National Standardization Strategic Framework
nssf

Standards and Innovation

Economic Role of Standards

This paper is primarily about the role of standards in the national system of innovation, where they are conceived mainly as a body of codified information that enables the effective dissemination of technology through the economy. Standards are a form of embodied technical knowledge accessible to all types of business, that enables more effective product and process development. By their precision of specification, standards let businesses and their customers economise on gathering product information and on testing for reliability and compatibility. Further studies in the series of economic analyses underpinning the NSSF will include attempts to model the overall contribution of standards to productivity and economic growth, and, through case studies, how they can be used effectively as a business tool. This paper is limited to some initial empirical investigations of standards as essential components of how business innovation takes place in the UK.

Annex 1 includes some basic data on business perceptions and utilisation of standards in their approaches to technological innovation. Annex 2 presents some quantified models of the various roles that standards perform in the innovation system and in the innovation production functions of business.

Standards typologies

Standards can be categorised by their function in business and the economy generally and by the process that generates them. The main focus of this paper is on a functional analysis of how standards affect business level innovation, with some indication of the wider role in the consequences for national innovation performance.

A useful taxonomy is set out in Peter Swann's report, for DTI which characterises standards as fulfilling four main purposes:

Compatibility/Interface standards; associated with network externalities.

These sorts of standard enable ready entry into a market for compatible products or to join a communications network . They serve to consolidate markets and encourage the development of critical mass.

Minimum Quality/Quality discrimination; associated with lower transactions costs and avoiding Greshams Law by creating confidence amongst buyers that products and

services will be fit for purpose. This group includes health and safety and environmental standards.

Variety Reduction*;* associated with economies of scale and stable development trajectories. Conformity to a standard reduces the number of different product offerings but enlarges the market, reducing production and distribution costs for suppliers and search and testing cost for buyers.

Information standards; facilitates trade and market development, codifies knowledge enabling dissemination and take up. Again transactions and search costs are lower and markets work more efficiently.

Economic effects and benefits

Each type of standard has observable economic impacts and some of these have been the subjects of empirical studies that attempt to quantify in some dimension, the value of standards. An early example was by Peter Swann and Paul Temple[1], who studied the role of standards in promoting international trade. The methodology involved simply counting the number of standards issued by the National Standards Bodies in specific product areas and this turned out to be correlated with the level of international trade in those products.

A much more extensive application of much the same methodology – correlating numbers of standards with levels of economic activity, was followed in a recent study in Germany. In this, technical standards act as a proxy measure for, but also a primary means of, the dissemination of existing technology. The approach involved decomposing post war German growth into elements due to increases in factor endowments (labour and capital) and technical progress. The latter in turn was decomposed into the roles of new technology (measured by patents), overseas technology (license payments) and technology diffusions (standards).

Innovation: Information and Constraints

Innovation in business is ultimately about survival, growth and profitability, but these are achieved via intermediate effects, which can be more readily observed than the final impacts, through business surveys. Innovation takes place in a complex network of knowledge flows, mediated and focussed by the capabilities and internal organisation of businesses. The business and market environment also can inhibit or constrain the ability to innovate or channel resources down one development path rather than another. This note brings out the roles of standards and regulations in this set of interdependencies of knowledge inputs and constraints, as part of a view of the whole that is often dubbed the

"national system of innovation." The data source used is the UK part of the Community Innovation Survey 2001 (CIS3), which covers enterprises of 10 or more employees across most industrial and commercial sectors. As it is obtained through a postal, sample survey, this data can show the role of standards and regulation at a quite generic level – we cannot pick out, for example, the variety of types of regulation that apply to different industries or to labour markets. But an interestingly indicative picture nonetheless emerges.

Standards are a core part of the infrastructure that supports efficient innovation. They provide a focus for critical mass effects in product and service markets. Standards can effect innovation through a variety of mechanisms. They form an important part of the framework conditions for business and influence the possible routes to market or legal validity of market offerings. As codified information, standards serve to spread knowledge of the requirements for market acceptability and contain quite explicit technical information, reducing uncertainty for both producers and customers. They promote and enable the diffusion of technology in a form that is readily assimilated by firms with the complementary capabilities to take up and use the new methods. And it is unproductive to "push" technology towards those without such capabilities. As a policy mechanism for technology diffusion standards are thus both effective and efficient.

The evidence adduced here supports the view of well implemented standardization as a contributor to innovation and thence to economic growth and productivity. But meeting standards and regulations can also be perceived by business as a constraint on their ability to undertake certain forms of innovation. There is though scope for debate about whether such constraints on individual businesses reduce competition and innovation at the level of the market or the economy as a whole. The argument is essentially that by setting some limits on novelty, the trajectory of product development is moved closer to the preferred path for customers, who value backward compatibility and some stability in market offerings. Many firms report finding meeting standards and regulations to be factors hampering individual innovation projects. But these firms also turn out to be more innovative than those not recording hampering effects.

