding into the analysis relate to so-called inputs and outputs into the innovation process in order to acknowledge that these are typically jointly reinforcing activities and not mutually exclusive steps in a linear process. Both, technological and non-technological activities go hand-in-hand in the development of new goods and services, and this is reflected by using the breadth of measures in the innovation survey related to organisational, marketing and design activities next to the more traditional indicators including in-house R&D. Specific emphasis is placed on the interactive nature of the innovation process by taking into account (a) different sources of information; (b) collaborative activities for innovation; and (c) acquisition of external knowledge. A harmonised approach is then applied to micro data of 18 OECD countries.

2.2. Policy and research questions

Linked to the discussion above, this paper is concerned with: a) the identification of core innovation modes that are found across the 18 countries. Particular emphasis is placed on systemic interrelations, sometimes conceived of as 'open' or connected innovation modalities; b) examining – via regression analyses – the role of different modes in firm performance as this indicates how modes represent in the functioning and effects of the wider innovation systems; and c) analysing the extent to which there is convergence around core modes across countries and within selected sectors across countries. The first research question related to a) above is:

RQ1. What core modes of innovation can be observed?

With respect to (b) and (c) above, we do not *a priori* expect to find common modes and impacts of modes across countries; instead we expect that differences as well as commonalities in country results will further our knowledge as to how respective innovation systems function, their similarities and how they differ. On the one hand, innovation practices are likely to depend on differences in national innovation systems and country specific socio-economic environments (*e.g.* Freeman, 1995; von Tunzelmann, 1995). On the other hand growing international dependency among economies and in particular the activities of transnational corporations, and their role in the generation and diffusion of innovations across national borders, may increase convergence in innovation practices (*e.g.* Cantwell, 1989; Castellani and Zanfei, 2006, Frenz and Ietto-Gillies, 2009; Filippetti *et al,* 2009). The relevant research questions are the following:

RQ2. Do mixed modes of innovation differ across countries?

RQ3. Is there a difference in the relationships between mixed modes and firm performance across countries?

RQ4. Is there similarity within specific sectors across countries with respect to the use that firms make of mixed modes?

A high degree of convergence within the individual modes and their effects across countries and within sectors across countries would suggest that national boundaries are of low relevance as a lens for analysing innovation and for developing a country specific policy mix to promote innovation. Conversely, lower convergence, especially at sector level, both with respect to the modes, and with respect to the economic effects of the modes, would indicate that national boundaries are an important angle for analysis and attach greater importance to a tailored set of instruments to foster innovation in national firms.

3. Methodology and data

3.1. Methodology

Our point of departure is to use observable patterns in the innovation surveys to arrive at a new conceptual understanding of modes of innovation guided by research questions identified in Section 2. Factor analyses are applied to micro-level data in individual countries to derive modes or practices of innovation. We use explorative (as opposed to confirmatory) factor analyses. The technique reduces a set of variables to underlying concepts (factors) which summarise combinations of activities. In other words, we discover which measures form coherent subsets. The measures of a subset/factor are correlated with one another and the strength of their correlation is summarised in factor loadings. Measures that score high in one factor are largely independent of other factors, but with some exceptions, where loadings on a variable are similar across more than one factor.

A centrally written Stata do-file is run by participating countries on their respective and latest available micro datasets. All measures feeding into the factor analyses are measured on a binary scale. Although, innovation surveys contain continuous data for some of the measures, such as the amount spent on R&D, we do not use this information for technical reasons. Binary data factor analysis involves the computation of a tetrachoric correlation matrix, and factor analysing this matrix, under the assumption that the observed binary variables correspond to latent continuous variables (*e.g.* Battisti and Stoneman, 2010). Five factor solutions are reported for all countries, in order to maximise comparability of results. For a large majority of countries this corresponds with the number of factors that have eigenvalues greater than one.

Modes of innovation are computed at the level of the individual countries. From the rotated factor matrix of the 18 individual countries we compute a 'core' factor matrix that contains average factor loadings for each of the modes. Averages are weighted by the GDP of countries.[5] The core modes are used to benchmark visually (by the use of radar diagrams) country specific patterns. Additionally, correlation analyses are used to examine the degree of heterogeneity in modes across countries (and how close a country's connotation of a mode is to the 'core' mode).

Factor scores for each mode are computed for each firm in the dataset and are then used as variables in models to estimate the relationship between modes of innovation and firm performance and growth. Performance is measured as log of labour productivity (turnover per employee in 2006) and growth in turnover as well as employment (both between 2004 and 2006). We assume a linear relationship between mixed modes and performance indicators. The regressions control for 2-digit industry groups, NUTS1 regions, enterprise size, operating in international markets and being part of a wider group. And, the regressions explaining change in turnover and employment between 2004 and 2006, additionally correct for turnover and employment levels at the beginning of the period (2004).

In a final step the results section compares the relative specialisation of industries in specific modes, across countries, by a comparison of mean factor scores within an industry across countries. Here, we use 'Analysis of Variance' to assess the amount of variation explained at the industry level.

3.2 Data

The measures used in the analyses are informed by the (harmonized) CIS 2006 questionnaire on which information is collected across all (or most) countries included in this study. The reference period for the innovation surveys is 2004 to 2006. Measures feeding into the factor analyses in each country, and, thus, forming the modes of innovation, reflect both inputs and outputs of the innovation process. They span technological and non-technological activities, including marketing and design. Specific emphasis is on the interactive element of the innovation process; the role of external sources, information from other businesses or research organisations, and collaborative innovation projects on innovation. Table 3 provides an overview of the measures feeding into the factor analyses in the 18 countries.

5. GDP measured in current USD figures for the year 2006 published by the World Bank as part of the World Development Indicators are used. We also computed weighted averages using the number of enterprises that responded to the individual surveys. In this case, countries in which the surveys are compulsory, such as Spain, unduly impact on generic modes. Nonetheless, results are highly similar and available upon request.

Table 3. CIS-2006-based measures feeding into the factor analysis

Name of measure	*Description of measure*
1 NEWFRM	Enterprise introduced a good or service only new to the firm
2 NEWMKT	Enterprise introduced a good or service that was new to the firms' market
3 INPCS	Enterprise introduced a new process
4 ORGSYS	Enterprise introduced new knowledge management system
5 ORGSTR	Enterprise introduced new workplace organisation
6 ORGREL	Enterprise introduced new relations with other firms
7 MKTDES	Enterprise introduced a significant change to design or packaging
8 MKTMET	Enterprise introduced new sales or distribution methods
9 RRDIN	Enterprise carried out in-house R&D
10 PROPAT	Enterprise applied for a patent
11 RMAC	Enterprise bought new machinery
12 PRODSG	Enterprise applied for a design right
13 PROCP	Enterprise claimed copy right
14 RTR	Enterprise had expenditures related to training for innovation processes
15 RMAR	Enterprise spent on market launch of new goods or services
16 EXTINN	New goods, services or processes were mainly developed externally
17 SOURCING	Enterprise bought in R&D or other knowledge, *e.g.* licensing-in
18 INFOMKT	Medium or high importance of information from other businesses
19 INFOKB	Medium or high importance of research organisations
20 CO	Enterprise co-operated on innovation with external partner

The left column of Table 3 gives the short name for each measure and the right column a description of the measures. The following restriction with respect to sample selection was made. Observations feeding into the analyses are those from innovation active enterprises – using a Eurostat definition. An enterprise is considered to be innovation active if it had a product innovation or a process innovation or any innovation activities to develop product or processes that were abandoned or are still ongoing during the reference period of the surveys. This is done for two reasons. First, because we are interested in exploring the range of practices among innovative firms, and second, because not all measures included in Table 3 are available for non-innovation active enterprises. In terms of the industry sectors included, observations cover all sectors in the individual datasets. In most cases this means, manufacturing plus most private services. In total there are 44 497 enterprises in the combined datasets used in this study.

4. Core modes of innovation

The first results section, addressing RQ1, describes the core innovation modes that are computed using weighted averages of factor loadings across the 18 countries. These core modes, to varying degrees and with different connotations, are in the country-specific results (presented in Section 5). The purpose of introducing the core modes is twofold: firstly, to bring the reader closer towards understanding the core/common elements of mixed modes without the complexity of looking at 18 countries' factor results simultaneously; and secondly, the core modes are used as a benchmark for individual countries' results in the subsequent section where country specific patterns are discussed with reference to their deviations from the core modes. Table 4 provides the factor loadings of the core mixed modes of innovation.

Table 4. Core modes based on weighted factor loadings across 18 countries

Measures feeding into the factor analysis	IP / technology innovating	Marketing based innovating	Process modernising	Wider innovating	Networked innovating
1 NEWFRM	0.09	0.73	-0.03	0.04	0.07
2 NEWMKT	0.35	0.60	-0.05	0.06	0.17
3 INPCS	0.02	-0.18	0.68	0.23	0.04
4 ORGSYS	0.05	0.03	0.11	0.64	0.21
5 ORGSTR	0.06	0.03	0.11	0.69	0.18
6 ORGREL	0.09	0.04	0.10	0.48	0.15
7 MKTDES	0.14	0.28	0.04	0.54	-0.01
8 MKTMET	0.11	0.23	0.01	0.44	-0.09
9 RRDIN	0.46	0.26	0.03	0.05	0.45
10 PROPAT	0.80	0.10	0.01	0.01	0.18
11 RMAC	0.05	0.07	0.67	0.06	0.08
12 PRODSG	0.77	0.11	0.06	0.09	0.02
13 PROCP	0.66	-0.02	0.02	0.12	0.04
14 RTR	0.14	0.24	0.41	0.24	0.17
15 RMAR	0.35	0.43	0.14	0.23	0.20
16 EXTINN	-0.28	-0.06	0.40	-0.12	-0.36
17 SOURCING	0.29	0.19	0.26	0.13	0.44
18 INFOMKT	0.09	0.31	0.32	0.17	0.15
19 INFOKB	0.17	-0.01	0.10	0.14	0.54
20 CO	0.25	0.16	0.18	0.11	0.53

* Factor loadings are average loadings across 18 countries based on a weighted mean. The weighting variable is countries' GDP in current USD 2006 taken from the World Bank World Development Indicators.

Source: OECD Innovation Microdata project, 2011.

High loadings in Table 4 indicate that a specific variable/measure shapes the mode it has a high correlation with. The definitions – names of modes – introduced in Table 4 and the text below, are stylized to common elements. The names reflect our own interpretation of the patterns that are revealed by the factor loadings.

Mode 1, entitled *IP/technology innovating mode*, contains at its core IPRs, and in many countries these are complemented by in-house R&D and new-to-market activities.

The second mode, Mode 2 – *marketing based innovating* – includes forms of product innovation, imitating and new-to-market, with expenditures related to the market introduction of innovations. *Marketing based innovating* is in its core also a strategy that leans towards sourcing information from other businesses.

Mode 3 is called *process modernising*. This mode typically links process innovations with equipment spending and training of personnel. *Process modernising* in many countries is considered by firms to be externally innovating (EXTINN), perhaps calling into question a generalisability of a 'user-firm innovation hypothesis' for explaining major process changes put forward by Baldwin and von Hippel (2011). External *process modernising* overlaps more readily with the 'supplier dominated innovation mode' identified in Pavitt's (1984) taxonomy.

Mode 4 is *wider innovating* and shows strong combinations of types of management and business strategy changes, including new sales and distribution methods. It represents what might be a classic non-technological innovation.

Mode 5, *networked innovating*, involves external knowledge sourcing in the form of bought-in R&D, licences or other knowhow and formal collaboration on innovation projects. It also leans towards accessing information from the knowledge base – universities and research organisations – pointing towards the relevance of the national infrastructure supporting innovation in a national system. Additionally the *networked innovating* mode exhibits a high loading of internal R&D capturing the 'two faces of R&D' (Cohen and Levinthal, 1989). An 'open innovation' mode – in the sense of a strategic process managed by lead companies – does not emerge distinctly. It is notable (and will be seen in greater depth in the next section) that in many countries different systems variables load up on a number of modes, including information from other businesses in connection with *marketing based innovating*, and external innovation with *process modernising*.

In each country specific variants may emerge, such as IP/technology modes that lean towards design or towards search, additionally to the core activities, and to these country specific patters we now turn.

5. Mixed modes of innovation across 18 countries

This section examines the extent to which modes are shaped by the country specific environments. In relation to RQ2, we observe country specific variants of the generic/core modes that are specifically marked with respect to the first and fifth mode – *IP/technology innovating* and *networked innovating* – while *wider innovating* and *process modernising* show the least amount of variability around core modes. This is explored with correlation analyses that are summarised in Table 5.

Table 5. Correlations between the generic modes and country modes

Country	IP / technology innovating	Marketing based innovating	Process modernising	Wider innovating	Networked innovating
Australia	0.94	0.70	0.38	0.85	0.46
Austria	0.92	0.79	0.91	0.92	0.52
Belgium	0.81	0.82	0.88	0.91	0.79
Canada	0.84	0.93	0.85	.	0.64
Chile	0.72	0.76	0.73	0.88	0.42
Czech Republic	0.87	0.90	0.90	0.92	0.85
Denmark	0.34	0.22	0.71	0.87	0.88
Estonia	0.88	0.89	0.89	0.89	0.87
Germany	0.94	0.93	0.92	0.91	0.90
Iceland	0.66	0.47	0.68	0.60	0.36
Ireland	0.99	0.95	0.68	0.96	0.67
Italy	0.93	0.93	0.88	0.94	0.88
Korea	0.77	0.49	0.75	0.87	0.67
Luxembourg	0.79	0.40	0.65	0.83	0.33
Netherlands	0.95	0.87	0.95	0.94	0.96
South Africa	0.81	0.03	0.54	0.92	0.72
Spain	0.93	0.87	0.83	0.97	0.89
United Kingdom	0.89	0.92	0.75	0.98	0.84
Average correlation	0.83	0.72	0.77	0.89	0.70
Standard deviation	0.15	0.28	0.15	0.09	0.20

* Pearson correlations between the generic modes and the country individual modes, for example, the correlation between the generic Mode 1 and the Austrian Mode 1 is r=0.98. r>0.50 are significant at p<0.05.

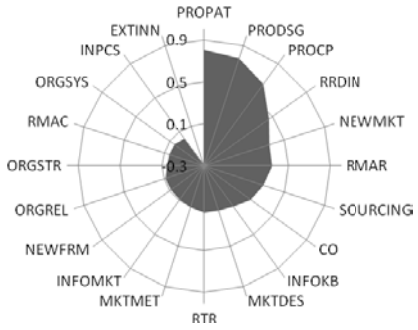
Source: OECD Innovation Microdata project, 2011.

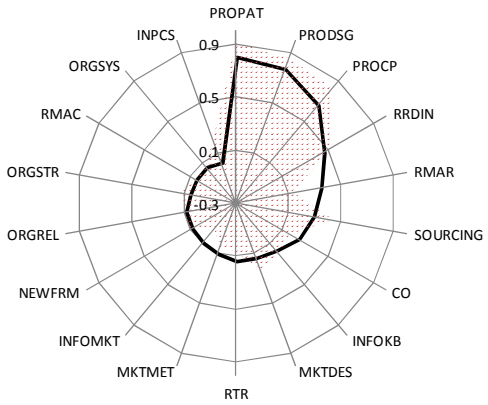
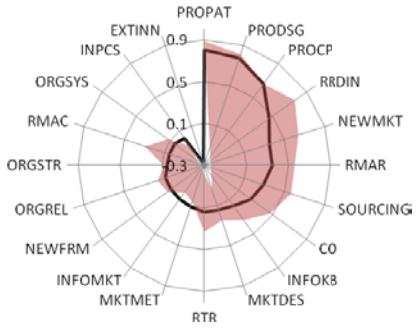
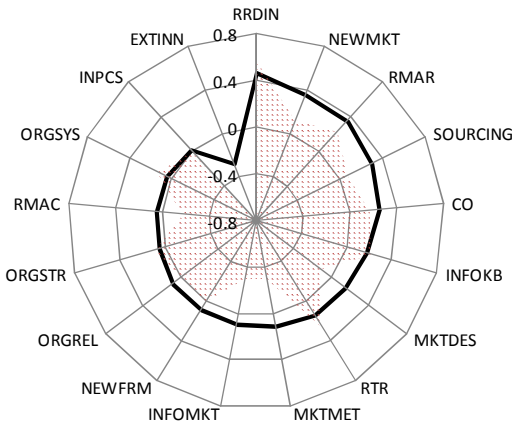
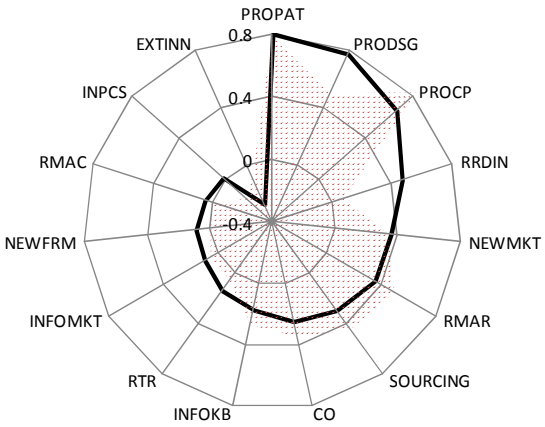
Table 5 explores the heterogeneity across countries relative to the generic modes. The highest correlations and with it the strongest similarities across countries (based on the average correlation and standard deviation across countries) are found with respect to Mode 4 *wider innovating*. The greatest degree of heterogeneity is found with respect to *networked innovating*. In the following we visually present, using radar diagrams, the shape of the five innovating modes within individual countries. We also group countries, using a hierarchical cluster analysis, based on their factor loadings for each of the five modes. The data underlying the radar diagrams and the cluster analyses is in Appendix 1.