There are two reasons why this is an apparent and not a real paradox. One is that what the individual firms perceives as a problem may be of benefit to the national innovation system and thereby to overall economic performance. Standards enable

larger markets and promote competition, so individual firms see a smaller market share and more competitors than they would like. But this diversity faces customers with more but more compatible choices and lower prices, promoting their welfare.

But the innovation promoting and hampering effects of standardization can also be reconciled by their interdependence as the constraint effect directs investment into certain paths and leading to more credibility and critical mass in markets for new technologies. Thus creating an infrastructure for future innovation,

Analysis

This section uses the UK innovation survey data to examine the interrelationships between different types of standards and innovation performance by UK business. There are 4 sections:

1. standards as a direct source of technical information that firms use in their innovation investments and product and process introductions. What sort of innovators use standards for information?

2. Standards as an impediment to innovation – meeting standards and regulations can be reported as hampering factors in firms attempts to carry forward innovation projects or to launch products. What is the net effect on the levels of innovation such firms carry out?

3. Standards in conjunction with other determinants of innovation. Do standards act as a catalyst to innovation activity, as a complement to other sorts of information or as a substitute for some of them?

4. Standards and innovation performance. How far is the use of standards associated with higher levels of innovation activity of more effective innovation outputs?

The broad picture

Standards and Regulations as information

Standards and Regulations feature as source of information to business, that enables innovation as well as market access and efficiency in production. The survey inquired

about three broad types of standard and regulation – Technical Standards, Environmental Standards and Regulations and health and Safety Standards and Regulations, in their role as technical knowledge inputs.

All three types of standard and regulation are widely used as information inputs (see Annex 1 for details)

Around 60% of all enterprises who are innovation active are users of one or more types of standard as a source of information. The share accessing standards based information increase with business size, with over nearly 80% of large business units citing a standard as a source for innovation. Only 25% of businesses who are not active in innovation record finding standards a valuable knowledge input.

Enterprises using any form of standard/regulation as knowledge inputs are more likely to introduce new products (including services) or processes to the business, than non users. Within the group of enterprises who innovation active this is a small but statistically significant difference. The Table below gives one example, for the case of environmental standards and regulations:

Crosstab

			ienviro		
			.00	1.00	Total
Product or process innovator	No	Count	10955	12953	23908
		Expected Count	9925.7	13982.3	23908.0
		% within ienviro	48.6%	40.8%	44.0%
	Yes	Count	11590	18806	30396
		Expected Count	12619.3	17776.7	30396.0
		% within ienviro	51.4%	59.2%	56.0%
Total		Count	22545	31759	54304
		Expected Count	22545.0	31759.0	54304.0
		% within ienviro	100.0%	100.0%	100.0%

Source CIS3

To summarise, 59% of users of environmental standards as knowledge are product or process innovators, against 51% of non- users. *This is statistically significant using a chi-square test.* This is an instance of a general result from analysis of this data, that use of standards and regulations as part of the information set for innovation directed business activity has a small, generally positive and statistically significant association with the extent and intensity of innovation outputs.

Regulations as an Inhibiting Factor

The survey also gathered responses on the factors that enterprises found to hamper their innovation efforts. Some 56% of businesses found the impact of regulations and standards to act as a hampering factor, but interestingly, the share was higher at 68% amongst innovation active businesses, than amongst innovation inactive, at 43%. This difference is statistically significant.

Standards and the Innovation Production Function

Regulation and Standards – Joint Impact

For a large share of enterprises, regulations and standards act as both a hampering factor and a source of information. While only 25% of those reporting them as not hampering innovation also found them to be a source of information, around 60% found them to fulfil both roles. *This overlap suggests that standards and regulations tend to channel rather than prevent innovation efforts.*

Many firms have reported that they find standards and regulations of various types to provide technical information of direct value in making their innovation investments and bringing products and processes to the market. But they also extensively find that their efforts at innovation can be hampered by standards and regulations. These appear to be mutually contradictory roles for standards. Their effects on the overall propensity to innovate can though be investigated with the survey data using moderately sophisticated techniques to model whether the reported hampering role offsets partly or wholly the positive effects of the technical information found in standards. The detailed results are reported in Annex 2, but the main conclusions from the analysis are:

- Standards as information are strongly associated with other technology sources, including other businesses and the science base and with the acquisition of plant and equipment for innovation purposes. But there is a small but significant negative relationship with firms' own generation of new technology

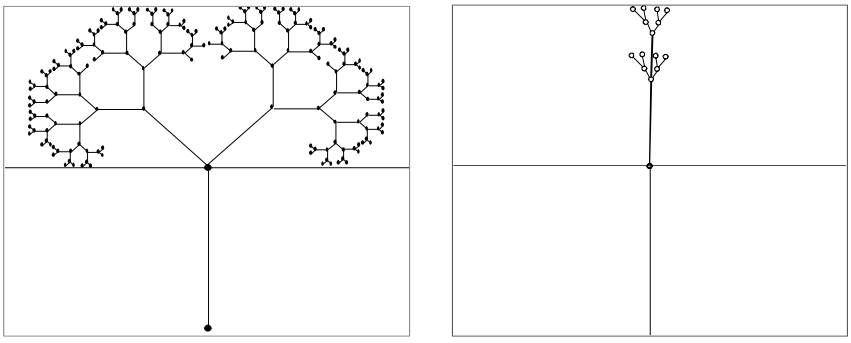
- regulations and standards acting as information and as hampering factors both have positive effects on the propensity to introduce new products or processes, with the information effect larger.

- The impact of standards on the propensity to innovate is smaller than that of the core technology inputs, intramural R&D and marketing expenditures and direct links with external specialists, But the impact is larger than that of capital expenditure directed to innovation and overall inclination to acquire external knowledge.

- Intensity of innovation output is significantly positively related to R&D spending and to embodied technology in plant and equipment and information from the market and from Health and safety standards. It is significantly negatively related to information from technical and environmental standards and regulations. There is a negative but statistically insignificant response of intensity to the hampering effects of standards and regulations.

These results are consistent with the analysis in Professor Swann's report that even the effects of standards (and some regulations) in constraining options for innovating outside of a certain area facilitate more productive innovation. Standards are and regulations can be ***innovation friendly*** in their essential characteristics. The way these apparently paradoxical effects arise is through establishing an orderly market framework that gives confidence to buyers and sellers and thus supports innovation led growth This can be summarised in a diagram abstracted from Peter Swann's paper for DTI.

Innovation Trees - with and without Standards



Source: G M Peter Swann: *The Economics of Standardardization, Report for DTI,* December 2000.

In the diagram, the horizontal dimension refers to horizontal product differentiation while the vertical refers to vertical product differentiation. Products higher up the tree are better than those lower down, but products further to the left are just different from those further to the right.

The standards supported innovation trajectory leads to a more richly populated product or service space because incumbent firms are able to develop varieties to meet differentiated customer needs, with confidence that there is a stable customer base. Firms, especially smaller firms, can enter product markets with new varieties, knowing that this customer base exists. The non-standardised trajectory is drawn on the assumption that competition takes place through the frequent introduction of incompatible "new" technologies, with property right protection, limiting entry possibilities, leading to monopolised, smaller markets.

The results from the DIN study that German growth has owed more to dissemination of technology via standardisation than to new technology embodied in patents is perhaps consistent with the idea that property rights, once granted, can restrict market development and innovation led growth. Some of the econometric analysis of the innovation survey data shows a negative relationship between patenting activity by enterprises and their interraction with standards as sources of information. This result is consistent with the negative relationship between standards usage and R&D.

Property rights do though stimulate investment in future new technologies. And through the publication of patent and design specifications, they provide another from of accessible codified technical knowledge.

Novel product innovation in the UK is strongly driven by R&D spending and patenting activity and relatively weakly by standards. So it would not be appropriate to conclude that property rights impede innovation. Novel product innovation is though a minority sport and standards appear to have a much more powerful effect on routine but vital follower or dissemination innovation. The important lesson from the analysis is that the market stimulation effects of standards derive in large part from their openness – they codify information available to all actual and potential market participants. This should not be compromised by overlap with property rights, which inform on potentially profitable innovation options but close access to them. Standards should avoid referring to proprietary knowledge.

References::

G M Peter Swann, *The Economics of Standardization, A report for DTI,* December 2000

DIN German Institute for Standardization, *Economic benefits of standardization,* 2000

Annex 1 – Standards and Innovation -summary statistics

The purpose of this annex is to summarise how standards and regulations appear as firstly a source of information for innovators, secondly as constraining the achievement of innovation and thirdly how far their innovations met regulations or standards. These data form the basis for the econometric analysis in Annex 2 and the summary of results and their implications in the main paper.

In the Third Community Innovation Survey (CIS 3) firms were asked about the role of three types of standards and regulations – Technical Standards, Environmental Standards & Regulations and Health & Safety Standards and Regulations as technical knowledge inputs. The variables are defined as follows:

- IFSTAND, which comes from question 12.1. Please indicate the sources of knowledge or information used in your technological innovation activities, and their importance during the period 1998 – 2000. Specialised – Technical standards 0 = Not Used, 1 = Low Importance, 2 = Medium Importance, 3 = High Importance.
- IFHEALTH, which comes from question 12.1. Please indicate the sources of knowledge or information used in your technological innovation activities, and their importance during the period 1998 – 2000. Specialised – Health and safety standards and regulations 0 = Not Used, 1 = Low Importance, 2 = Medium Importance, 3 = High Importance.
- IFENVIRO, which comes from question. 12.1 Please indicate the sources of knowledge or information used in your technological innovation activities, and their importance during the period 1998 – 2000. Specialised – Environmental standards and regulations 0 = Not Used, 1 = Low Importance, 2 = Medium Importance, 3 = High Importance.

The question on Standards and regulations hampering innovation was:

- HPREGS, which comes from Question 8.1. A range of factors may inhibit your ability to innovate. Other factors – Impact of regulations or standards 0 = No effect, 1 = Low effect, 2 = Medium effect, 3 = High effect.