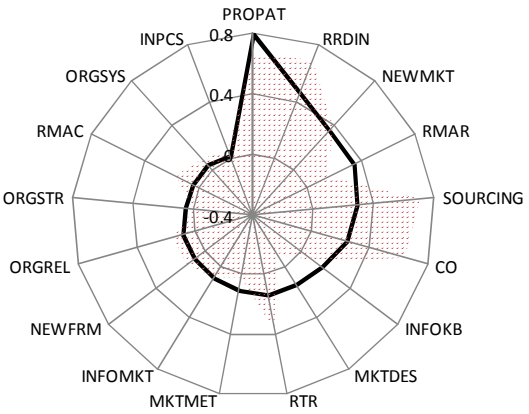
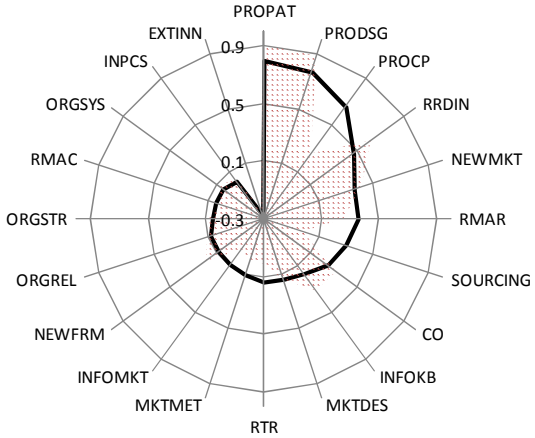
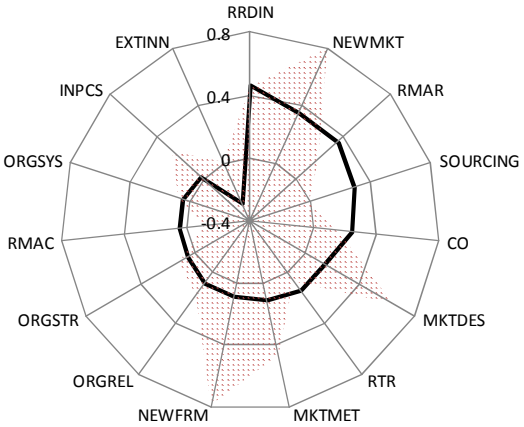
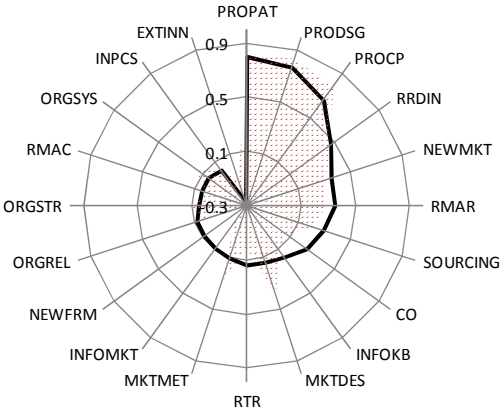
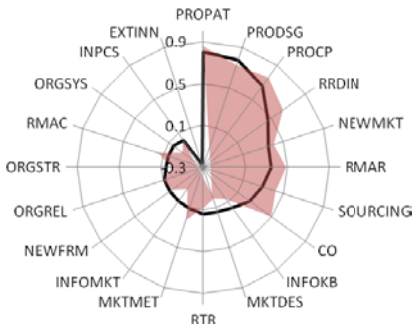
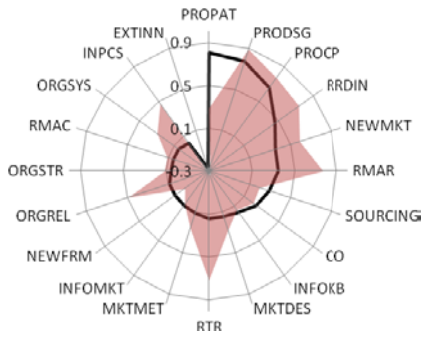
IP/technology innovating

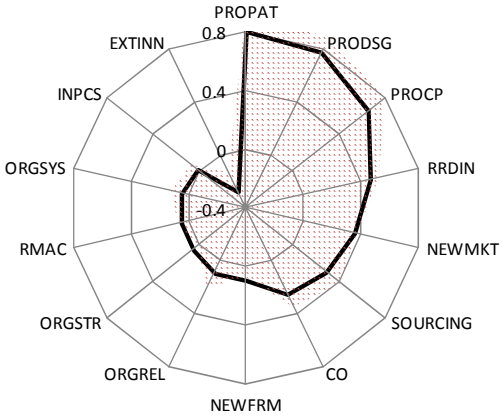
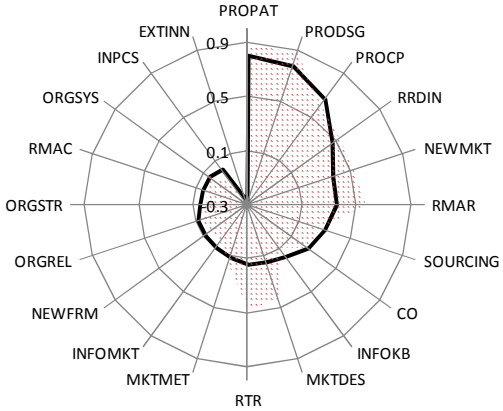
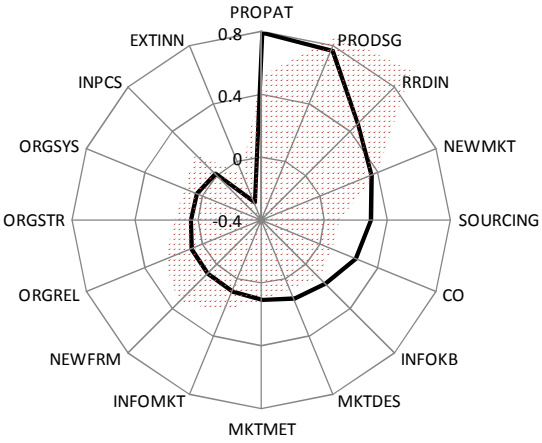
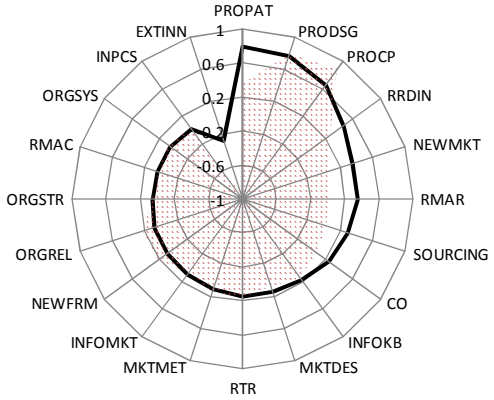
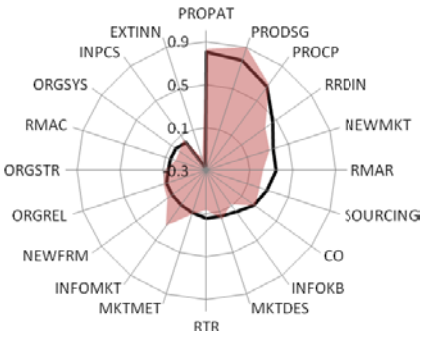
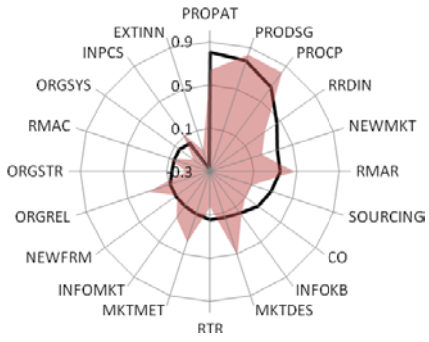
With respect to the first mode – entitled *IP/technology innovating* – the activities that typically hang together are IP (specifically patents and design rights). It is the loading of these variables which led to the interpretation and naming of this mode of innovation. Figure 1 pictures radar diagrams of Mode 1 for each country as well as the generic mode in the first cell. The variables feeding into the modes determine the axes of the radar diagram. Variables are ordered from highest loading – here PROPAT – to lowest loading – EXTINN – on the generic IP/technology innovating mode. Variables with loadings above 0.5 are PROPAT, PRODSG and PROCP in order of impact. RRDIN and NEWMKT have the next highest loading (0.46 and 0.35 respectively).

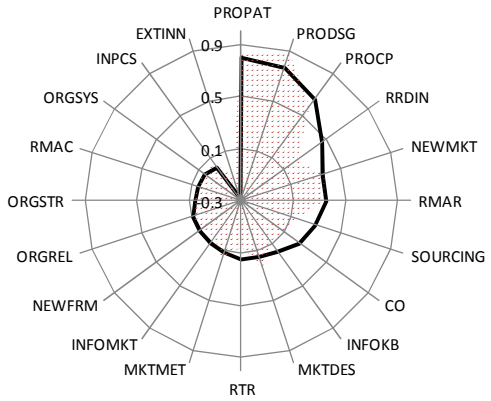
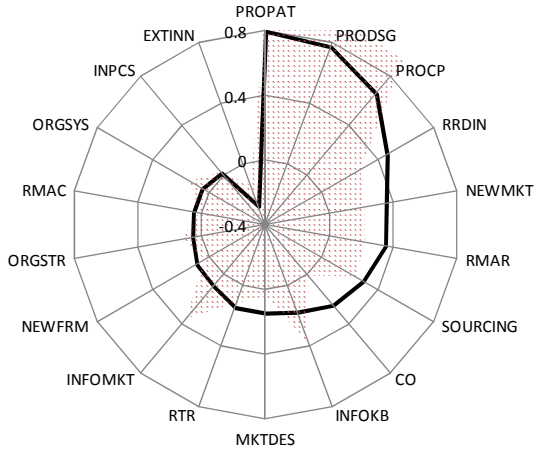
Figure 1. IP/technology innovating mode across countries

<table>
<tr><td>Generic Mode 1 IP/technology innovating</td><td></td></tr>
<tr><td>
</td><td>Typical activities:

PROPAT – Enterprise applied for a patent
PRODSG – Enterprise applied for a design right
PROCP – Enterprise claimed copy right
RRDIN – Enterprise carried out in-house R&D</td></tr>
<tr><td>Australia</td><td>Austria</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Belgium</td><td>Canada</td></tr>
<tr><td>
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</td></tr>
</table>

Chile	Czech Republic
	
Denmark	**Estonia**
	
Germany	**Iceland**
	

Ireland	Italy
	
Korea	**Luxembourg**
	
Netherlands	**South Africa**
	

Spain	United Kingdom
	

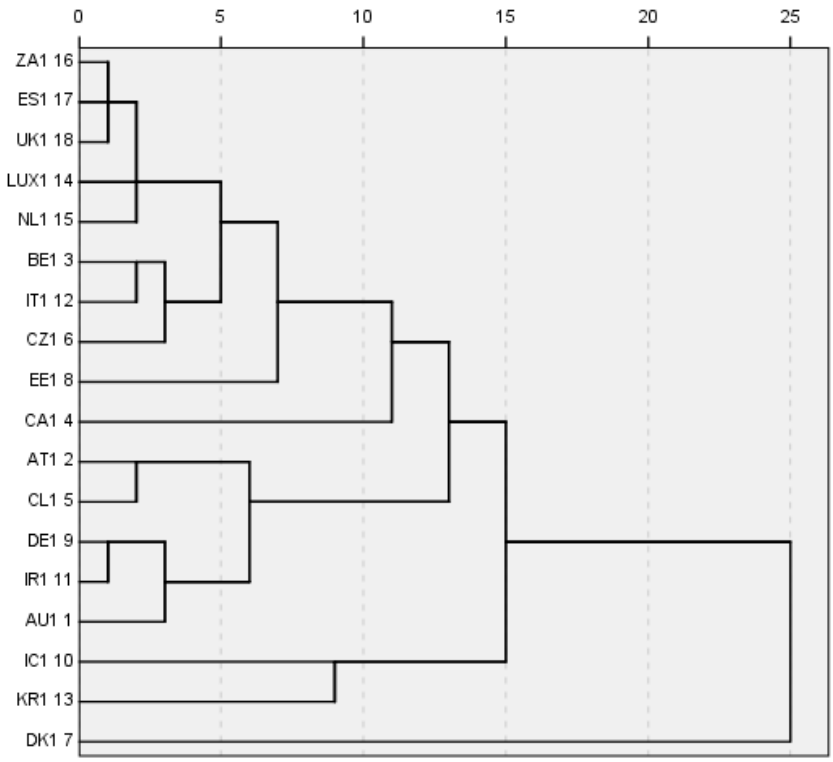
Note: the innovation surveys in Belgium, Chile and Denmark do not include information on IPRs. The Korean dataset does not include copyright claims. Ireland does not include marketing innovations, expenditure on market introduction or training as well as information sources. Canada has no information on organisational and marketing innovations, while the United Kingdom has two (instead of three) measures of organisational innovating and one (instead of two) measure of marketing innovations. The Australian analysis groups NEWMKT and NEWFRM into one variable, includes specific types of process innovation (*i.e.* not INPCS alone), and omits EXTINN. The sample size for Iceland is small (n=78). In the case of South Africa, NEWFRM and NEWMKT are mutually exclusive categories.

Source: OECD Innovation Microdata project, 2011.

The radar diagram of the generic *IP/technology innovating* mode is transposed as a black line over each individual country's radar diagram (the shaded area) to help contrast country specific strategies. The typical or core Mode 1 with loadings above 0.5 on PROPAT, PRODSG and PROCOP, and with no other loadings above 0.5 is found in Estonia, the Netherlands, Spain and the United Kingdom. Mode 1 has above 0.5 loadings on NEWMKT for Austria, Denmark, Iceland and Italy. In many, but not all, countries in-house R&D loads up with Mode 1 (r>0.5). This is the case for Austria, Belgium, Chile, the Czech Republic, Germany, Iceland, Ireland, Italy and Korea. *IP/technology innovating* excludes externally generated innovation with a negative loading on EXTINN (r<-0.5). This 'closed' IP/technology mode is observed in Austria, Belgium, Germany and Luxembourg.

Next to the core mode, Figure 1 shows distinct IP/technology strategies specific to the individual countries around in-house and new-to-market innovating as per the discussion above; around marketing push strategies (Austria, Canada, Iceland, Italy and South Africa); around 'closed' innovating (Austria, Belgium, Germany and Luxembourg); around collaborative innovating (Chile and Germany); and around strategies leaning towards design activities (Denmark and South Africa). The cluster analysis reveals which countries exhibit *IP/technology innovating* modes that are closest in their construction and loadings with the individual variables feeding into the factor analysis.

Figure 2. Dendrogram grouping countries by their loadings on IP/technology innovating



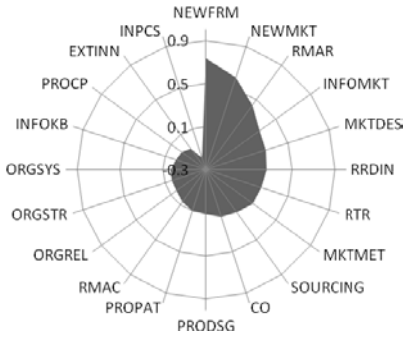
Source: OECD Innovation Microdata project, 2011.

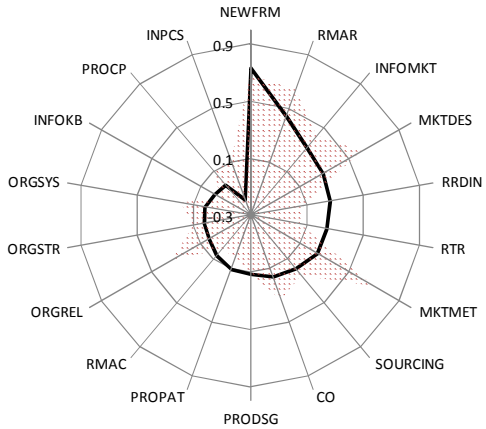
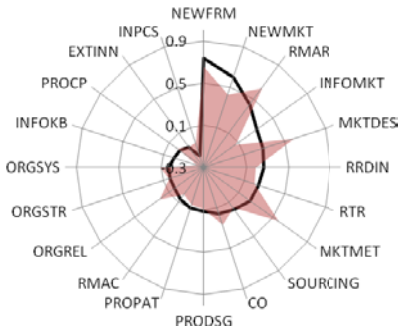
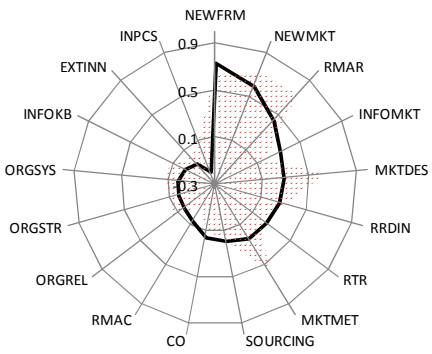
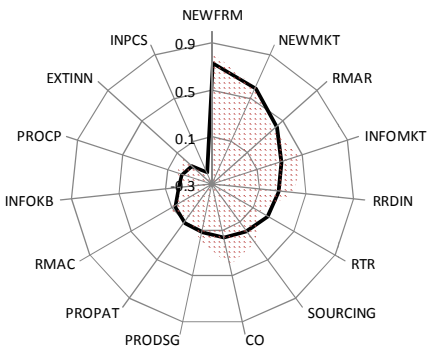
Countries closest in the construction of their *IP/technology innovating* mode are joined by the vertical lines in Figure 2 early on (close to the left hand side of the figure). Three broad groups emerge: *i)* South Africa, Spain, the United Kingdom, Luxembourg and the Netherlands are grouped early in the process; *ii)* Belgium, Italy and the Czech Republic; *iii)* Austria, Chile, Germany, Ireland and Australia. Denmark's corresponding mode joins last. This is due to data limitations, because the Danish innovation survey did not provide information on IPR protection.