The effects of innovation on meeting regulatory or policy requirements was:

- FRANGE, which comes from question 11.1. Please indicate the impact that your innovation activities have had on your enterprise in the period 1998-2000. Product oriented effects – Increased range of goods or services 0 = None, 1 = Low Impact, 2 = Medium Impact, 3 = High Impact.
- FMKTSHRE, which comes from question 11.1. Please indicate the impact that your innovation activities have had on your enterprise in the period 1998-2000. Product oriented effects – Opened new market or increased market share 0 = None, 1 = Low Impact, 2 = Medium Impact, 3 = High Impact.
- FQUALITY, which comes from question 11.1. Please indicate the impact that your innovation activities have had on your enterprise in the period 1998-2000. Product oriented effects – Improved quality of goods or services 0 = None, 1 = Low Impact, 2 = Medium Impact, 3 = High Impact.
- FFLEXIB, which comes from question 11.1. Please indicate the impact that your innovation activities have had on your enterprise in the period 1998-2000. Process oriented effects – Improved production flexibility 0 = None, 1 = Low Impact, 2 = Medium Impact, 3 = High Impact.
- FLABOUR, which comes from question 11.1. Please indicate the impact that your innovation activities have had on your enterprise in the period 1998-2000. Process oriented effects – Reduced Unit Labour Costs 0 = None, 1 = Low Impact, 2 = Medium Impact, 3 = High Impact.
- FCAPAC, which comes from question 11.1. Please indicate the impact that your innovation activities have had on your enterprise in the period 1998-2000. Process oriented effects – Increased Capacity 0 = None, 1 = Low Impact, 2 = Medium Impact, 3 = High Impact.
- FMATERL, which comes from question 11.1. Please indicate the impact that your innovation activities have had on your enterprise in the period 1998-2000. Process oriented effects – Reduced materials and/or energy per product unit 0 = None, 1 = Low Impact, 2 = Medium Impact, 3 = High Impact.
- FENVIRON, which comes from question 11.1. Please indicate the impact that your innovation activities have had on your enterprise in the period 1998-2000. Other effects – Improved environmental impact or health and safety aspects 0 = None, 1 = Low Impact, 2 = Medium Impact, 3 = High Impact.
- FREGS, which comes from, question 11.1. Please indicate the impact that your innovation activities have had on your enterprise in the period 1998-2000. Other effects – Met regulations or standards 0 = None, 1 = Low Impact, 2 = Medium Impact, 3 = High Impact.

All the above variables have been converted into binary form so that we could carry out more specific tests for example yes there was an impact or no there wasn't rather than there was a low impact or a medium impact or a large impact

The Tables below show analyses of these variables by:

- Business Size - SML , which breaks respondents into small, medium or large 0 = Small, 1 = Medium, 2 = Large
- INNOVAC, which checks if a company is innovation active or not, 0 = Not Innovation Active, 1 = Innovation Active

By comparing the sources of knowledge or information that companies used in their technological activities against the consequences i.e. impact innovation has had on the company, or the range of factors that inhibit their ability to innovate, it can be deduced what type of effect standards have on innovation. The Chi squared statistic is used to test if there is a relationship between different variables.

The figured used to get these results came from weighed data and only valid data is included in the proportions i.e. ignoring missing data.

Basic Figures

Some 44% of firms do use standards and regulation as a source of information or knowledge, but this share is much higher for innovation active companies at 60.3% than for non innovation active companies, at 23.8%.

Both groups of companies show higher use of information from Health and Safety Standards and Regulations than either Environmental Standards and Regulations or Technical Standards. Of all companies 47.1% (63% of innovation active and 26.8% of non active firms) said Health and Safety standards and regulations were of use to them, where 42.1% (59.3% of innovation active and 20.2% of non active firms) said Technical Standards were of use and finally 43.5% (58.5% of innovation active and 24.4% of non active firms) said Environmental Standard and Regulations were of use to them.

The share of users increases with business size, with 40.5% of small companies, 56.12% of medium and 65.7 % large firms citing these sources. The extent of use of the different types of standard was similar between sizes of business:

- 43.8% of small firms found Health and Safety Standards and Regulations of use to them (compared with 37.9% used Technical Standards and 39.8% used Environmental Standards and Regulations),
- 57.4% of medium firms found Health and Safety Standards and Regulations of use to them (compared with 55.5% used Technical Standards and 55.3% used Environmental Standards and Regulations),
- And 66.1% of larger firms found Health and Safety Standards and Regulations of use to them (compared with 65.6% used Technical Standards and 65.1% used Environmental Standards and Regulations.

Effects on Innovation

We can now examine whether particular types of standard providing information is associated with innovation outputs and effects. Table 1 shows a relationship between Health and Safety standards as an input and improvements in environmental impact of health and safety as one of the results of innovation.

Table 1: Cross tabulation of H & S information against H & S impacts.

Impact of Innovation		Health & Safety Standards and Regulations		Total
		No	Yes	
Improved Environmental impact or Health & Safety aspects	No	44340	17799	62139
		48.9%	19.6%	68.6%
	Yes	3603	24884	28487
		4.0%	27.5%	31.4%
Total		47943	42683	90626
		52.9%	47.1%	100.0%

While 48.9% of firms have not used health and safety standards information and only 4% of the firms claim that health and safety aspects have improved without such input, but 27.5% of firms have used health and safety information and their innovation has improved environmental and Health and Safety conditions. Health and safety aspects have improved, which does make sense!

This analysis is repeated for innovation active firms in Table 2. Only 31.5% of the innovation active firms made no use any health and safety standards information as a source of information and hence didn't notice any improvements to their health and safety aspects, but 40.8% of the innovation active firms did use health and safety as a source of information and did generate improvements in environmental and health and safety aspects impacts.

Table 2: Cross tabulation of H & S information against H & S aspects for Innovation active firms.

		Health & Safety Standards and Regulations		
		No	Yes	Total
Improved Environmental impact or Health & Safety aspects	No	16354	11634	27988
		31.5%	22.4%	53.9%
	Yes	2784	21165	23949
		5.4%	40.8%	46.1%
Total		19138	32799	51937
		36.8%	63.2%	100.0%

Tables 3 to 5 below break out the results by size of - be it small, medium or large, Interesting results include:

Table 3: Cross tabulation of H & S information against H & S aspects for small firms.

		Health & Safety Standards and Regulations		
		No	Yes	Total
Improved Environmental impact or Health & Safety aspects	No	37042	13857	50899
		52.3%	19.6%	71.9%
	Yes	2854	17050	19904
		4.0%	24.1%	28.1%
Total		39896	30907	70803
		56.3%	43.7%	100.0%

Table 4: Cross tabulation of H & S information against H & S aspects for medium firms.

		Health & Safety Standards and Regulations		
		No	Yes	Total
Improved Environmental impact or Health & Safety aspects	No	6055	3234	9289
		38.8%	20.7%	59.6%
	Yes	582	5720	6302
		3.7%	36.7%	40.4%
Total		6637	8954	15591
		42.6%	57.4%	100.0%

Table 5: Cross tabulation of H & S information against H & S aspects for large firms.

		Health & Safety Standards and Regulations		
		No	Yes	Total
Improved	No	1243	708	1951

Environmental impact or Health & Safety aspects		29.4%	16.7%	46.1%
	Yes	167	2114	2281
		3.9%	50.0%	53.9%
Total		1410	2822	4232
		33.3%	66.7%	100.0%

Larger firms tend to use the health and safety source of information more than smaller firms (66.7% of large firms compared with 57.4% of medium firms and 43.7% of small firms), and the share who report positive impacts of their innovations depending in part on Health and Safety Standards information also increase significantly with firm size. By putting technical standards as a source of information or knowledge against various effects of innovation such as Increased range of goods or services; Opened new market or increased market share; Improved quality of goods or services; Improved production flexibility; Reduced unit labour costs; increased capacity; and Reduced materials and/or energy per produced unit we can see which factor is effected the greatest and least. Each time it is improved quality of goods or services that has been effected the greatest and reduced materials and/or energy per produced unit is effected the least and this stays constant when the data is spilt into company size – small, medium and large and when the data is split into innovation active companies and non innovation active companies. We can see in the following tables that this is true; 74.9% of the non innovation active companies don't tend to use sources of information nor see the effects of innovation whilst 49.7% of innovation active companies do use technical standards as a source of information and do see the effects of innovation.

Table 6: Cross tabulation of Effects on innovation – improved quality of goods or services against Technical Standards as a source of information or knowledge.

		Technical Standards		
		No	Yes	Total
Improved Quality of goods or services	No	37675	9053	46728
		41.6%	10.0%	51.6%
	Yes	14494	29404	43898

services		16.0%	32.4%	48.4%
Total		52169	38457	90626
		57.6%	42.4%	100.0%

Table 7: Cross tabulation of Effects on innovation – improved quality of goods or services against Technical Standards as a source of information or knowledge for innovation active companies.

		Technical Standards		
		No	Yes	Total
Improved Quality of goods or services	No	8821	5274	14095
		17.0%	10.2%	27.1%
	Yes	12041	25802	37843
		23.2%	49.7%	72.9%
Total		20862	31076	51938
		40.2%	59.8%	100.0%

Table 8: Cross tabulation of Effects on innovation – improved quality of goods or services against Technical Standards as a source of information or knowledge for non innovation active companies.

		Technical Standards		
		No	Yes	Total
Improved Quality of goods or services	No	28854	3778	32632
		74.6%	9.8%	84.3%
	Yes	2453	3602	6055
		6.3%	9.3%	15.7%
Total		31307	7380	38687
		80.9%	19.1%	100.0%

Factors Hampering Innovation

Following on from the effects and outputs of innovation we can examine factors hampering innovation to deduced whether or not Sources of Information or knowledge is associated with hampering a firm's ability to innovate

By examining the following tables we can see that 35.6% of firms that used the Health and Safety as a sources of information or knowledge also experienced some hampering factors as a result of impact on regulations and standards. 31.2% of those firms asked who did not use any sources of information or knowledge on health and safety did not experience any hampering factors due to Impact of regulations or standards.