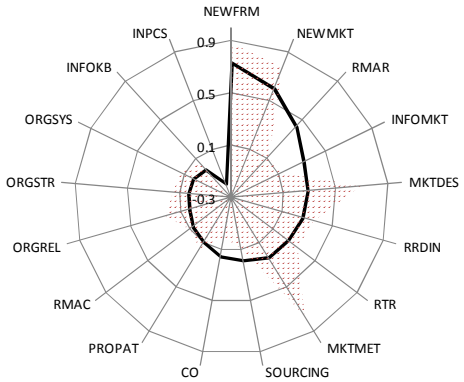
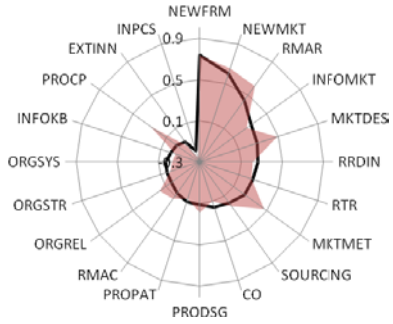
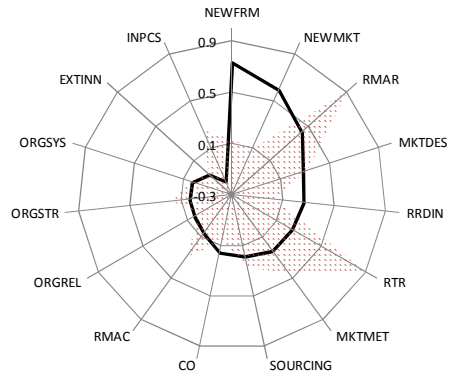
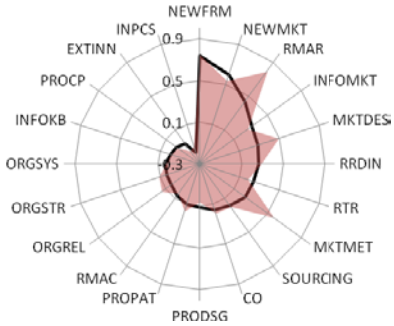
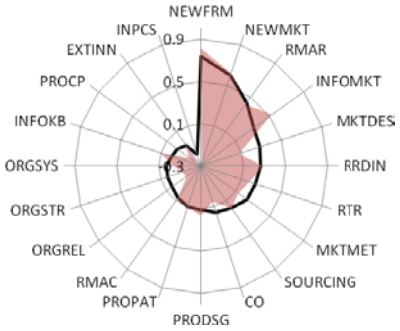
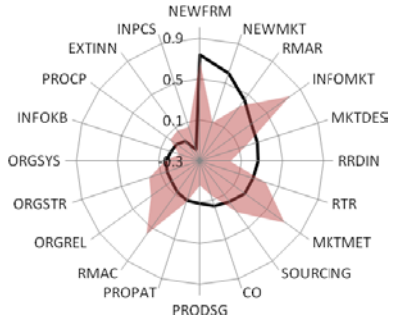
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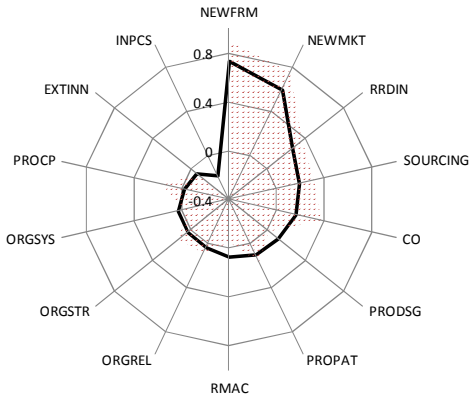
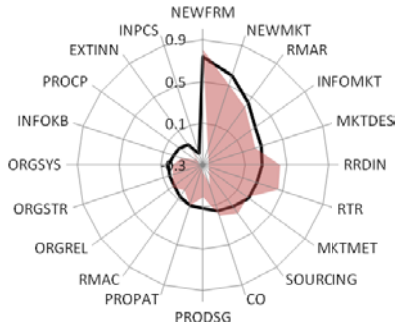
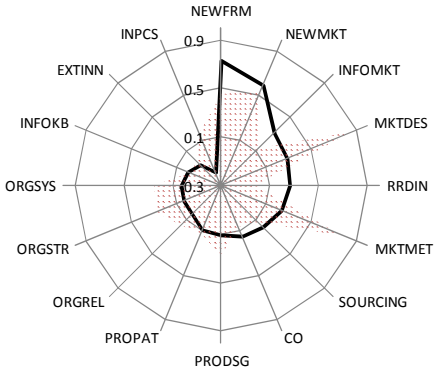
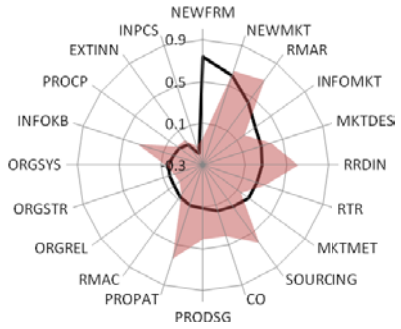
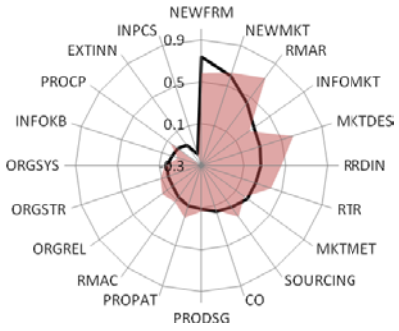
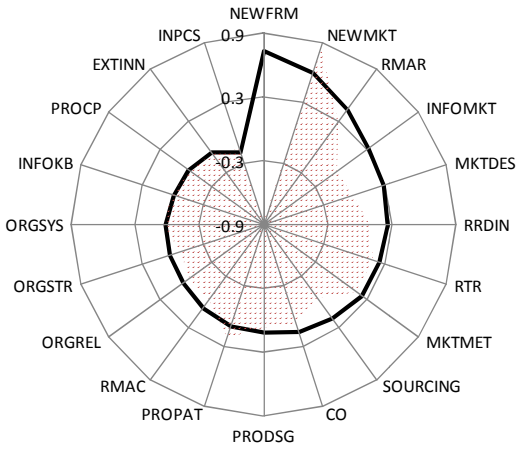
Mode 2 – *marketing based innovating* – is summarised in Figure 3.

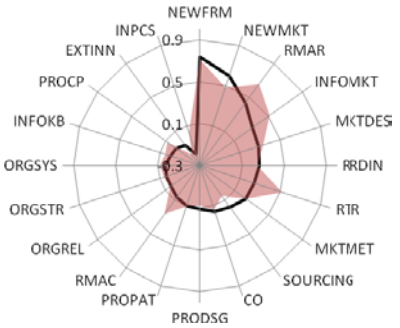
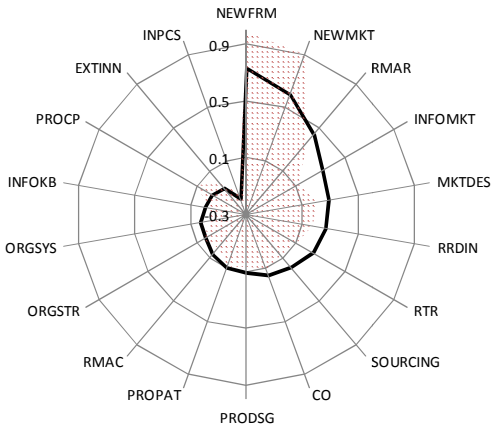
Figure 3. Marketing based innovating

<table>
<tr><td>Generic Mode 2 Marketing based innovating</td><td></td></tr>
<tr><td>
</td><td>Typical activities:

NEWFRM – Enterprise introduced a good or service only new to the firm
NEWMKT – Enterprise introduced a good or service that was new to the firms' market
RMAR – Enterprise spent on market launch of new goods or services.</td></tr>
<tr><td>Australia</td><td>Austria</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Belgium</td><td>Canada</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Chile	Czech Republic
	
Denmark	**Estonia**
	
Germany	**Iceland**
	

Ireland	Italy
	
Korea	**Luxembourg**
	
Netherlands	**South Africa**
	

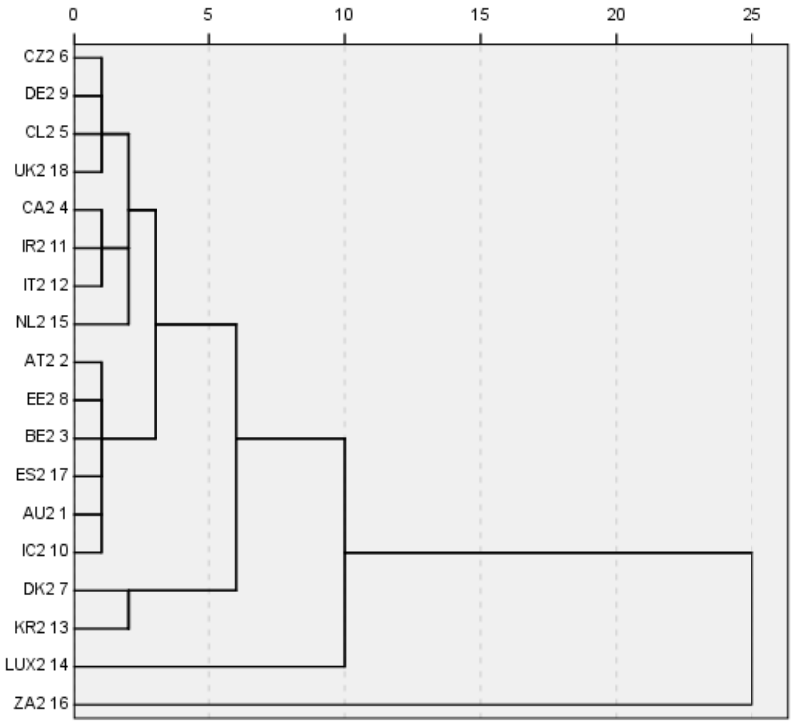
Spain	United Kingdom
	

Note: as per Figure 1.

Source: OECD Innovation Microdata project, 2011.

The core mode has loadings above 0.4 on NEWFRM, NEWMKT and RMAR. This mode is about creating a market for a new good or service. It might also be influenced by an emphasis on information sourced from other market participants and changes to design or packaging. In all countries – with the exception of South Africa where NEWFRM and NEWMKT are two mutually exclusive categories – this mode suggests that firms do both imitate and innovate. Differences across countries can be summarised by the extent to which this mode leans more strongly towards market leading or market following as captured by differences in the loading of new-to-market and new-to-firm innovating. In Belgium, Korea, Luxembourg, the Netherlands and South Africa new-to-market has the strongest loading and the connotation of this mode is towards a strong push-strategy. In the other countries this mode is associated relatively more with a follower strategy where new goods and services are imitated and released onto the market in connection with marketing activities or design changes. In Denmark and Spain a unique mode links expenditure on marketing with training. In Luxembourg, new-to-market innovating is coupled with marketing expenditures, but also internal R&D, patenting and sourcing. While in Iceland there is a mode based on new marketing strategies, purchasing of machinery or equipment, and information sourcing from other firms. Figure 4 groups countries according to their innovation mode 2 using a hierarchical clustering technique.

Figure 4. Dendrogram grouping countries by their loadings on marketing based imitating



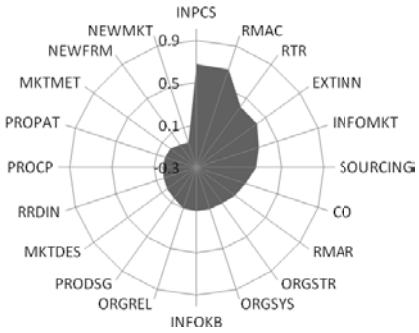
Source: OECD Innovation Microdata project, 2011.

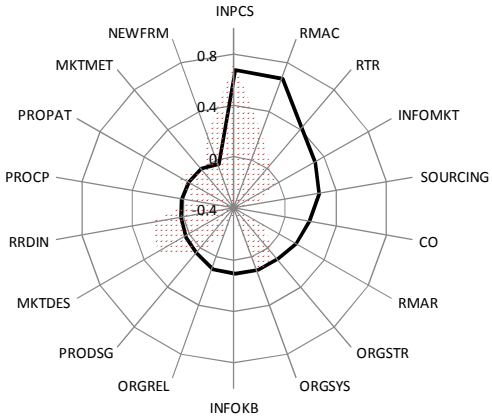
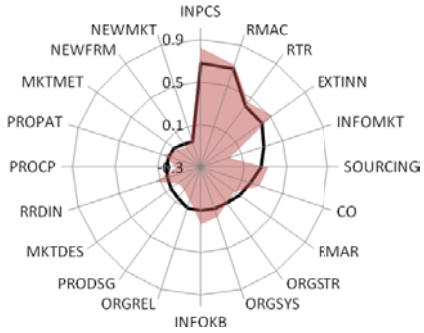
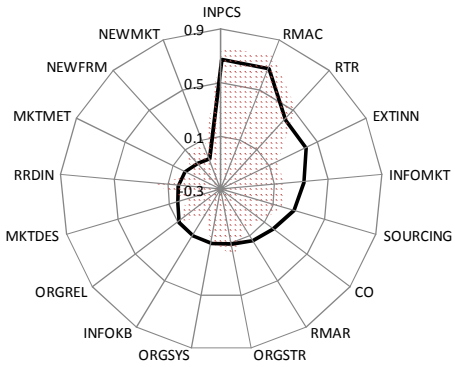
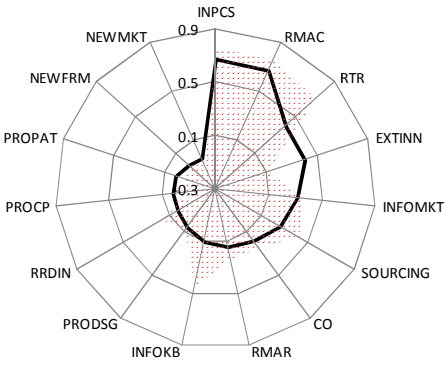
Figure 4 suggests that in Denmark, Korea, Luxembourg and South Africa the *marketing based innovating* modes are distinct from those revealed in other countries. The remaining countries link early in the clustering process. This pattern is in part due to differences in datasets. In Korea the variable expenditure on marketing is not available, and in South Africa the two product innovation variables NEWMKT and NWFRM are mutually exclusive groups. Denmark is missing information on sources of information and patenting. Luxembourg, where the full breadth of variables is available, is among the group of marketing led innovating, leaning towards new-to-market activities, with marketing expenditures. Luxembourg has the highest loading on internal R&D, sourcing and patenting with respect to Mode 2.

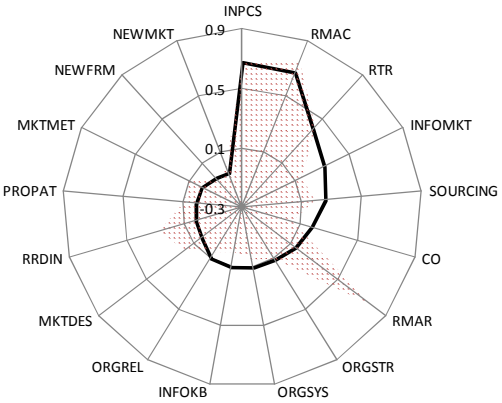
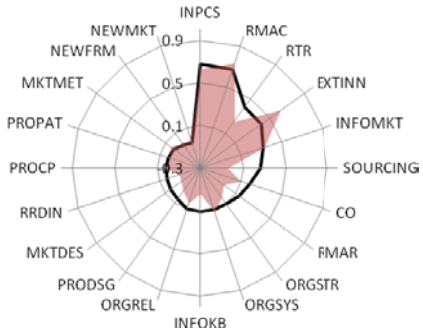
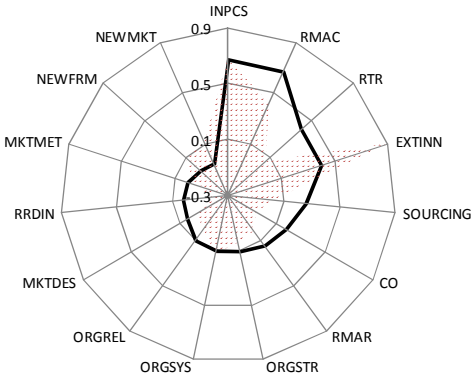
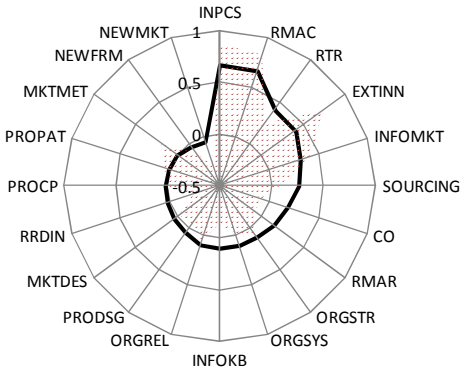
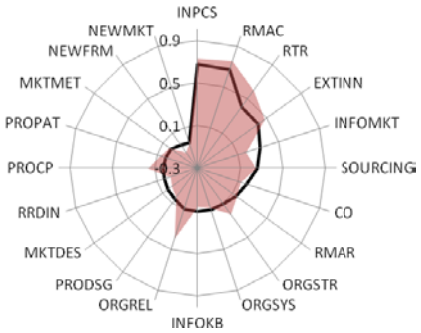
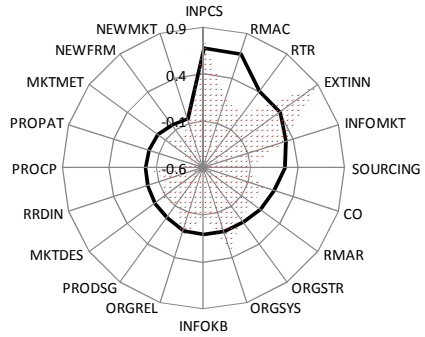
Process modernising

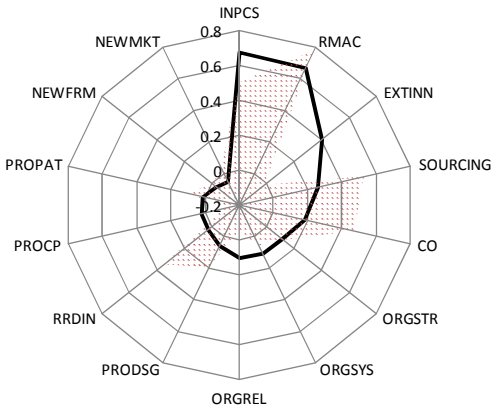
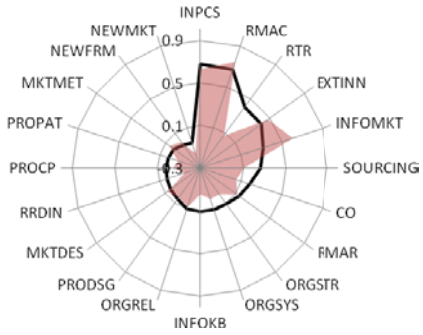
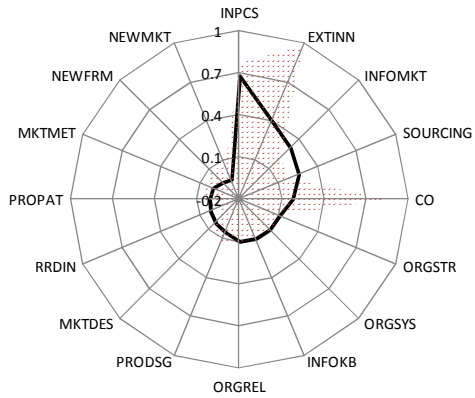
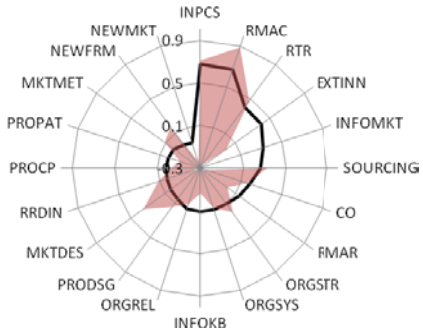
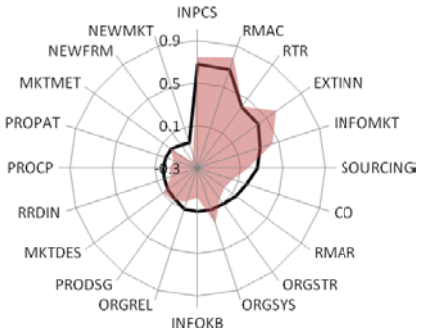
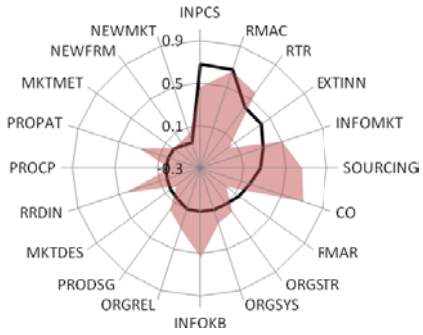
The typical *process modernising* mode, combines process innovation with the acquisition of new machinery and equipment. In many countries training of staff also loads up.