Table 9: Cross tabulation of H & S information against impact of regulations or standards as a hampering factor for all firms.

		Health & Safety Standards and Regulations		Total
		No	Yes	
Impact of regulations or standards.	No	29219	11199	40418
		31.2%	12.0%	43.1%
	Yes	19911	33358	53269
		21.3%	35.6%	56.9%
Total		49130	44557	93687
		52.4%	47.6%	100.0%

From the following table we can also see that 33.5% of companies that used Environmental standards and Regulations as a source of information or knowledge also experienced some hampering factors as a result of standards and regulations,

Table 10: Cross tabulation of Environmental information against impact of regulations or standards as a hampering factor for all firms.

	Environmental standards and regulations		Total
	No	Yes	

Impact of regulations or standards.	No	30559	9859	40418
		32.6%	10.5%	43.1%
	Yes	21842	31427	53269
		23.3%	33.5%	56.9%
Total		52401	41286	93687
		55.9%	44.1%	100.0%

For 33% of the companies using Technical Standards as a source of information or knowledge also experienced some hampering factors as a result of impact on regulation and standards.

Table 11: Cross tabulation of Technical Standards information against impact of regulations or standards as a hampering factor for all firms.

		Technical Standards		Total
		No	Yes	
Impact of regulations or standards.	No	31335	9082	40417
		33.4%	9.7%	43.1%
	Yes	22366	30903	53269
		23.9%	33.0%	56.9%
Total		53701	39985	93687
		57.3%	42.7%	100.0%

By splitting the companies into innovation active companies and non innovation active companies we can see how each of the tables come together.

Firstly by looking at Health and Safety as a source of information or knowledge. Of the non-innovation active firms 50.1% did not experience any hampering factors due to impact of regulations or standards also did not use any sources of information on health and safety, only 18% of the non innovation active firms that did use the health and safety as a source of information also did experience the impact of regulations and standards as a hampering factor.

Table 12: Cross tabulation of H & S information against impact of regulations or standards as a hampering factor for non-innovation active firms.

		Health & Safety Standards and Regulations		Total
		No	Yes	
Impact of regulations or standards.	No	20351	3622	23973
		50.1%	8.9%	59.0%
	Yes	9365	7320	16685
		23.0%	18.0%	41.0%
Total		29716	10942	40658
		73.1%	26.9%	100.0%

By examining the innovation active firms we see a completely different situations in that respect. 16.7% didn't experience any hampering factors due to regulations and standards also did not use any health and safety standards and regulations as a source of information. But 49.1% did experience the impact of regulation and standards as a hampering factor and did use health and safety as a source of information.

Table 13: Cross tabulation of H & S information against impact of regulations or standards as a hampering factor for innovation active firms.

		Health & Safety Standards and Regulations		Total
		No	Yes	
Impact of regulations or standards.	No	8868	7577	16445
		16.7%	14.3%	31.0%
	Yes	10546	26038	36584
		19.9%	49.1%	69.0%
Total		19414	33615	53029
		36.6%	63.4%	100.0%

By looking at the Environmental standards and regulations as a source of information or knowledge against impact of regulations as a hampering factor we see a similar pattern.

50.9% of companies did not experience any hampering factors and didn't use environmental standards and regulations as a source of information. Whilst only 16.5% of the companies did experience hampering factors and did use environmental standards and regulations as a source of information.

Table 14: Cross tabulation of Environmental standards and regulations as a source of information against impact of regulations or standards as a hampering factor for non innovation active firms.

		Environmental Standards and Regulations		Total
		No	Yes	
Impact of regulations or standards.	No	20679	3294	23973
		50.9%	8.1%	59.0%
	Yes	9959	6726	16685
		24.5%	16.5%	41.0%
Total		30638	10020	40658
		75.4%	24.6%	100.0%

Again for the innovation active firms the story for the environmental standards and regulations is similar to the health and safety table. Only 18.6% of companies claimed they didn't experience any hampering factors and didn't use any environmental standards and regulations and 46.6% od companies did use environmental standards and regulations and did experience hampering effects.

Table 15: Cross tabulation of Environmental standards and regulations as a source of information against impact of regulations or standards as a hampering factor for innovation active firms.

		Environmental Standards and Regulations		Total
		No	Yes	
Impact of regulations or standards.	No	9880	6565	16445
		18.6%	12.4%	31.0%
	Yes	11884	24701	36585
		22.4%	46.6%	69.0%
Total		21764	31266	53030
		41.0%	59.0%	100.0%

Technical standards as a source of information or knowledge against impact of regulations or standards as a hampering factor follows the same pattern, with 53.0% of non innovation active firms not using the technical standards as a source of information or knowledge or experiencing hampering factors whilst only 14.5% do experience hampering factors and use technical standards as a source of information or knowledge. Again for the innovation active firms 47.2% of the companies did use technical standards as a form of information or knowledge and experienced some hampering factors.