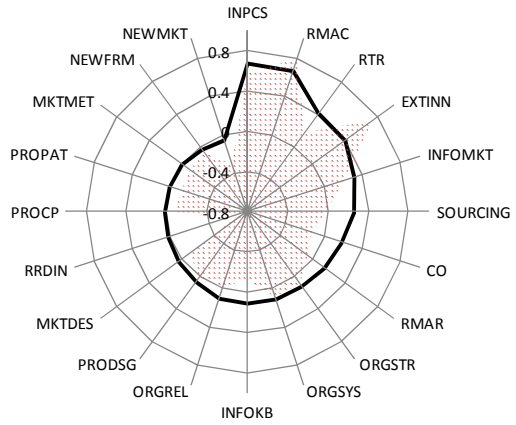
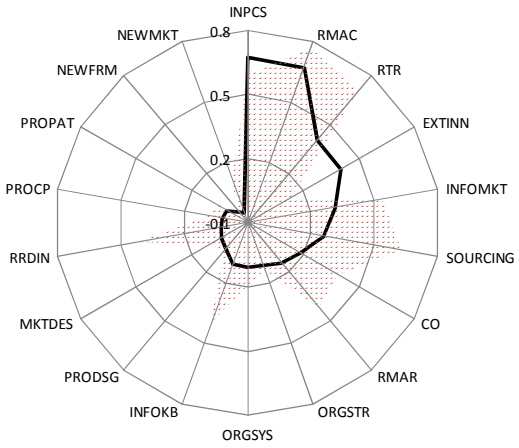
Figure 5. Process modernising

<table>
<tr><td>Generic Mode 3 Process modernising</td><td></td></tr>
<tr><td>
</td><td>Typical activities:

INPCS – Enterprise introduced a new process
RMAC – Enterprise bought new machinery
RTR – Enterprise had expenditures related to training for innovation processes
EXTINN – New goods, services or processes were mainly developed externally.</td></tr>
<tr><td>Australia</td><td>Austria</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Belgium</td><td>Canada</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Chile	Czech Republic
	
Denmark	**Estonia**
	
Germany	**Iceland**
	

Ireland	Italy
	
Korea	**Luxembourg**
	
Netherlands	**South Africa**
	

Spain	United Kingdom
	

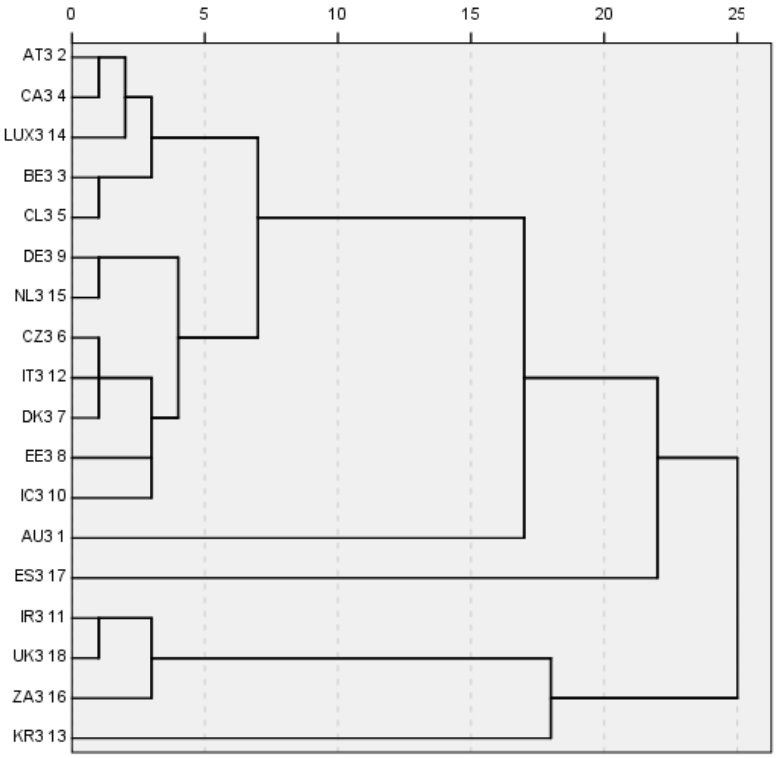
Note: as per Figure 1.

Source: OECD Innovation Microdata project, 2011.

There are two main variants of process modernising; both are outward-oriented. The most common variant is *external* process modernising pointing towards consultancy input into processes. External process modernising is observed in Austria, the Czech Republic, Denmark, Estonia, Germany, Iceland, Korea, the Netherlands and Spain. The second main variant is *connected* or *joint* process modernising and might load – instead of EXTINN, which has a low or negative loading – SOURCING and/or CO. Corresponding modes are found in Canada, Korea, Ireland, South Africa and the United Kingdom. In Chile, the *process modernising* innovation mode is coupled with expenditures on market introduction of innovations.

In the above interpretation of the two types of *process modernising* modes we used information on factor loadings that was greater than 0.5 (*i.e.* we consider individual correlations only when these are strong). The dendrogram below (Figure 6 below) uses the full information on factor loadings. It comes to a similar, albeit not exactly the same grouping of countries on *process modernising*.

Figure 6. Dendrogram grouping countries by their loadings on process modernising



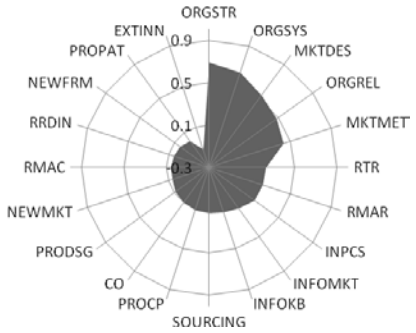
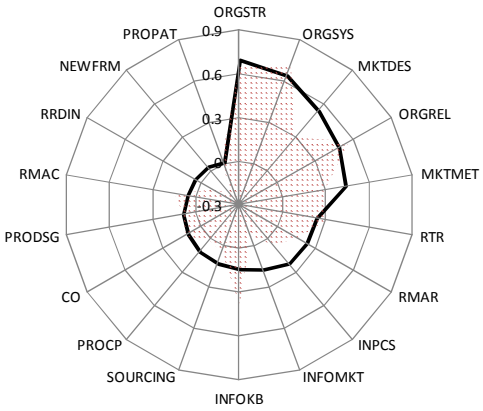
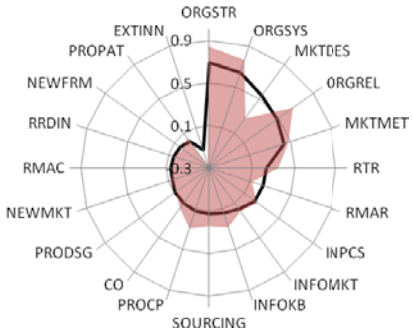
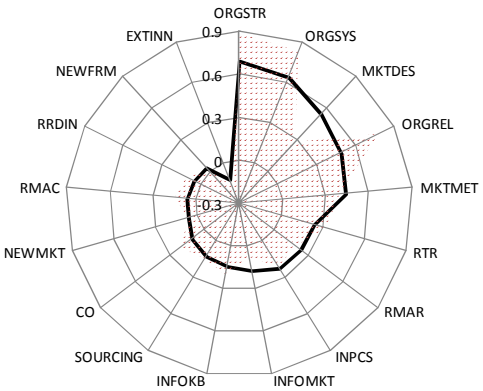
Source: OECD Innovation Microdata project, 2011.

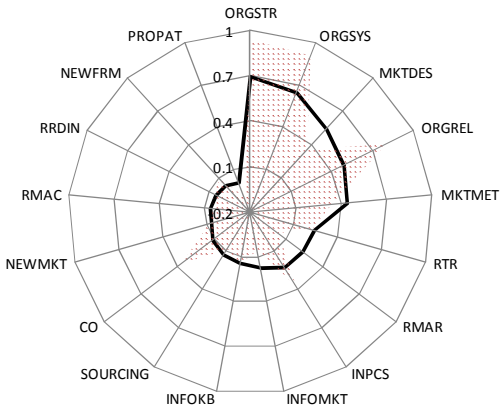
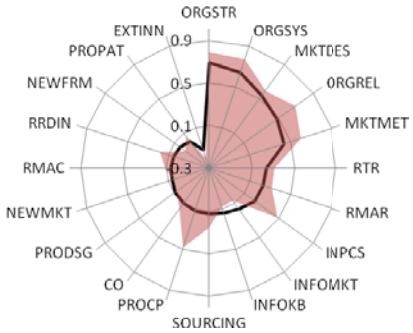
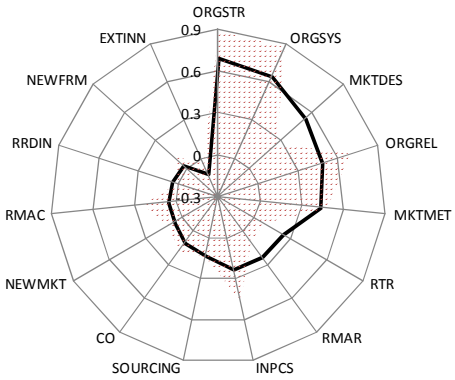
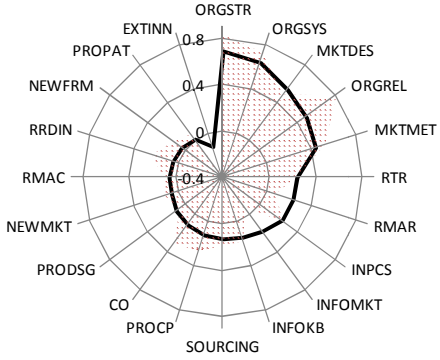
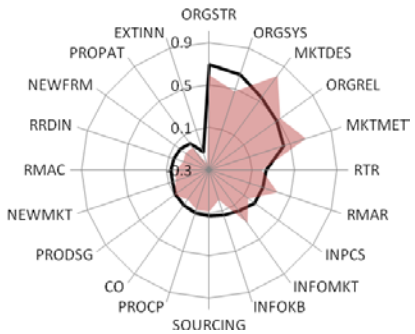
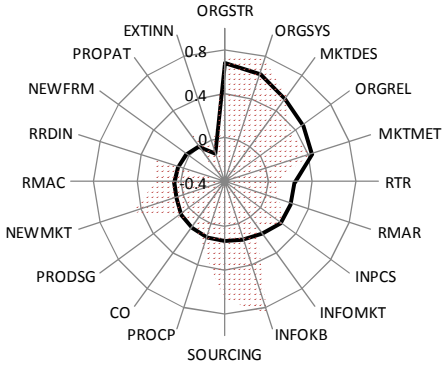
The dendrogram suggests that the construction of *process modernising* on the whole, *i.e.* taking into account all factor loadings, is particularly similar for: *i)* Austria, Canada, Luxembourg, Belgium, Chile; *ii)* Germany, the Netherlands, the Czech Republic Italy, Denmark, Estonia and Iceland; and *iii)* Ireland, the United Kingdom and South Africa.

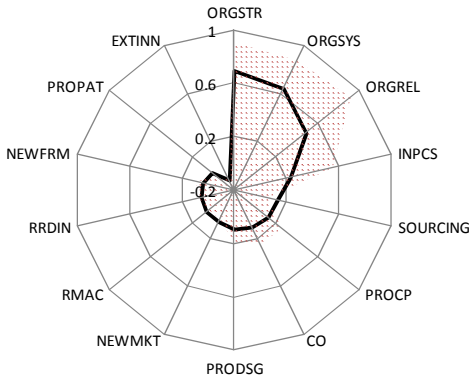
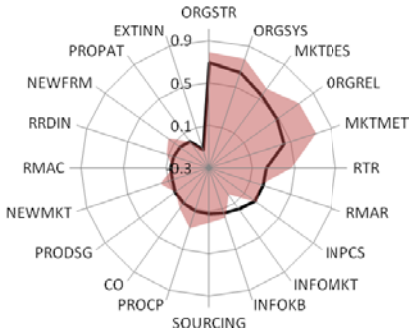
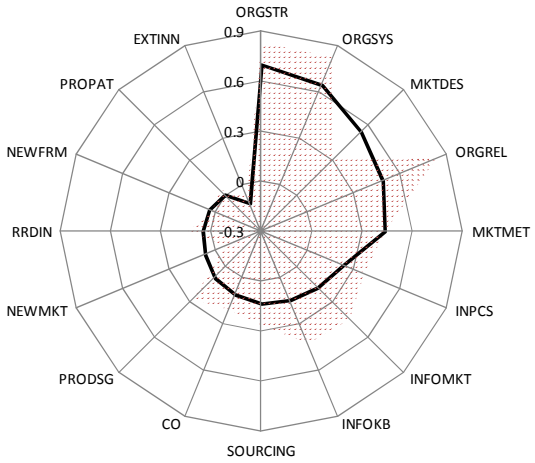
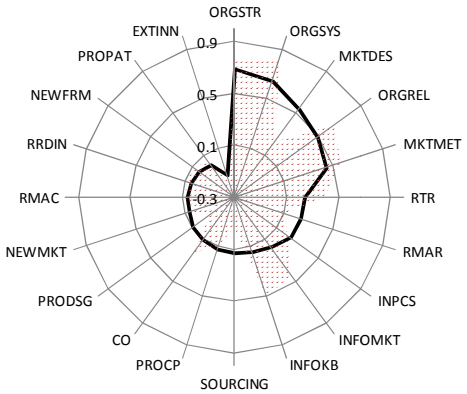
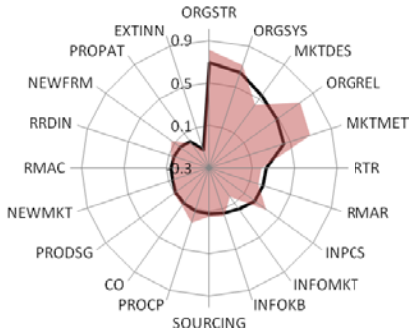
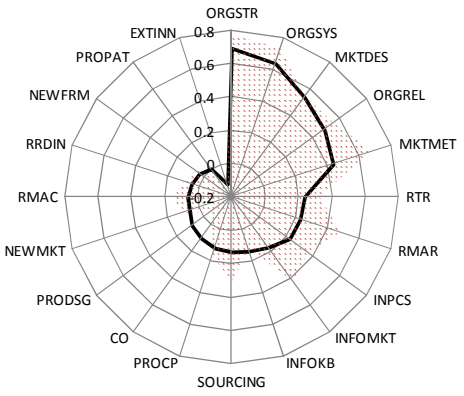
Wider innovating

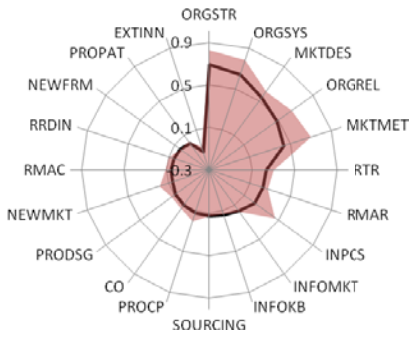
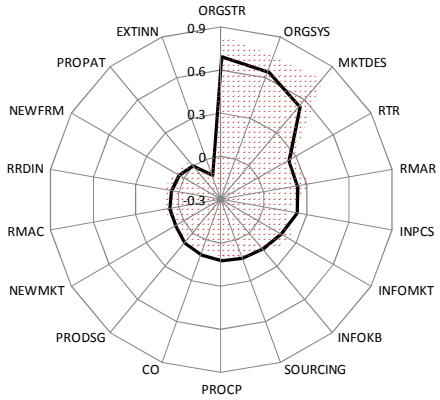
Wider innovating is a mode that appears in almost all countries with a very similar loading on organisational and managerial changes linked with marketing innovations. Such a mode is also reported on in Battisti and Stoneman (2010), analysing UK data.

Figure 7. Wider innovating

<table>
<tr><td>Generic Mode 4 Wider innovating</td><td></td></tr>
<tr><td>
</td><td>Typical activities:
ORGSTR – Enterprise introduced new workplace organisation
ORGSYS – Enterprise introduced new knowledge management system
MKTDES – Enterprise introduced a significant change to design or packaging
ORGREL – Enterprise introduced new relations with other firms
MKTMET – Enterprise introduced new sales or distribution methods</td></tr>
<tr><td>Australia</td><td>Austria</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Belgium</td><td>Canada</td></tr>
<tr><td>
</td><td>Information on variables that characterise the wider innovating mode – ORGSYS, ORGSTR, ORGREL, MKTDES and MKTMET – is not available for Canada and no mode is reported.</td></tr>
</table>

Chile	Czech Republic
	
Denmark	**Estonia**
	
Germany	**Iceland**
	

Ireland	Italy
	
Korea	**Luxembourg**
	
Netherlands	**South Africa**
	

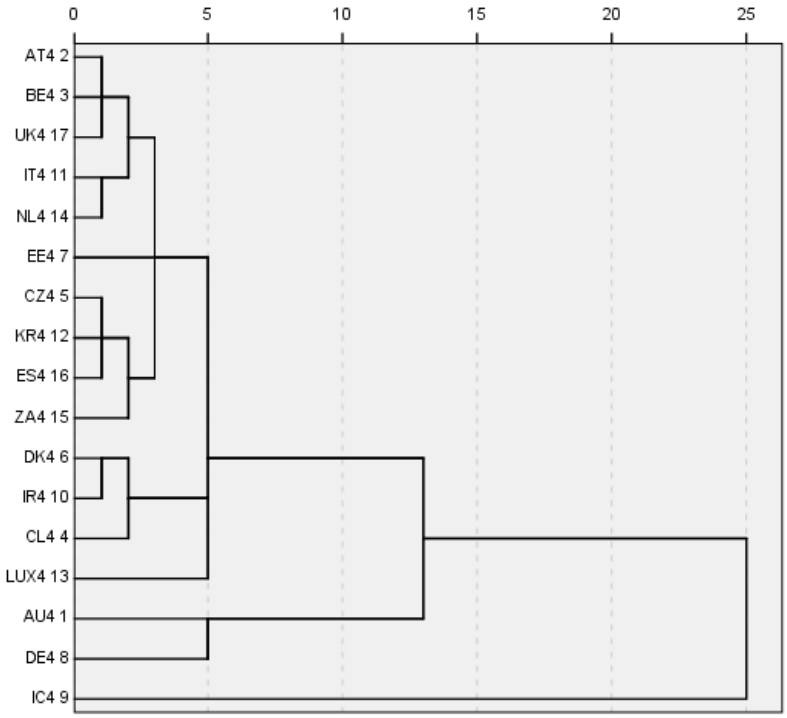
Spain	United Kingdom
	

Note: as per Figure 1.

Source: OECD Innovation Microdata project, 2011.

Compared with the previously presented modes, *wider innovating* is a mode that is comparatively homogeneous across countries (see also Table 5). It joins, in order of relevance, new workplace organisation, new knowledge management techniques with changes to design and packaging. In many countries new relations with other firms and new sales and distribution methods also load up. In Iceland and Luxembourg, information sources from research organisations, too, load up on the factor (r>0.5); and in Iceland further the variable sourcing (bought-in R&D and other knowledge) (r>0.5).

Figure 8. Dendrogram grouping countries by their loadings on wider innovating



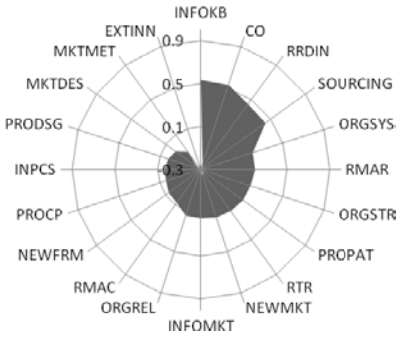
Source: OECD Innovation Microdata project, 2011.

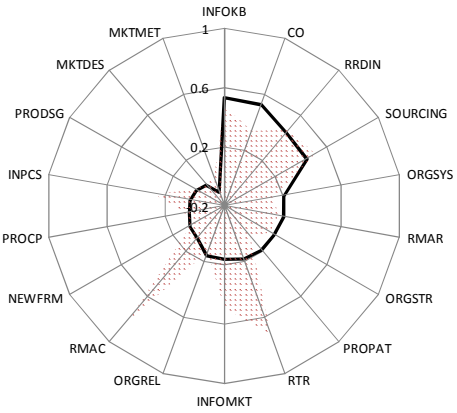
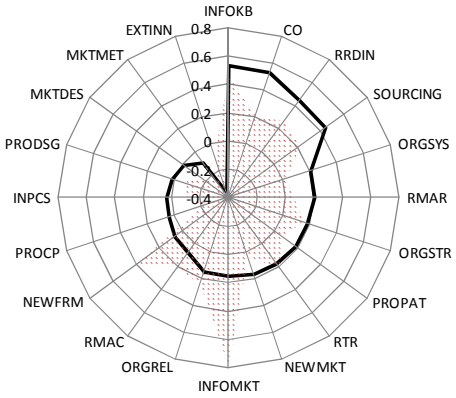
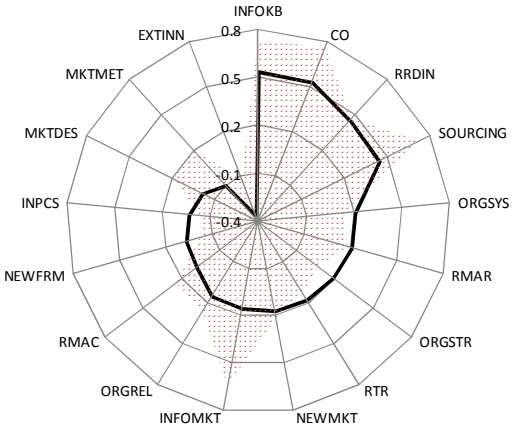
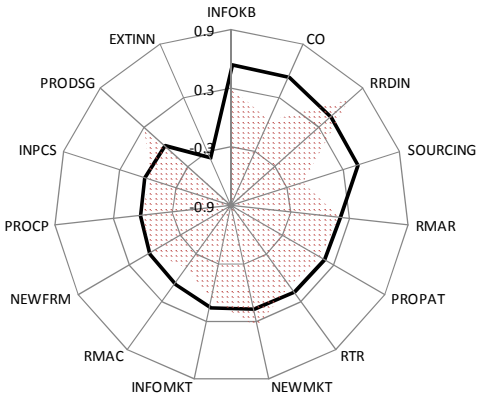
Figure 10 groups: *i)* Austria, Belgium, the United Kingdom, Italy, the Netherlands; *ii)* the Czech Republic, Korea, Spain, South Africa; *iii)* Denmark, Ireland and Chile. Iceland, discussed above, is least like any of the remaining countries in its construction of *wider innovating*.

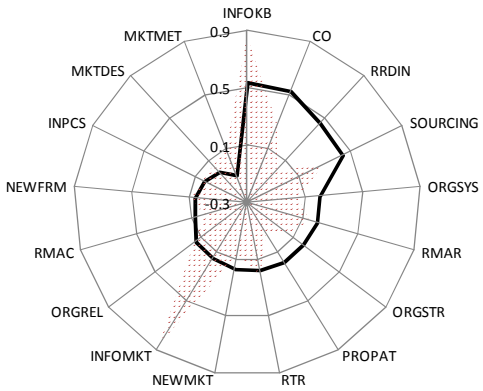
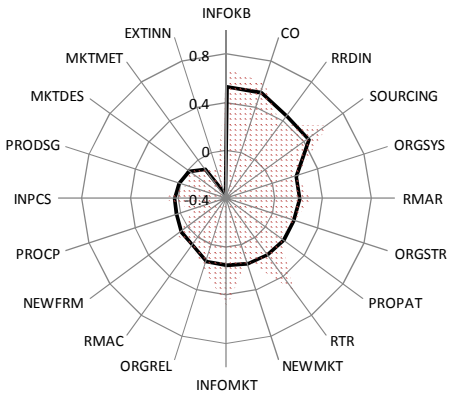
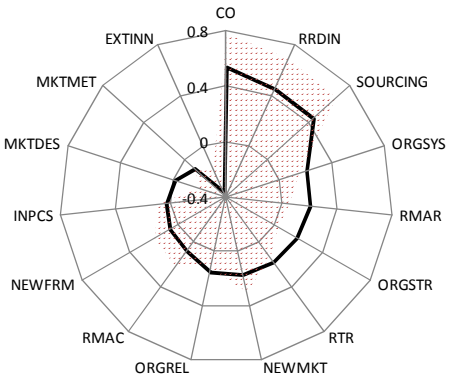
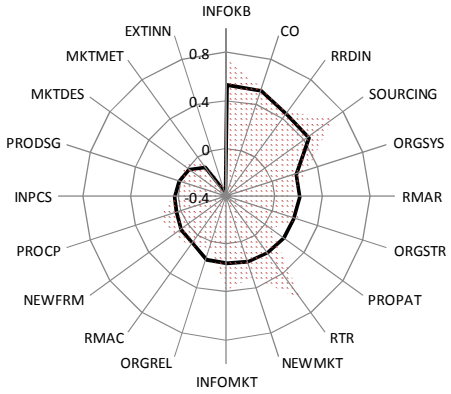
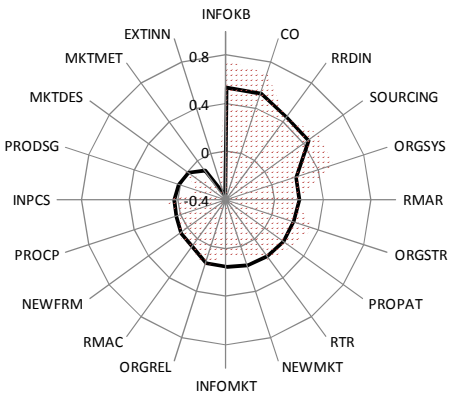
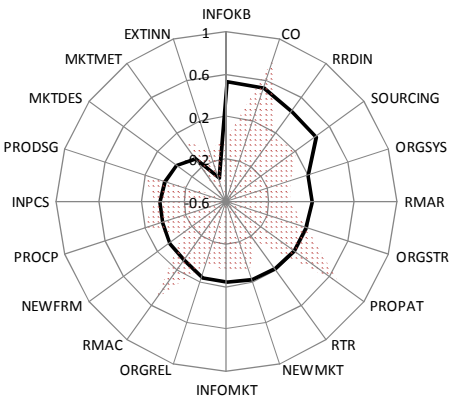
Networked innovating

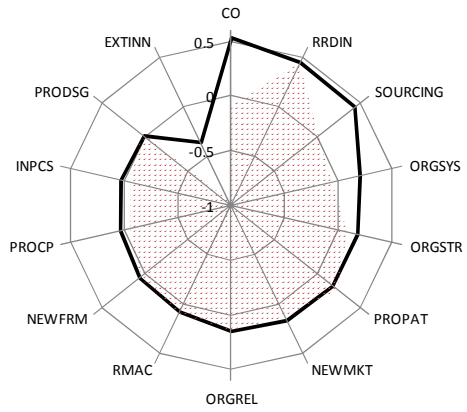
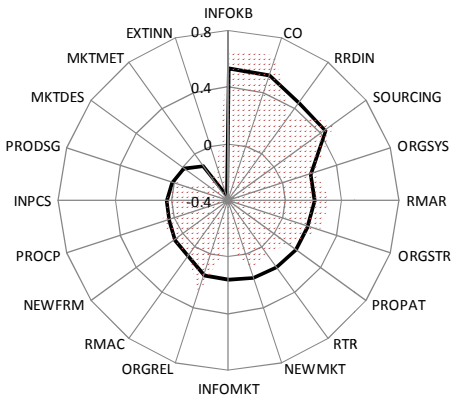
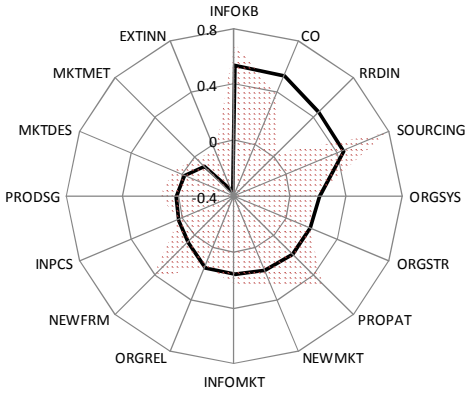
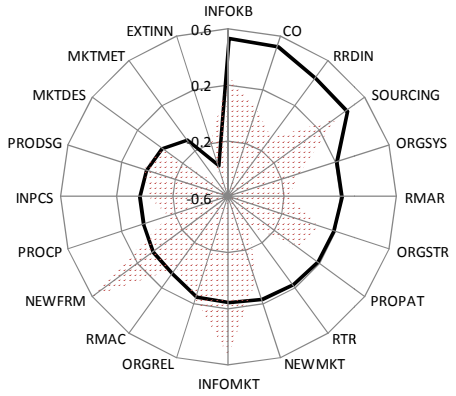
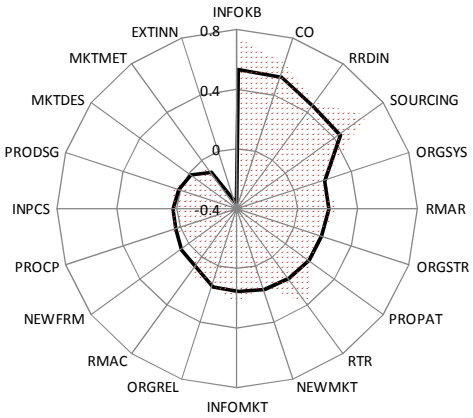
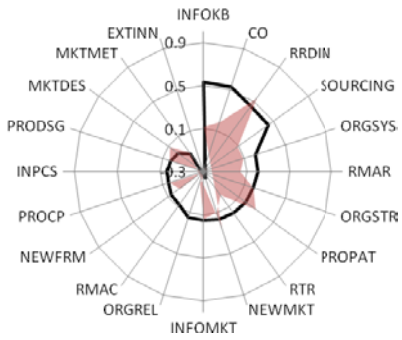
The fifth core mode – networked innovating – shows a considerable degree of heterogeneity across countries (see also Table 5).

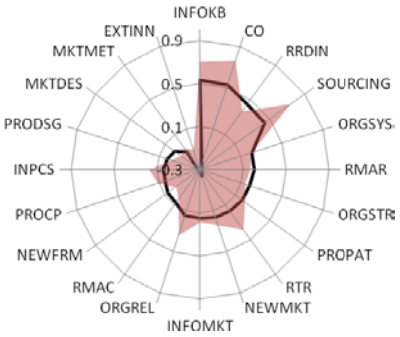
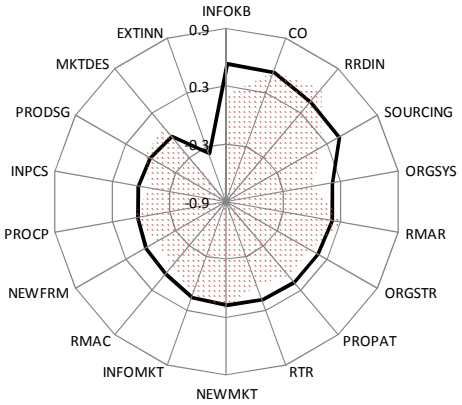
Figure 9. Networked innovating

<table>
<tr><td>Generic Mode 5 Networked innovating</td><td></td></tr>
<tr><td>
</td><td>Typical activities:

INFOKB – Medium or high importance of information from research organisations
CO – Enterprise cooperated on innovation with external partner
RRDIN – Enterprise carried out internal R&D
SOURCING – Enterprise bought in R&D or other knowledge.</td></tr>
<tr><td>Australia</td><td>Austria</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Belgium</td><td>Canada</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Chile	Czech Republic
	
Denmark	**Estonia**
	
Germany	**Iceland**
	

Ireland	Italy
	
Korea	**Luxembourg**
	
Netherlands	**South Africa**
	

Spain	United Kingdom
	

Note: as per Figure 1.

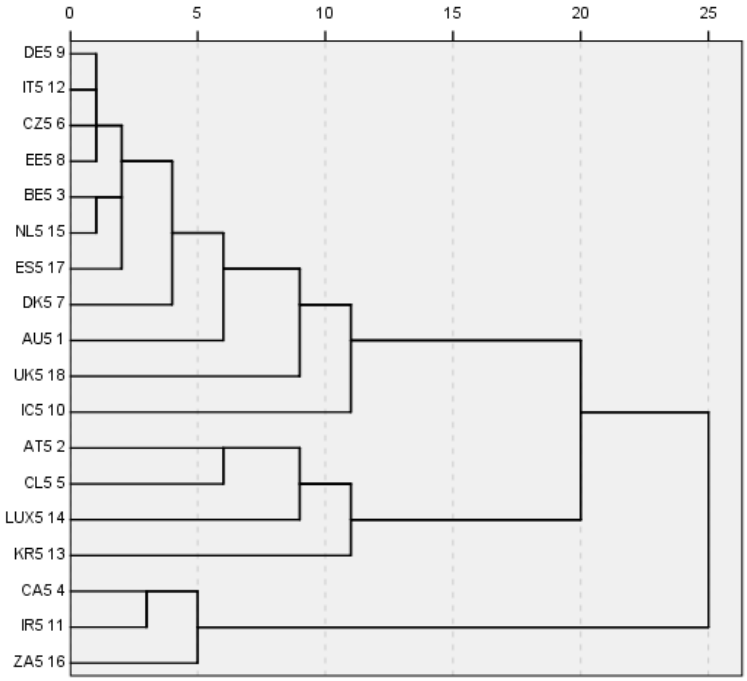
Source: OECD Innovation Microdata project, 2011.

Two distinct patterns, rather than one core pattern, with country specific connotations emerge. Firstly, the most frequent 'networked innovating' mode is one that has high loadings for cooperation, information from businesses and the research base and/or sourcing (bought in technology) together with in-house R&D (*e.g.* Belgium, Denmark, Estonia, the Czech Republic, Germany and the Netherlands and Spain). In the case of Iceland and Korea, cooperation goes hand in hand with patenting which emphasises the thin line that can occur between competition and cooperation.

Secondly, a different mode of networked innovating emerges in the case of Austria and Luxembourg. Here, networked innovating relates to searching markets through information sources – market based – and products only new-to-firm. We term this search-based imitating. With respect to Chile the innovation survey does not contain information on new-to-firm only. Thus, the networked innovating mode only has information sources from both businesses and the research base loading together. That means we are not sure if these firms are leaning more towards imitating or towards innovating.

Finally, in Canada, Ireland, South Africa and the United Kingdom, Mode 5 is characterised by a strong negative loading on EXTINN, together with a positive loading on in-house R&D. In the case of Canada a moderate loading (r=0.30) on information from the knowledge base (which is not available in the Irish database) and for the United Kingdom a strong loading on collaboration on innovation projects (r=0.53).

Figure 10. Dendrogram grouping countries by their loadings on networked innovating



Source: OECD Innovation Microdata project, 2011.