Annex 2. Innovation and standards – Econometrics

This Annex presents some models of standards and regulations in business innovation in the form of estimated equations relating standards usage and responses to the other components of innovative activity and achievement.

Model 1

The degree to which firms perceived standards and regulations as valuable sources of knowledge to apply to their innovation actions depends on the other resources and information inputs deployed.. Equation 1 shows the estimated impact of important variables on the propensity to make any use of standards and regulations.

Standards as information are strongly associated with other technology sources, including other businesses and the science base and with the acquisition of plant and equipment for innovation purposes. But there is a small but significant negative relationship with firms' own generation of new technology, measured here by patenting and R&D spending.

Logistic Regression . Dependent Variable: Any form of standard as information for innovation. Equation includes sectoral dummies (not shown).
Statistically Significant Independent Variables in the Equation

	B	S.E.	Wald	Sig.	Proportional Impact Exp(B)
IFWITHIN(1)	.898	.034	691.259	.000	2.455
IFWITHIN(2)	.628	.031	404.566	.000	1.873
IFWITHIN(3)	.793	.035	526.705	.000	2.209
IFOTHENT(1)	.672	.041	275.099	.000	1.959
IFOTHENT(2)	.565	.039	206.524	.000	1.760
IFOTHENT(3)	.472	.052	82.443	.000	1.603
IFSUPPL(1)	1.249	.030	1698.341	.000	3.488
IFSUPPL(2)	1.457	.030	2374.465	.000	4.295
IFSUPPL(3)	1.032	.035	854.562	.000	2.806
IFCLIENT(1)	.998	.031	1065.106	.000	2.713
IFCLIENT(2)	1.380	.034	1614.519	.000	3.974
IFCLIENT(3)	1.443	.043	1133.838	.000	4.233
IFCOMPET(1)	.276	.030	82.104	.000	1.317
IFCOMPET(3)	.285	.063	20.560	.000	1.330
IFCONSLT(1)	.395	.031	158.033	.000	1.484
IFCONSLT(2)	.702	.040	313.265	.000	2.017

IFCONSLT(3)	.169	.060	7.850	.005	1.184
IFRDLABS(1)	.806	.055	216.011	.000	2.239
IFRDLABS(2)	1.259	.095	176.496	.000	3.521
IFRDLABS(3)	1.256	.199	39.774	.000	3.511
IFUNIV(2)	.664	.069	91.492	.000	1.943
IFUNIV(3)	.639	.113	31.777	.000	1.895
IFGOVT			38.840	.000	
IFGOVT(1)	.211	.060	12.390	.000	1.235
IFOTHPUB(1)	1.003	.045	499.148	.000	2.727
IFOTHPUB(2)	1.011	.068	222.565	.000	2.750
IFOTHPUB(3)	1.745	.131	178.184	.000	5.726
R&D in-house XINTER(1)	-.340	.040	72.224	.000	.712
R&D extra-mural XEXTRA(1)	-.231	.061	14.573	.000	.794
Capex for Innovation XMACH(1)	.299	.024	160.528	.000	1.348
PATENTS Sought	-.156	.053	8.631	.003	.856
Constant	-1.749	.310	31.853	.000	.174

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	65784.946	.464	.620

Classification Table

		Predicted		
		INSTND		Percentage Correct
	Observed	.00	1.00	
Step 1	INSTND .00	33206	7624	81.3
	1.00	6350	39534	86.2
Overall Percentage				83.9

Model 2 Standards and the Innovation Production Function

Many firms have reported that they find standards and regulations of various types to provide technical information of direct value in making their innovation investments and bringing products and processes to the market. But they also extensively find that their efforts at innovation can be hampered by standards and regulations. These appear to be mutually contradictory roles for standards. Their effects on the overall propensity to innovate can though be investigated with the survey data using moderately sophisticated techniques to model whether the reported hampering role offsets partly or wholly the positive effects of the technical information found in standards.

The results reported below use logistic regression, a statistical modelling technique that takes interactions and the effects of other variables into account.
regulations and standards acting as information and as hampering factors both have positive effects on the propensity to introduce new products or processes, with the information effect larger.
The impact of standards on the propensity to innovate is smaller than that of the core technology inputs, , intramural R&D and marketing expenditures and direct links with external specialists, But the impact is larger than that of capital expenditure directed to innovation and overall inclination to acquire external knowledge.

Logistic Regression - Dependent Variable - Product or Process Innovaton

	B	S.E.	Wald	Exp(B)
Intramural R&D	0.805	0.03	700.402	2.236
Extramural R&D	0.061	0.045	1.887	1.063
Capex for Innovation	0.169	0.025	44.504	1.185
External Knowledge	0.092	0.027	11.505	1.096
Training for Innovation	0.399	0.023	311.813	1.49
Market preparation	0.944	0.026	1275.105	2.569
Technology from HEIs	0.388	0.034	131.442	1.474
Technology from private research institutes	0.765	0.133	33.201	2.15
Information from Standards and Regulations	0.306	0.025	150.314	1.358
Standards and Regulations Hampering	0.139	0.023	35.172	1.149

Constant	1.085	0.061	318.186	2.959

Notes 1 All variables measured as binaries (Yes/No):
, 2. includes dummies for size and sector (not shown)

Model 3. Novel Innovation and Standards

This model shows the relationship between the intensity of innovation, measured by the share of turnover accounted for by products new to the market, and the resource and information inputs to innovation activity.