Figure 1 groups: *i)* Germany, Italy, the Czech Republic, Estonia, Belgium, the Netherlands and Spain. Then adds to that cluster in ascending order Denmark, Australia, the United Kingdom and Iceland; *ii)* the next cluster contains, Austria, Chile, Luxembourg and Korea; and finally *iii)* Canada and Ireland are grouped together with South Africa.

To sum up, and with reference to RQ2, we observe heterogeneity across countries within the modes. These differences are best revealed in the radar diagrams (and can be tracked in the more detailed information provided in Annex 1). Importantly, we observe very distinct patterns in connection with the loadings of all measures capturing how firms interact with the wider innovation system. Questions in the innovation surveys of most countries cover the acquisition of information for innovation from universities and other government sponsored research institutes. This is the INFOKB variable in the description of the innovation modes above. In the majority of countries, this information source features most strongly in the networked innovation mode, where firms engage with external sources. The other variables featuring in the networked innovation mode vary between countries. In some cases, collaboration on projects loads together with knowledge base information, but in others the relationship is negative.

In a few countries, information from the knowledge base is strongly featured in other modes. For example, in Iceland and Luxembourg it is more part of the wider innovating mode, while in South Africa and the United Kingdom it is an element in open process modernising, together with investment in training and upgrading of equipment and IT.

6. Effects of mixed modes of innovation on firm performance and growth across countries

In Section 6 the third research question – (RQ3) is there a difference in the relationships between mixed modes and firm performance and growth across countries? – is addressed. In the regressions the key independent variables are the factor scores of the five mixed modes. Further, the models control for size (log of employment), whether or not the enterprise is operating in international markets, if it belongs to a wider company group, industry and regional dummies at approximately NACE2 and NUTS1.[6]

Table 6, presenting the first set of regression results, shows that in all but three countries, one or more innovation modes are positively associated with levels of labour productivity which we proxy by the natural log of turnover per employee. This is a demanding test because the data in the sample is for innovation active firms only, thus biasing the coefficients towards zero.

As was found in OECD (2009), there is no consistent cross-country pattern as to which modes show significant associations with productivity. *Networked innovating* is positively associated with higher productivity in most countries: six out of 15. *Process modernising* and *wider innovating* are positively and significantly associated with productivity in five, while the *IP/technology innovating* and *marketing based innovating* modes are only linked to higher productivity in three out of the 15 countries.

Because the sample contains innovation active firms only, all results, *i.e.* finding a positive or negative relationship between a specific innovation mode and productivity, are relative to other innovation active businesses, but not relative to enterprises without innovation related activities. Thus, the negative coefficient for *marketing based innovating* in the case of Australia does not suggest that firms that carry out marketing related activities do overall achieve lower sales per employee.

6. Alternative models to the standardised models presented in this report were produced. For example, next to the controls introduced in Section 3, Canada and the United Kingdom included skills variables that were positive and significant in both countries. In the case of Korea, a skills variable was also included but this was only significant in terms of productivity. The results are highly similar across different models.

Table 6. The impact of mixed modes of innovation on labour productivity

Log turnover per employee 2006	Australia	Austria	Belgium	Canada	Chile	Czech Republic	Denmark	Estonia	Iceland
IP/technology innovating	0.198***	0.085	0.034	0.0179	0.093	-0.005	0.056	0.145	-0.594
	(0.061)	(0.065)	(0.072)	(0.069)	(0.105)	(0.058)	(0.043)	(0.126)	(0.424)
Marketing based innovating	-0.114**	0.082*	-0.002	-0.00595	-0.137	0.021	-0.008	0.046	-0.109
	(0.049)	(0.044)	(0.057)	(0.035)	(0.116)	(0.040)	(0.042)	(0.073)	(0.207)
Process modernising	0.013	0.109**	-0.012	0.0634*	0.303***	0.038	0.063	0.105	0.221
	(0.045)	(0.054)	(0.056)	(0.035)	(0.111)	(0.052)	(0.063)	(0.083)	(0.267)
Wider innovating	0.049	0.151***	0.012	.	0.026	0.133***	-0.021	0.127*	-0.139
	(0.046)	(0.048)	(0.052)	.	(0.107)	(0.046)	(0.044)	(0.073)	(0.172)
Networked innovating	0.047	0.059	0.088	-0.0397	0.463***	0.187***	0.091**	0.062	-0.297
	(0.044)	(0.060)	(0.066)	(0.042)	(0.119)	(0.044)	(0.043)	(0.089)	(0.220)
Market is international	0.445***	0.220***	0.157**	-0.00621	0.603***	0.072*	0.126***	0.188	-0.044
	(0.043)	(0.048)	(0.066)	(0.040)	(0.115)	(0.038)	(0.049)	(0.087)	(0.228)
Belongs to a group	.	0.339***	0.380***	0.332***	.	0.553***	0.305***	0.380***	0.127
	.	(0.048)	(0.053)	(0.035)	.	(0.041)	(0.051)	(0.063)	(0.192)
Log employment 2006	0.244***	0.081***	0.017	0.0539***	-0.102***	-0.030**	0.046***	-0.001	0.107
	(0.024)	(0.018)	(0.024)	(0.017)	(0.037)	(0.015)	(0.016)	(0.033)	-0.094
Industry dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Regional dummies	Included	Included	Included	Included	Included	Included	Included	Included	Not included
Observations	3 560	1 720	1 378	3 629	1 062	2 508	1 331	1 057	76
R-squared	0.286	0.291	0.21	0.23	0.22	0.32	0.344	0.42	0.619

Table 6. The impact of mixed modes of innovation on labour productivity (continued)

Log turnover per employee 2006	Ireland	Korea	Luxembourg	Netherlands	Spain	United Kingdom
IP/technology innovating	0.052	-0.007	0.123	0.223***	-0.03	0.142***
	(0.165)	(0.085)	(0.150)	(0.066)	(0.031)	(0.033)
Marketing based innovating	0.153	-0.086	0.315**	0.096**	0.023	0.026
	(0.098)	(0.053)	(0.147)	(0.047)	(0.019)	(0.033)
Process modernising	0.133	-0.067	-0.133	0.318***	-0.042**	0.138***
	(0.098)	(0.058)	(0.130)	(0.045)	(0.021)	(0.040)
Wider innovating	0.009	0.096*	0.296**	0.078	-0.011	0.054
	(0.117)	(0.050)	(0.134)	(0.052)	(0.019)	(0.033)
Networked innovating	-0.075	0.015	0.008	0.146***	0.106***	0.081**
	(0.121)	(0.043)	(0.130)	(0.045)	(0.025)	(0.041)
Market is international	0.171	0.139***	0.186	0.127***	0.371***	0.384***
	(0.109)	(0.042)	(0.117)	(0.047)	(0.018)	(0.033)
Belongs to a group	0.389***	0.298***	0.560***	0.388***	0.431***	0.372***
	(0.123)	(0.062)	(0.102)	(0.041)	(0.019)	(0.035)
Log employment 2006	0.010	0.162***	-0.014	-0.118***	0.02***	-0.048***
	(0.045)	(0.019)	(0.042)	(0.020)	(0.007)	(0.012)
Industry dummies	Included	Included	Included	Included	Included	Included
Regional dummies	Not included	Included	Not included	Not included	Not included	Included
Observations	756	1 365	310	3 331	14 804	4 616
R-squared	0.20	0.26	0.35	0.173	0.327	0.219

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors are provided in brackets. All regressions are computed with a constant. Australia controlled for employment size bands instead of using the log employment 2006. Ireland controls for foreign ownership. Canada uses 2002 and 2004 data, Korea 2005 and 2007, and Chile 2005 and 2006.

Source: OECD Innovation Microdata project, 2011.

Tables 7 and 8 compare the link between mixed modes and growth measured as change in turnover between 2004 and 2006 and change in employment between 2004 and 2006 respectively. Additionally to the control variables used in Table 6, the regressions correct for the level of turnover in 2004 and employment in 2004. In the latter model the size control log of employments 2006 is dropped.

As previously reported in connection with productivity, we find no single innovation mode that is significant for all (or almost all) countries. *Wider innovating* exhibits most frequently significant positive coefficients (in eight out of 14 countries) with turnover growth, followed by *networked innovating* (in seven). Austria and the Netherlands show significant positive associations between growth and all the innovation modes. *Process modernising* is positively associated in six cases (and negatively in Spain); while *IP/technology innovating* and *market based innovating* show fewer positive associations.

In the case of employment, *wider innovating* is positively associated with growth in the most countries (eight), followed by *process modernising* (in seven). *Networked innovating* and *IP/technology innovating* modes display positive coefficients in six countries and both *IP/technology innovating* and *marketing based innovating* have a negative association with employment growth in one of the countries examined (Estonia and the Czech Republic respectively).

Linking mixed modes of innovation to performance, novel to this strand of work, informs about the functioning and performance of different innovation systems. Finding not only heterogeneity across modes, but even stronger country specific pattern in the effects of mixed modes stresses national differences. In conclusion, and addressing RQ3: even if common innovation patterns have been identified, there is no 'single' mode or form of innovation across countries that underlies the overall impact of innovation and there appear to be major national differences in patterns of competitive and comparative advantage (both with respect to levels of productivity and growth in turnover).

Table 7. The impact of mixed modes of innovation on change in turnover

Change in turnover from 2004 to 2006	Austria	Belgium	Canada	Chile	Czech Republic	Denmark	Estonia	Iceland
IP/technology innovating	0.103**	-0.014	-0.00231	0.012	-0.097**	0.034	-0.135	0.093
	(0.046)	(0.023)	(0.046)	(0.040)	(0.038)	(0.030)	(0.095)	(0.220)
Marketing based innovating	0.060*	0.024	0.00471	-0.033	-0.059**	0.010	0.075	-0.008
	(0.031)	(0.021)	(0.026)	(0.036)	(0.024)	(0.029)	(0.053)	(0.130)
Process modernising	0.085**	0.054**	0.0552*	0.044	0.019	0.024	0.141**	-0.166
	(0.040)	(0.021)	(0.030)	(0.040)	(0.031)	(0.041)	(0.059)	(0.139)
Wider innovating	0.117***	0.039*	.	0.045	0.076***	-0.014	0.104**	0.124
	(0.034)	(0.021)	.	(0.034)	(0.027)	(0.035)	(0.052)	(0.168)
Networked innovating	0.095**	0.049**	-0.0222	0.082*	0.098***	0.105***	0.040	-0.137
	(0.037)	(0.024)	(0.031)	(0.045)	(0.027)	(0.031)	(0.062)	(0.127)
Market is international	0.070**	0.036	-0.0251	0.049	0.063**	0.065*	0.069	0.184
	(0.031)	(0.026)	(0.027)	(0.042)	(0.025)	(0.039)	(0.064)	(0.125)
Belongs to a group	0.096**	0.009	0.133***	.	0.212***	0.152***	0.170***	0.127
	(0.041)	(0.019)	(0.026)	.	(0.028)	(0.036)	(0.048)	(0.117)
Log employment 2006	0.319***	0.084***	0.406***	0.088***	0.306***	0.387***	0.439***	0.339**
	(0.057)	(0.022)	(0.043)	(0.023)	(0.028)	(0.052)	(0.071)	(0.144)
Log turnover 2004	-0.320***	-0.089***	-0.376***	-0.083***	-0.332***	-0.396***	-0.461***	-0.410**
	(0.056)	(0.020)	(0.044)	(0.023)	(0.027)	(0.045)	(0.057)	(0.165)
Industry dummies	Included	Included	Included	Include	Included	Included	Included	Included
Regional dummies	Included	Included	Included	Include	Included	Included	Included	Not included
Observations	1 677	1 375	3 176	1 060	2 380	1 300	991	66
R-squared	0.219	0.09	0.33	0.1199	0.32	0.320	0.4784	0.614

Table 7. The impact of mixed modes of innovation on change in turnover (continued)

Change in turnover from 2004 to 2006	Ireland	Korea	Luxembourg	Netherlands	Spain	United Kingdom
IP/technology innovating	-0.055	-0.009	0.032	0.149***	0.041**	-0.008
	(0.134)	(0.046)	(0.056)	(0.045)	(0.019)	(0.033)
Marketing based innovating	0.033	-0.036	0.046	0.082***	0.084***	0.061*
	(0.083)	(0.033)	(0.060)	(0.029)	(0.012)	(0.036)
Process modernising	0.207**	0.007	-0.065	0.147***	-0.025*	0.024
	(0.110)	(0.037)	(0.050)	(0.029)	(0.013)	(0.039)
Wider innovating	-0.073	0.056**	0.207***	0.118***	0.081***	0.004
	(0.130)	(0.029)	(0.061)	(0.032)	(0.012)	(0.033)
Networked innovating	-0.204	0.029	-0.025	0.063**	0.086***	0.031
	(0.174)	(0.026)	(0.057)	(0.027)	(0.016)	(0.039)
Market is international	-0.400*	-0.019	0.113**	0.018	0.086***	0.162***
	(0.220)	(0.024)	(0.049)	(0.028)	(0.012)	(0.035)
Belongs to a group	0.083	0.067*	0.115**	0.100***	0.149***	0.089**
	(0.160)	(0.037)	(0.046)	(0.030)	(0.014)	(0.038)
Log employment 2006	0.203**	0.267***	0.112***	0.274***	0.307***	0.443***
	(0.080)	(0.033)	(0.032)	(0.033)	(0.015)	(0.039)
Log turnover 2004	-0.245***	-0.244***	-0.137***	-0.309***	-0.326***	-0.413***
	(0.060)	(0.029)	(0.030)	(0.035)	(0.014)	(0.037)
Industry dummies	Included	Included	Included	Included	Included	Included
Regional dummies	Not included	Included	Not included	Not included	Not included	Included
Observations	284	1 355	299	3 311	13 571	2 026
R-squared	0.21	0.22	0.22	0.250	0.281	0.341

Note: as per Table 6. Results for Australia are not available.

Source: OECD Innovation Microdata project, 2011.

Table 8. The impact of mixed modes of innovation on change in employment

Change in employment from 2004 to 2006	Austria	Belgium	Canada	Chile	Czech Republic	Denmark	Estonia	Iceland
IP/technology innovating	0.131***	0.030	0.0937***	-0.017	0.040	-0.016	-0.154*	0.046
	(0.033)	(0.020)	(0.030)	(0.028)	(0.040)	(0.023)	(0.089)	(0.127)
Marketing based innovating	0.021	0.047***	0.0504**	0.006	-0.046*	0.036	0.102**	0.086
	(0.017)	(0.016)	(0.023)	(0.031)	(0.025)	(0.023)	(0.043)	(0.110)
Process modernising	0.073***	0.050***	0.115***	0.007	0.048	-0.012	0.172***	-0.149
	(0.020)	(0.018)	(0.025)	(0.035)	(0.032)	(0.031)	(0.047)	(0.091)
Wider innovating	0.063***	0.085***	.	0.029	0.156***	-0.032	0.141***	0.085
	(0.018)	(0.018)	.	(0.035)	(0.030)	(0.024)	(0.046)	(0.119)
Networked innovating	0.048**	0.052***	-0.0365	0.03	0.159***	0.035	0.151***	-0.056
	(0.023)	(0.019)	(0.032)	(0.027)	(0.029)	(0.026)	(0.042)	(0.153)
Market is international	0.032	-0.004	0.0936***	0.082*	0.123***	0.005	0.114**	0.089
	(0.022)	(0.018)	(0.025)	(0.043)	(0.029)	(0.030)	(0.049)	(0.120)
Belongs to a group	0.004	0.006	0.228***	.	0.219***	0.063**	0.151***	0.146
	(0.018)	(0.015)	(0.023)	.	(0.028)	(0.030)	(0.036)	(0.092)
Log employment 2004	-0.114***	-0.067***	-0.191***	-0.045***	-0.200***	-0.067***	-0.277***	-0.134**
	(0.011)	(0.008)	(0.013)	(0.011)	(0.016)	(0.011)	(0.032)	(0.057)
Industry dummies	Included	Included	Included	Included	Included	Included	Included	Included
Regional dummies	Included	Included	Included	Included	Included	Included	Included	Not included
Observations	1 673	1 376	3 176	1 076	2 380	1 307	1 001	74
R-squared	0.205	0.14	0.14	0.0587	0.23	0.088	0.4229	0.387

Table 8. The impact of mixed modes of innovation on change in employment (continued)

Change in employment from 2004 to 2006	Ireland	Korea	Luxembourg	Netherlands	Spain	United Kingdom
IP/technology innovating	0.035	0.097***	0.063	0.063***	0.062***	0.056**
	(0.066)	(0.031)	(0.057)	(0.023)	(0.013)	(0.028)
Marketing based innovating	0.056	0.046**	0.052	-0.013	0.061***	0.030
	(0.073)	(0.020)	(0.045)	(0.014)	(0.009)	(0.026)
Process modernising	0.014	0.045**	0.048	0.053***	0.023**	0.038
	(0.056)	(0.023)	(0.050)	(0.018)	(0.009)	(0.032)
Wider innovating	-0.062	0.093***	0.132***	0.031*	0.120***	0.016
	(0.064)	(0.020)	(0.037)	(0.016)	(0.009)	(0.025)
Networked innovating	-0.012	0.048***	0.037	0.012	0.050***	0.013
	(0.089)	(0.016)	(0.042)	(0.016)	(0.011)	(0.025)
Market is international	-0.006	0.003	0.067	0.018	-0.002	-0.040
	(0.119)	(0.016)	(0.043)	(0.015)	(0.007)	(0.028)
Belongs to a group	0.110	0.016	0.037	0.008	0.080***	0.079***
	(0.088)	(0.020)	(0.042)	(0.012)	(0.009)	(0.027)
Log employment 2004	-0.122***	-0.059***	-0.095***	-0.061***	-0.096***	-0.059***
	(0.032)	(0.007)	(0.031)	(0.008)	(0.005)	(0.011)
Industry dummies	Included	Included	Included	Included	Included	Included
Regional dummies	Not included	Included	Not included	Not included	Not included	Included
Observations	284	1,385	299	3,309	13,703	2,038
R-squared	0.13	0.09	0.21	0.083	0.149	0.061

Note: as per Table 6. Results for Australia are not available.

Source: OECD Innovation Microdata project, 2011.

7. Mixed modes of innovation within sectors across countries

The mixed modes project results set out so far, point towards the relevance of country specific innovation patterns and heterogeneity in the way that firms implement innovation routines. One plausible explanation could lie in differences in sector mix in the participating countries. That is, cross-country heterogeneity of innovation patterns could reflect their industrial structure, with more homogeneous innovation strategies in individual sectors in each country. The modes set out in this study can be identified in broadly defined business sectors, in order to investigate issues of sector mix and the international convergence or lack of convergence of sectors. This section compares the innovation modes/strategies of firms active in specific industry sectors across countries, to test if there is evidence of this pattern of convergence in innovation modes at the industry level, or more specifically, if there is evidence of firms in a specific industry specialisation in one or more innovation modes (and if this specialisation is consistent irrespectively of the country).

The intensities of application of the innovation modes are measured by the mean factor scores for an industry in each country. As factor scores are distributed with mean zero and standard deviation of one, a positive score on a mode represents a relative orientation towards that mode in the industry, while a negative score shows below national average use of the mode.

The specialisation within industries is presented in Table 9 and the amount of variation explained by means of analysis of variance in the specialisation scores is examined.[7] This is followed by the presentation of more in-depth results for three sectors – medium technology manufacturing – vehicles; low technology services – wholesale; and high technology services – knowledge intensive business services. Comparative advantages of countries may well lie within traditionally low-tech sectors and with service sectors.

Specialisation across industries

Table 9 is based on the following data: for each country with data for an industry, we compute cross country average factor scores for that industry. These averages when positive indicate a specialisation of firms in that industry (or an above average intensity with respect to the innovation mode). When negative, the averages indicate that a specific mode is less relevant (used) by firms in a specific industry.

7. We owe this suggestion to Mark Schankerman following the presentation of an earlier draft at the Network of Industrial Economists meeting at Nottingham University 19 March 2010.

Table 9. Mixed modes specialisation of industries

Industry	Countries	Firms	IP / technology innovating	Marketing based innovating	Process modernising	Wider innovating	Networked innovating
Primary, extraction	9	200	0.03	-0.58	0.06	-0.10	0.28
Food, beverages	16	2,775	0.04	0.13	0.10	-0.04	-0.03
Textiles, apparel, leather	15	1,598	0.01	0.06	-0.04	-0.14	-0.07
Wood, pulp, paper, publishing, printing	16	2,842	-0.14	-0.13	0.23	-0.02	-0.24
Coke, petroleum, chemicals, rubber and plastics	16	3,756	0.21	0.12	-0.07	-0.07	0.15
Mineral products, basic metals, metal production	16	4,442	0.10	-0.13	0.11	-0.17	0.01
Machinery, electrical, communication, medical equipment	16	5,930	0.39	0.22	-0.07	-0.13	0.14
Motor vehicles, other transport equip.	16	1,476	0.26	-0.06	0.05	-0.09	0.25
Manufacturing n.e.c.	15	1,717	0.15	0.01	0.01	-0.12	-0.15
Electricity, gas, water supply, water purification	14	532	-0.26	-0.51	0.03	0.12	0.26
Construction	8	1,998	-0.27	-0.32	0.02	-0.02	-0.03
Wholesale, trade	14	3,635	-0.15	-0.07	-0.04	0.10	-0.26
Hotels, restaurants	6	767	-0.32	0.06	-0.02	0.02	-0.29
Transport services	14	1,815	-0.40	-0.19	0.06	0.08	-0.11
Post and telecoms	10	386	-0.21	0.17	-0.09	0.18	-0.12
Financial services and insurances	14	1,746	-0.46	0.11	0.03	0.48	0.06
Real estate, renting of equipment	5	414	-0.35	-0.13	0.10	0.15	-0.17
KIBS, computer, R&D, legal, accounting	14	5,864	-0.09	0.03	-0.13	0.11	0.12
Total		41,893					
F-statistic			21.59***	16.92***	3.69***	16.27***	15.40***
ω			0.77	0.73	0.40	0.73	0.72

* The observations are those countries that computed industry specialisation scores (in total 15 countries). Average factor scores in each industry are calculated using a weighted mean. The weight is the number of observations in each industry and country. ω>0.5 following the ANOVA suggests a substantive effect size.

Source: OECD Innovation Microdata project, 2011.

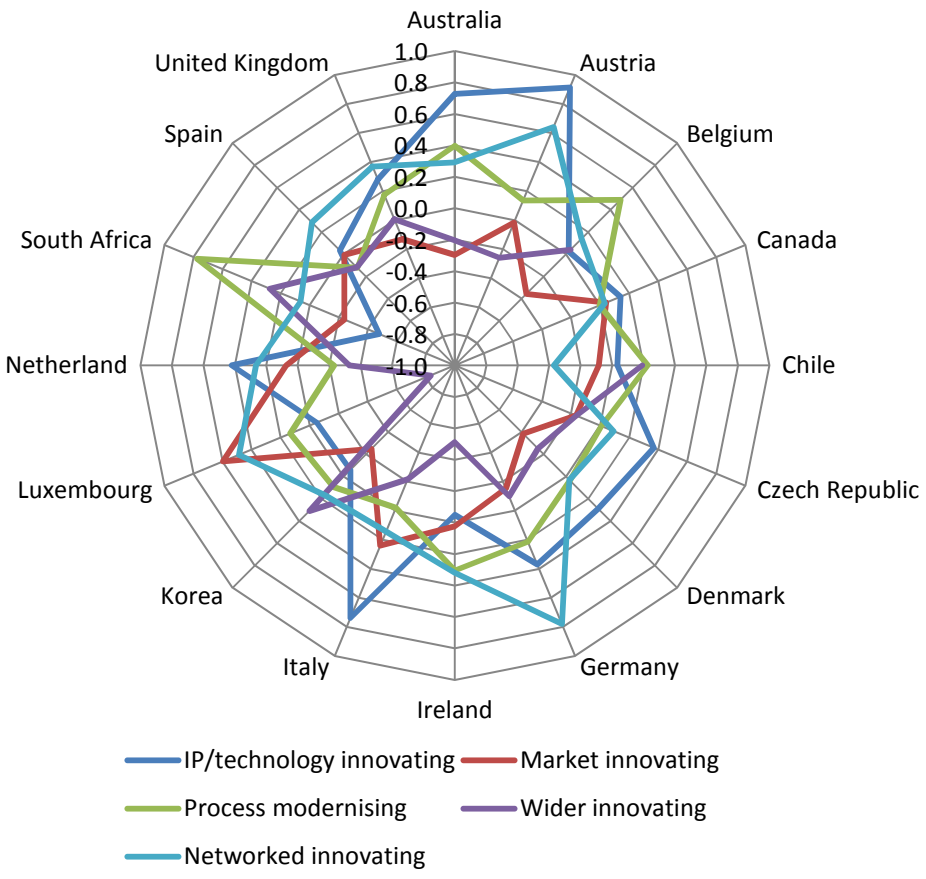
IP/technology innovating and *process modernising* are modes more dominantly applied in manufacturing industries, specifically high use of *IP/technology innovating* is found in traditionally high-tech manufacturing sectors (*e.g.* communication and medical equipment) across all countries. *Wider innovating* on the converse is more strongly applied in services sectors, specifically financial services and insurances. *Networked innovating* also appears to play a stronger role in high-tech manufacturing industries.

The significant F statistics and associated size effects captured by ω indicate that a substantive amount of variation in this specialisation on mixed modes can be explained at the sectoral level across countries, suggesting that a country's sector mix is one determinant of national patterns of innovation strategies. But other determinants of specialisation in the modes, including national system characteristics are also of considerable importance. The next section looks in more detail at the relative specialisation within industries across countries for three selected sectors.

Vehicles sector

Figure 11 summarises the relative orientation towards mixed modes of vehicle manufacturing firms across countries. Values above zero suggest a relative specialisation in the innovation mode, while values below zero suggest that vehicle manufactures are less likely to pursue a specific mode relative to the country average. Similarity in specialisation across countries is where the lines representing the specialisation on modes cut the country-individual axes at the same level/height. Spikes – inward or outward – in Figure 11 indicate country-specific patterns.

Figure 11. Relative orientation of vehicle producing firms on core modes



Source: OECD Innovation Microdata project, 2011.

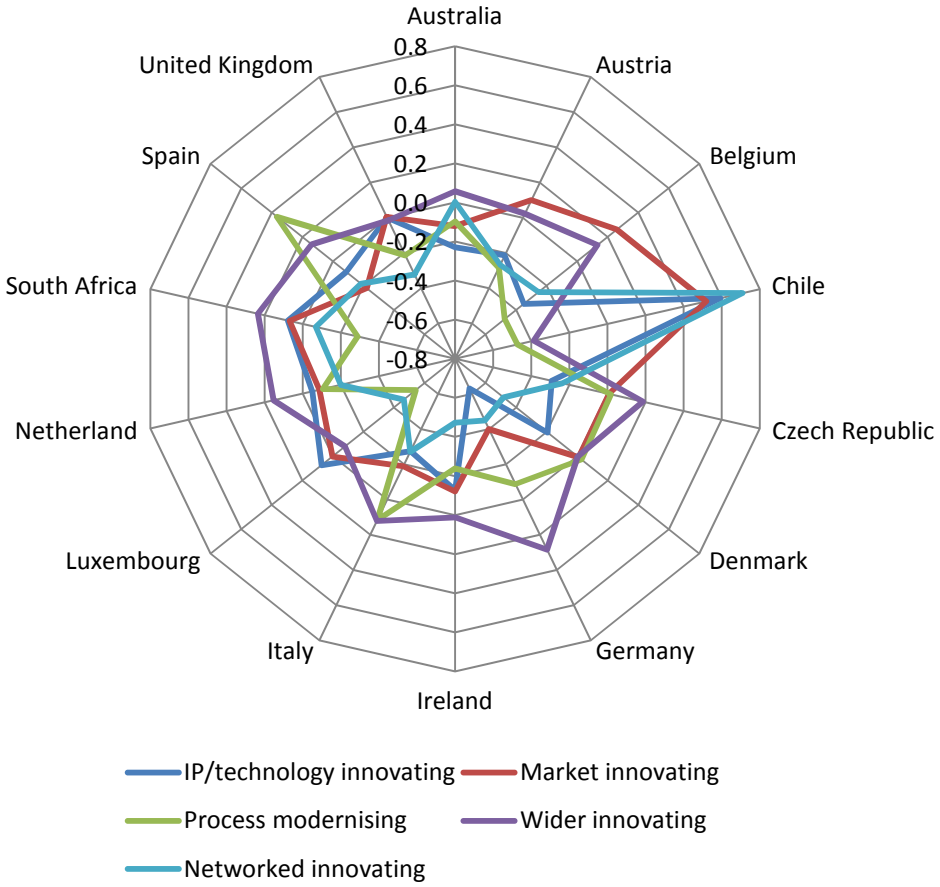
The nature of the innovation system for vehicles manufacturing varies across countries, providing no support for the hypothesis of convergence in the sense of behaviour tightly determined by factors common to the industry and not to the nation. This is not to go to the other extreme and deny any industry level similarities across countries. But these are mediated by strategies and external opportunities that are local and national. Internal company resources are deployed in conjunction with sources of information from other firms and to the generic aspects of the business environment and knowledge infrastructure.

In the case of Austria and Italy, the vehicles sector specialises in *technology based innovation*, in conjunction with *networking*. In Germany, on the other hand, networked activity is the main mode, supported by technology and externally oriented *process modernising*. In Belgium and South Africa, external *process modernising* is the leading modality. In general, *wider innovating* – based on managerial and strategic change – is less favoured in the vehicles sector in most countries except in Korea and Chile, where it is one of the leading modes.

Wholesale

We next turn to a low technology sector not usually considered as showing strongly innovative behaviour.

Figure 12. Relative orientation of wholesale firms on core modes



Source: OECD Innovation Microdata project, 2011.

While in several countries the level of the innovation modes indictors are low and often negative *i.e.* the sector is well below the national average scores on most modes, there are examples of high

scores. For example, in Chile the sector reports high inclination towards *networked innovating*, *IP/technology innovating* and *market based innovating*. Netherlands' wholesalers also show high networking and an even higher orientation to the use of own account technology. In Germany, South Africa and Belgium, *wider innovation* is the dominant mode for the sector.

Knowledge intensive business services

The knowledge intensive business services sector exhibits higher innovation propensities than other sectors in most countries in the project.

Figure 13. Relative specialisation of knowledge intensive business services on the core modes



Source: OECD Innovation Microdata project, 2011.

There is inter-country heterogeneity, with alternative patterns of strategic combinations of the innovation modes. In the case of the United Kingdom, for example, *wider innovating* shows the highest relative score, but this is close to the other modes. In Italy, *networked innovating* is the leading orientation of the sector. In Spain and South Africa, *process modernisation* is more heavily represented in the sector, although this mode is a less prominent part of the innovation strategy of the sector in most countries.

Addressing RQ4, these results do not support a hypothesis that innovation strategies are dominated by sector characteristics. The ANOVA results reported above indicate that there is a degree of commonality in an industry across country boundaries. But both sectoral and firm size related patterns in modes of innovation across 18 countries and representing the revealed behaviour of (over 44,000) innovation active businesses reflect the continuing importance of national systems of innovation, including institutional structures and formal and tacit knowledge exchange channels, even in the face of globalising forces such as transnational corporations and international frameworks for trade and regulation (Smith, 2010).

8. Discussion and conclusions

This study is in an emerging tradition of applying exploratory data analysis techniques, in our case factor analysis, to tease out some underlying 'latent' variables that represent coherent innovation strategies for groups of firms. Contrary to most studies using innovation survey data, in this paper both inputs and outputs into the innovation process feed into mixed modes, as do activities linked to technological knowledge, but also non-technological activities, while interactions with outside sources and network configurations are also incorporated. The complexities and non-linearities of real innovation processes are usefully captured and summarised through this modelling strategy, and we believe that new insights into the workings of the innovation system have emerged.

The factor scores, representing the extent to which individual firms engage in, or make use of, a specific mode of innovation are compared between countries, and across countries within sectors. Moreover, factor scores are linked via regressions to measures of labour productivity and growth at the firm level to reflect the functioning of national innovation systems.

Mode 1, entitled *IP/technology innovating* mode, contains at its core IPRs, and in many countries this is complemented by in-house R&D and new-to-market activities. The second mode, Mode 2 – *marketing based innovating* – includes forms of product innovation, leaning towards new-to-firm imitating, with marketing expenditures for the introduction of innovations. Marketing based innovating is in its core also a strategy that leans towards sourcing information from other businesses. Mode 3, *process modernising*, typically links process innovations with equipment spending and is driven by external developments feeding into the innovation strategy. In many countries training of employees is linked to this mode. Mode 4 is *wider innovating* and shows strong combinations of types of management and business strategy changes, including new sales and distribution methods. Mode 5, *networked innovating*, generally involves external knowledge sourcing in the form of bought-in R&D or licences and formal collaboration, while leaning towards accessing information from the knowledge base – universities and research organisations.

The coherence and relevance of the mixed modes is tested by using them as explanatory factors in equations explaining economic performance. In most countries one or more innovation modes are positively associated with labour productivity. However, there is no consistent cross-country pattern as to which modes show significant associations with productivity. Even if common innovation patterns have been identified, there is no 'single' mode or form of innovation across countries that underlies the overall impact of innovation and there appear to be major national differences in patterns of competitive and comparative advantage (with respect to levels of productivity and growth in turnover and employment).

The model can also test the plausible explanation for inter-country heterogeneity that this could lie in differences in sector mix in the participating countries. Phenomena, such as the various facets of globalisation, are arguable shifting relevance away from national systems of innovation and national policies towards an international framework. One implication would be a convergence towards greater similarity of innovation modes within an industry across countries, compared with patterns across countries themselves. We test this proposition through analysing innovation modes at the industry level. In general, sectoral innovation orientations are importantly embedded in national systems, as well as exhibiting a degree of convergence at the sectoral level.

The modes identified in this study are influenced by the availability and selection of measures feeding into the modes and country datasets. One notable exception is the United States where no comparable data are yet available. For technical and availability reasons measures used in this study capture the propensity of firms – not the intensity – to engage in a specific set of activities. Differences across countries are assessed through observing patterns, rather than statistically testing for a difference, across countries. The scope for such techniques is limited due to the fact that this type of micro level data cannot be pooled.

The core modes are used to explore a variety of propositions about the driving forces of innovation to enable more informed judgements on the desirability and likely success of alternative policies. In connection with concepts of openness we find that "openness as an innovative strategy is not a panacea nor a simple choice, for the firm or the policy maker" (Acha, 2008), but that different forms of openness are highly context bound – embedded in national and sectoral environments of firms. The continued pertinence of national, as opposed to globalised, innovation systems emerges strongly, shown by the heterogeneity of country level patterns of mode use and their productivity impacts, but also by significant nation related variations in innovation strategies in business sectors. The public knowledge base, a key factor in national innovation policies in many countries, plays an important role in several modes, but this role varies between countries, indicating that the public knowledge base is a part of specific national innovation systems and features as a complementary asset in a range of strategic orientations. The policy implications point towards instruments that optimize the benefits of the natural affinities between public knowledge and innovators under specific modes rather than instruments to force broad-spectrum outreach.