Intensity of innovation output is significantly positively related to R&D spending and to embodied technology in plant and equipment and information from the market and from Health and safety standards. It is significantly negatively related to information from technical and environmental standards and regulations. There is a negative but statistically insignificant response of intensity to the hampering effects of standards and regulations.

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-3.525	2.358		-1.495	.135
	IFCLIENT	2.397	.445	.072	5.381	.000
	IFCOMPET	.166	.503	.005	.329	.742
	IFCONF	-1.166	.517	-.034	-2.254	.024
	IFCONSLT	-.719	.435	-.022	-1.654	.098
	IFENVIRO	-3.106	.614	-.102	-5.057	.000
	IFFAIRS	-.227	.477	-.007	-.476	.634
	IFGOVT	-6.509	.817	-.117	-7.964	.000
	IFHEALTH	4.944	.606	.168	8.162	.000
	IFOTHENT	4.506	.340	.163	13.266	.000
	IFOTHPUB	5.157	.535	.132	9.646	.000
	IFPRI	1.284	.678	.026	1.895	.058
	IFRDLABS	-5.630	.598	-.135	-9.420	.000
	IFSTAND	-1.181	.437	-.040	-2.706	.007
	IFSUPPL	2.761	.430	.081	6.424	.000
	IFTECH	.413	.486	.013	.849	.396
	IFTRADE	-.830	.507	-.023	-1.637	.102
	IFUNIV	-.558	.552	-.014	-1.011	.312
	IFWITHIN	.650	.460	.017	1.412	.158
	XINTER	7.268	.761	.115	9.556	.000
	XKNOW	4.221	.805	.065	5.242	.000
	XMACH	12.971	.793	.194	16.356	.000
	XMARKET	-7.333	.769	-.118	-9.535	.000
	XTRAIN	-6.411	.817	-.103	-7.844	.000
	Manufacturing or service	14.002	.802	.225	17.468	.000
	SME or larger firm	-8.457	1.188	-.085	-7.119	.000
	Impact of regulations or standards	-.556	.363	-.019	-1.532	.126
	Excessive perceived economic risk (high)	-8.813	.983	-.102	-8.965	.000

a. Dependent Variable: SHARENOV

b. Selecting only cases for which PRODINOV = 1

Model 4 Improved Products

Much innovation takes the form of improvement to existing products and services. Similar analysis to the above finds that the share of turnover in improved products is positively related to R&D, Training and Marketing expenditures and to information from technical standards, but there is a small but statistically significant negative impact of standards and regulations encountered as hampering factors. That is, incremental changes is prmoted by the information content of technical standards, but discouraged by the limitations imposed by regulations.

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.342	1.154		2.897	.004
	IFWITHIN	1.030	.220	.042	4.672	.000
	IFOTHENT	-.131	.175	-.007	-.750	.453
	IFSUPPL	.176	.209	.007	.839	.401
	IFCLIENT	2.226	.218	.099	10.219	.000
	IFCOMPET	.819	.235	.033	3.486	.000
	IFCONSLT	1.058	.213	.044	4.975	.000
	IFRDLABS	-1.995	.309	-.067	-6.446	.000
	IFUNIV	-.300	.278	-.011	-1.079	.280
	IFGOVT	-.235	.398	-.006	-.591	.554
	IFOTHPUB	-.579	.286	-.020	-2.024	.043
	IFPRI	1.610	.360	.044	4.467	.000
	IFCONF	-.893	.271	-.036	-3.296	.001
	IFTRADE	.038	.266	.001	.142	.887
	IFTECH	1.017	.259	.041	3.930	.000
	IFFAIRS	-.552	.231	-.023	-2.388	.017
	IFSTAND	.527	.228	.025	2.313	.021
	IFHEALTH	-.281	.324	-.013	-.868	.385
	IFENVIRO	.033	.324	.002	.102	.919
	PCOOP	-.149	.430	-.003	-.346	.729
	XINTER	2.403	.413	.051	5.825	.000
	XEXTRA	-.126	.553	-.002	-.227	.820
	XMACH	3.196	.412	.064	7.763	.000
	XKNOW	-1.031	.423	-.021	-2.435	.015
	XDESIGN	-3.435	.420	-.070	-8.173	.000
	XTRAIN	2.585	.392	.059	6.595	.000
	XMARKET	1.425	.389	.032	3.666	.000
	Manufacturing or service	1.554	.401	.035	3.875	.000
	SME or larger firm	1.062	.609	.015	1.743	.081
	Impact of regulations or standards	-1.213	.176	-.058	-6.902	.000

a. Dependent Variable: PRODIMP

b. Selecting only cases for which PRODINOV = 1

[1] Swann, P and P Temple