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ANNEX

Country specific factor analyses

Variable names		AU1	AU2	AU3	AU4	AU5	AT1	AT2	AT3	AT4	AT5	BE1	BE2	BE3	BE4	BE5	CA1	CA2	CA3
1	NEWFRM	0.11	0.68	0.21	-0.19	0.06	0.13	0.65	-0.07	0.01	0.39	0.00	0.66	0.10	0.01	-0.02	0.00	0.82	-0.04
2	NEWMKT						0.64	0.43	-0.01	0.08	0.04	0.13	0.72	0.05	0.07	0.22	0.34	0.60	-0.11
3	INPCS	0.20	0.10	0.74	0.06	0.28	-0.07	-0.05	0.82	0.25	-0.11	0.00	0.08	0.76	0.21	-0.04	-0.18	-0.26	0.75
4	ORGSYS	0.05	0.19	0.17	0.72	0.14	0.13	0.11	0.19	0.77	0.02	0.13	0.13	0.11	0.83	0.14			
5	ORGSTR	0.13	0.10	0.07	0.66	0.15	0.08	0.04	0.11	0.84	0.16	0.09	0.09	0.20	0.88	0.07			
6	ORGREL	0.07	0.33	-0.16	0.57	0.13	0.16	0.21	0.03	0.67	0.24	0.00	0.14	0.10	0.78	0.26			
7	MKTDES	0.24	0.60	0.28	0.30	0.00	0.25	0.59	-0.04	0.28	-0.15	-0.12	0.63	-0.03	0.28	0.19			
8	MKTMET	0.06	0.70	-0.04	0.29	0.00	0.06	0.56	-0.01	0.48	-0.24	-0.30	0.56	-0.06	0.40	0.21			
9	RRDIN	0.51	0.08	0.25	-0.09	0.48	0.76	0.19	0.15	0.04	0.26	0.58	0.32	0.21	0.11	0.47	0.07	0.40	0.16
10	PROPAT	0.91	0.01	0.11	0.05	0.07	0.89	0.07	0.06	0.05	0.06						0.78	0.05	-0.06
11	RMAC	0.06	0.02	0.22	0.15	0.81	0.29	0.02	0.71	0.04	0.22	-0.18	-0.07	0.77	0.15	0.24	0.01	0.14	0.76
12	PRODSG	0.86	0.12	0.07	0.09	0.03	0.82	0.10	-0.04	0.08	-0.06						0.49	0.19	0.08
13	PROCP	0.83	0.10	-0.07	0.02	0.07	0.66	0.01	-0.07	0.29	-0.21						0.83	0.02	-0.07
14	RTR	0.07	0.05	0.04	0.30	0.72	0.33	0.20	0.45	0.34	0.22	0.24	0.19	0.52	0.32	0.13	0.06	0.16	0.71
15	RMAR	0.14	0.64	-0.13	0.16	0.17	0.56	0.63	0.08	0.12	0.06	0.23	0.73	0.04	0.19	0.18	0.49	0.39	0.25
16	EXTINN						-0.54	-0.06	0.52	-0.26	-0.09	-0.79	0.00	0.17	-0.17	-0.11	-0.09	0.03	0.12
17	SOURCING	0.44	0.26	-0.20	0.05	0.51	0.57	0.17	0.33	0.24	0.21	0.07	0.19	0.17	0.15	0.73	0.44	0.31	0.42
18	INFOMKT	-0.05	0.43	-0.03	-0.07	0.48	0.01	0.07	-0.02	0.20	0.79	-0.30	0.18	0.17	0.07	0.64	0.06	0.49	0.36
19	INFOKB	0.20	-0.06	-0.34	0.38	0.48	0.34	-0.23	0.23	0.28	0.47	0.23	0.11	-0.07	0.21	0.74	0.27	-0.08	0.45
20	CO	0.17	0.33	-0.38	0.13	0.34	0.47	0.27	0.27	0.16	0.21	0.17	0.10	0.08	0.21	0.77	0.35	0.40	0.25

Source: OECD Innovation Microdata project, 2011.

Variable names		CA4	CA5	CL1	CL2	CL3	CL4	CL5	CZ1	CZ2	CZ3	CZ4	CZ5	DK1	DK2	DK3	DK4	DK5	EE1
1	NEWFRM		0.04	0.15	0.88	-0.07	0.10	0.09	0.20	0.74	-0.02	-0.03	0.11	0.79	0.13	0.11	0.12	0.20	-0.28
2	NEWMKT		0.36	0.39	0.77	0.00	0.08	0.07	0.41	0.66	-0.01	0.05	0.14	0.80	0.10	0.11	0.12	0.30	0.32
3	INPCS		-0.03	0.06	-0.30	0.67	0.37	0.04	0.04	-0.26	0.63	0.49	0.12	0.26	0.25	0.67	0.46	0.09	0.04
4	ORGSYS			0.10	0.14	0.06	0.90	0.05	0.08	-0.03	0.13	0.78	0.21	0.08	0.04	0.12	0.87	0.15	0.18
5	ORGSTR			-0.01	0.15	0.10	0.93	0.05	0.09	0.00	0.04	0.79	0.19	0.12	0.17	0.04	0.88	0.03	0.12
6	ORGREL			0.15	0.23	0.05	0.80	0.16	0.11	0.18	0.05	0.69	0.22	0.18	-0.01	0.00	0.69	0.13	0.04
7	MKTDES			-0.10	0.69	0.18	0.35	0.05	0.14	0.49	-0.08	0.60	-0.01	0.64	0.31	-0.04	0.26	-0.19	0.39
8	MKTMET			0.03	0.76	0.11	0.34	0.09	0.01	0.47	0.04	0.60	-0.09	0.47	0.45	-0.05	0.49	-0.09	0.29
9	RRDIN		0.71	0.70	0.35	0.28	0.07	0.01	0.62	0.22	-0.10	0.18	0.36	0.45	0.03	-0.19	0.00	0.69	0.45
10	PROPAT		0.15	0.66	0.16	0.09	-0.09	-0.05	0.90	0.07	0.00	0.06	0.15						0.82
11	RMAC		-0.12	0.17	0.10	0.76	0.04	0.01	0.01	0.14	0.74	0.11	0.09	-0.11	0.30	0.42	0.25	0.22	0.01
12	PRODSG		0.29						0.88	0.19	-0.03	0.08	-0.05						0.84
13	PROCP		0.02						0.26	0.29	0.03	0.48	-0.11						0.78
14	RTR		0.10	0.37	0.33	0.42	0.23	0.21	0.01	0.23	0.24	0.31	0.54	0.07	0.88	0.06	0.08	0.14	0.01
15	RMAR		0.21	0.16	0.12	0.79	0.03	0.16	0.25	0.61	-0.03	0.32	0.30	0.18	0.90	0.01	0.10	0.06	0.28
16	EXTINN		-0.88						-0.22	-0.12	0.62	-0.20	-0.15	0.01	-0.06	0.89	-0.04	-0.17	-0.10
17	SOURCING		-0.13	0.71	0.09	0.19	0.09	0.29	-0.02	0.23	-0.04	0.26	0.64	-0.01	0.28	0.03	0.14	0.66	0.21
18	INFOMKT		0.07	0.09	0.12	0.15	0.06	0.85	-0.04	0.26	0.33	0.07	0.49						-0.14
19	INFOKB		0.30	0.11	0.06	0.01	0.14	0.86	0.31	-0.05	-0.06	0.08	0.68						0.11
20	CO		0.04	0.64	0.01	0.05	0.36	0.28	0.32	0.10	0.10	0.17	0.61	0.16	0.07	-0.06	0.18	0.77	0.06

Source: OECD Innovation Microdata project, 2011.

Variable names		EE2	EE3	EE4	EE5	DE1	DE2	DE3	DE4	DE5	IC1	IC2	IC3	IC4	IC5	IR1	IR2	IR3	IR4
1	NEWFRM	0.75	-0.11	0.12	0.15	0.06	0.81	-0.12	-0.02	0.10	-0.02	0.67	-0.23	-0.37	-0.08	0.07	0.89	-0.01	0.09
2	NEWMKT	0.54	-0.28	0.12	0.31	0.41	0.62	-0.05	0.03	0.07	0.59	0.10	-0.05	0.48	0.09	0.37	0.75	0.03	0.03
3	INPCS	-0.11	0.87	0.25	0.04	0.03	-0.33	0.73	0.15	0.11	0.47	0.05	0.77	0.26	0.07	0.07	-0.38	0.50	0.56
4	ORGSYS	0.03	-0.02	0.73	0.32	-0.06	-0.05	0.09	0.48	0.53	0.30	0.04	0.32	0.78	0.03	0.12	-0.03	0.06	0.88
5	ORGSTR	0.11	0.10	0.84	0.24	-0.01	-0.11	0.23	0.59	0.36	0.12	0.21	0.07	0.76	0.18	0.02	0.12	0.12	0.91
6	ORGREL	0.15	0.06	0.80	0.06	0.11	-0.13	0.39	0.53	0.19	0.49	0.28	0.18	0.35	0.02	0.20	0.09	-0.05	0.92
7	MKTDES	0.49	-0.02	0.48	0.04	0.01	0.08	-0.01	0.79	0.03	0.28	0.16	-0.04	0.57	-0.53				
8	MKTMET	0.57	0.20	0.53	-0.03	0.22	0.13	0.03	0.66	-0.26	0.26	0.71	-0.09	0.42	0.11				
9	RRDIN	0.29	-0.23	0.24	0.47	0.64	0.29	-0.04	-0.04	0.44	0.74	0.00	-0.17	0.26	0.14	0.53	0.37	0.35	0.07
10	PROPAT	0.18	0.06	0.06	0.07	0.86	0.11	0.07	-0.04	0.26	0.29	0.12	-0.51	0.16	0.70	0.89	0.17	0.09	-0.03
11	RMAC	0.05	0.83	0.11	0.12	0.16	0.08	0.76	0.02	0.09	0.11	0.58	0.16	0.23	0.53	0.07	-0.05	0.78	0.04
12	PRODSG	0.07	-0.05	0.06	0.02	0.73	0.16	0.04	0.10	-0.15	0.89	-0.07	-0.12	0.14	0.22	0.90	0.02	0.19	0.20
13	PROCP	-0.04	-0.01	0.26	0.19	0.76	-0.17	0.16	0.09	0.00	0.78	0.05	-0.03	0.23	0.22	0.81	0.17	-0.11	0.26
14	RTR	0.18	0.25	0.22	0.67	0.09	0.18	0.60	0.20	0.21	0.72	0.37	0.11	0.07	-0.14				
15	RMAR	0.80	-0.07	0.07	0.14	0.49	0.42	0.15	0.38	0.17	0.77	0.37	0.04	0.13	0.00				
16	EXTINN	-0.15	0.73	-0.38	-0.29	-0.58	-0.03	0.48	-0.24	-0.21	-0.35	0.07	0.88	-0.07	-0.08	-0.13	-0.08	-0.02	-0.11
17	SOURCING	0.21	0.08	0.19	0.70	0.43	0.19	0.25	0.09	0.54	0.20	0.31	-0.13	0.68	0.21	0.42	0.31	0.53	0.05
18	INFOMKT	0.27	0.44	-0.08	0.39	-0.04	0.53	0.18	0.31	0.06	0.08	0.78	0.31	0.10	0.05				
19	INFOKB	-0.01	-0.13	0.17	0.74	0.07	0.11	0.06	-0.01	0.76	0.14	-0.09	-0.08	0.86	-0.01				
20	CO	0.20	-0.08	0.31	0.55	0.50	0.05	0.12	0.04	0.70	0.21	0.05	0.07	0.06	0.81	0.35	0.37	0.47	0.25

Source: OECD Innovation Microdata project, 2011.

Variable names		IR5	IT1	IT2	IT3	IT4	IT5	KR1	KR2	KR3	KR4	KR5	LUX1	LUX2	LUX3	LUX4	LUX5	NL1	NL2
1	NEWFRM	0.07	0.03	0.80	0.00	0.17	0.08	0.34	0.45	0.09	0.02	0.43	0.22	-0.04	0.17	0.09	0.62	0.15	0.58
2	NEWMKT	0.13	0.52	0.50	-0.16	0.18	0.12	0.40	0.55	0.06	-0.06	0.29	0.07	0.65	-0.24	0.08	0.03	0.31	0.63
3	INPCS	-0.05	-0.10	-0.50	0.63	0.25	0.04	0.19	0.17	0.77	0.37	0.03	0.02	-0.11	0.71	0.21	-0.04	0.06	-0.20
4	ORGSYS	-0.06	0.07	-0.01	0.01	0.77	0.25	0.13	0.25	0.12	0.83	0.18	0.08	0.06	0.09	0.83	-0.07	0.01	0.05
5	ORGSTR	0.09	0.01	0.00	0.00	0.79	0.28	0.15	0.27	0.10	0.83	0.18	0.06	-0.01	0.21	0.76	0.09	0.09	0.11
6	ORGREL	0.14	0.07	0.06	0.08	0.73	0.29	0.26	0.16	0.11	0.83	0.15	0.23	-0.03	0.05	0.65	0.17	0.12	0.16
7	MKTDES		0.43	0.22	0.08	0.61	-0.24	0.08	0.85	0.06	0.31	0.07	0.08	0.39	0.36	0.23	0.00	0.18	0.61
8	MKTMET		0.16	0.22	0.06	0.75	-0.20	0.11	0.77	0.05	0.44	-0.02	0.15	0.15	0.11	0.56	-0.52	0.13	0.20
9	RRDIN	0.44	0.53	0.44	-0.15	0.12	0.33	0.94	-0.02	-0.06	0.14	0.04	0.28	0.61	0.11	0.09	-0.08	0.37	0.46
10	PROPAT	0.24	0.89	0.11	-0.08	0.00	0.14	0.51	0.13	0.07	0.05	0.50	0.36	0.64	-0.10	0.04	0.01	0.83	0.22
11	RMAC	0.10	0.02	0.00	0.75	0.04	0.09						0.03	0.05	0.89	0.07	0.03	0.00	0.12
12	PRODSG	0.05	0.88	0.01	0.04	0.09	0.00	0.88	0.28	0.15	0.28	0.13	0.79	0.41	0.15	-0.06	0.03	0.90	0.13
13	PROCP	-0.05	0.61	-0.22	-0.05	0.30	0.09						0.89	0.01	-0.03	0.10	-0.15	0.68	0.06
14	RTR		0.47	0.46	0.07	0.47	0.06						0.16	0.32	0.47	0.39	-0.35	0.07	0.39
15	RMAR		0.57	0.38	0.12	0.21	0.32						0.01	0.70	0.01	0.11	-0.17	0.22	0.73
16	EXTINN	-0.96	-0.42	-0.11	0.48	-0.11	-0.14	-0.08	-0.02	0.98	-0.07	-0.05	-0.92	0.00	0.00	-0.17	-0.19	-0.18	-0.31
17	SOURCING	0.02	0.26	0.27	0.11	0.21	0.53	0.10	0.13	0.18	0.26	0.78	0.04	0.61	0.32	-0.07	0.34	0.22	0.30
18	INFOMKT		0.05	0.27	0.60	0.01	-0.09	0.23	0.13	0.22	0.45	0.23	0.07	0.19	-0.38	0.45	0.53	0.33	0.26
19	INFOKB		0.09	-0.08	-0.05	0.19	0.66	0.12	-0.02	0.09	0.43	0.70	0.15	0.35	-0.06	0.51	0.26	0.09	-0.06
20	CO	-0.09	0.24	0.21	0.05	0.17	0.67	0.09	0.07	0.84	0.21	0.39	0.08	0.41	0.16	0.23	0.05	0.26	0.14

Source: OECD Innovation Microdata project, 2011.

Variable names		NL3	NL4	NL5	ZA1	ZA2	ZA3	ZA4	ZA5	ES1	ES2	ES3	ES4	ES5	UK1	UK2	UK3	UK4	UK5
1	NEWFRM	-0.23	0.14	-0.06	0.07	-0.87	0.01	0.07	-0.03	0.06	0.71	-0.08	0.03	-0.03	0.03	0.98	-0.03	0.08	-0.07
2	NEWMKT	-0.16	0.05	0.14	0.20	0.85	0.05	0.12	0.09	0.37	0.48	-0.30	0.19	0.24	0.22	0.90	0.11	0.04	0.20
3	INPCS	0.74	0.36	0.02	0.14	-0.15	0.46	0.37	-0.32	0.06	0.03	0.58	0.46	0.17	0.02	-0.14	0.59	0.17	-0.09
4	ORGSYS	0.24	0.72	0.19	-0.11	0.04	0.24	0.74	0.09	0.06	0.08	0.08	0.78	0.20	0.14	-0.04	0.19	0.76	0.01
5	ORGSTR	0.06	0.81	0.17	-0.08	-0.08	0.20	0.77	0.19	0.07	0.06	0.09	0.82	0.14	0.12	0.06	0.13	0.84	0.09
6	ORGREL	0.03	0.76	0.14	0.30	-0.04	0.30	0.55	-0.19	0.10	0.05	-0.02	0.65	0.34					
7	MKTDES	0.09	0.44	-0.06	0.51	-0.01	-0.01	0.54	0.09	0.25	0.33	-0.10	0.61	-0.08	0.04	0.20	0.10	0.79	0.12
8	MKTMET	0.02	0.70	-0.06	0.39	0.18	0.02	0.68	-0.08	0.17	0.24	-0.09	0.70	-0.05					
9	RRDIN	-0.04	0.08	0.48	0.32	0.10	0.44	0.10	0.54	0.23	0.24	-0.72	0.10	0.37	0.28	0.17	0.42	0.10	0.63
10	PROPAT	-0.06	-0.01	0.21	0.64	0.21	0.31	-0.05	0.30	0.85	0.11	-0.11	0.03	0.22	0.95	0.09	0.06	0.04	0.10
11	RMAC	0.79	0.03	0.14	0.09	-0.03	0.65	0.15	-0.35	0.04	0.27	0.79	0.11	0.04	0.02	0.01	0.77	0.11	-0.03
12	PRODSG	0.08	0.11	0.07	0.84	0.07	0.19	-0.04	0.04	0.90	0.08	0.01	0.13	-0.01	0.95	0.07	0.07	0.09	0.06
13	PROCP	-0.04	0.24	0.07	0.83	-0.04	-0.01	0.17	0.03	0.60	0.08	-0.07	0.20	0.11	0.93	0.11	0.08	0.09	0.08
14	RTR	0.41	0.19	0.39	0.03	0.19	0.57	0.32	-0.04	0.05	0.52	0.18	0.30	0.39	0.12	0.11	0.70	0.27	0.02
15	RMAR	0.01	0.18	0.27	0.48	0.30	-0.01	0.49	0.04	0.34	0.65	-0.06	0.28	0.17	0.23	0.36	0.42	0.34	0.33
16	EXTINN	0.61	-0.11	-0.34	-0.09	-0.08	0.03	-0.11	-0.85	-0.09	-0.17	0.75	-0.07	-0.11	-0.14	-0.02	0.13	-0.11	-0.84
17	SOURCING	0.17	0.15	0.66	0.10	-0.05	0.65	0.31	0.09	0.14	0.05	-0.01	0.13	0.74	0.25	0.08	0.63	0.12	0.23
18	INFOMKT	0.44	0.03	0.24	0.23	-0.04	0.50	0.43	0.14	0.04	0.51	0.21	0.18	0.19	0.36	0.12	0.54	0.27	0.12
19	INFOKB	-0.03	0.17	0.75	0.19	0.01	0.54	0.13	0.12	0.08	0.04	-0.13	0.13	0.71	0.38	-0.03	0.40	0.17	0.21
20	CO	0.05	0.13	0.62	0.10	0.07	0.71	0.01	0.18	0.10	0.14	-0.13	0.15	0.77	0.02	0.11	0.39	0.07	0.53

Source: OECD Innovation Microdata project, 2011.