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PRODUCT AND PROCESS INNOVATIONS: HOW ARE THEY DEFINED? HOW ARE THEY QUANTIFIED?

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This paper considers the alternative meanings attributed to the terms product and process innovation, and demonstrates, on the basis of the SPRU database on innovations in Great Britain, how the total number of product and process innovations varies according to the definition adopted. Only 3.1% of the innovations monitored can be univocally labelled as either products or processes, whilst as many as 96.9% of them fall into a grey zone. The authors conclude that these terms, although useful tools of analysis, should be defined more precisely in the studies of the economics of technological change.

Introduction

It was Joseph *Schumpeter* who introduced at the beginning of this century the distinction between product and process innovations. In one of the most quoted pages of his *Theory of Economic Development*,[1] the former is defined as 'the introduction of a new good – that is one with which consumers are not yet familiar – or a new quality of a good', and the latter as 'the introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned ... and can also exist in a new way of handling a commodity commercially'.

Since then, there is virtually no book on technological change which has not compared, directly or indirectly, innovations in products to those in processes, but little attention has been paid to the analytical clarity of these definitions. In an influential review article, for example, *Blaug*[2] stated that 'the terms are self-explanatory'. The purpose of this article is to challenge this view and to point out, on the contrary, that there are several alternative definitions of product and process innovations which deserve to be considered on methodological and empirical grounds.

In the next section, the importance of distinguishing between products and processes for the analysis of technological change is discussed. In section 3 some of

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the methodological definitions are reported, showing their differences and their implications. Section 4 reports some empirical evidence on the variation in number of both product and process innovations according to the definition adopted, and attempts to quantify their number. This section is based upon a sample of significant innovations introduced in the U.K. derived from the SPRU data base.[3] In the conclusions we stress that a more precise specification of the meaning attributed to the terms product and process innovations would aid clearer understanding among students of technological change.

Does the difference between product and process innovations matter?

The dichotomy between innovations in product and process has been used for a variety of purposes in economic studies, which can be summarized under five headings: i) the business cycle, ii) the product life-cycle, iii) management of the firm, iv) employment, v) appropriability and imitation.

The business cycle. It is often argued that the nature of innovations introduced into the economic system is strongly sensitive to the phases of the business cycle.[4] Firms tend to rationalize their production processes and to lower costs during economic recession, whilst tending to create new markets, and therefore to introduce new products, in the phases of expansion.

The product life-cycle. The typology of innovations introduced is also affected by the life cycle of a given industry. In an influential model, *Utterback* and *Abernathy*[5] have suggested that the majority of the innovations introduced are products in the initial phases of the development of an industry, but a shift towards processes occurs when an industry is moving towards maturity and stagnation.

Employment. Process innovations are likely to lead to a reduction in employment when they are initially introduced, whilst the introduction of new market products and final demand commodities are likely to lead to an increase in employment.[6, 7]

Firm management. Changes in products and processes imply differentiated risks and uncertainties for the innovating firm. Process innovations are uncertain in the technical and engineering dimensions only, whilst innovations in products additionally face uncertain acceptance in the market place.[8]

Appropriability and imitation. The methods used by firms both to appropriate the fruits of their innovations and to imitate those of their rivals may also change according to the type of innovation. Innovations in products are more easily imitated than those in processes as they are easier to observe and subject to reverse

engineering (for empirical evidence, see *Mansfield et al.*[9]; *Levin et al.*[10]). While the former are often legally protected through patents and other property rights, the latter are more likely to be protected by industrial secrecy.

We have mentioned above only a few of the areas where the distinction between products and processes is used, and we make no claims to have covered all of them. The cases mentioned, however, are enough to justify two statements: firstly, it is quite clear that this dichotomy is considered very useful in order to understand the nature of technological change. Secondly, it can already be seen that the implicit definitions adopted are different, and that there is not necessarily internal consistency.

Definitions of product and process innovations

The distinction between product and process innovation can be approached from different viewpoints and the implications of this should be explored. We will focus here on the definitions which can actually be tested on the SPRU innovation data base (an attempt to develop a taxonomy of product and process innovations has already been made by *Freeman et al.*[4], and *Simonetti*[11]).

a) *Interviewing.* The majority of studies have classified innovations into 'products' and 'processes' relying on the opinion of designated experts. This approach tend to focus on the *innovations* rather than the *innovators*. The classification of innovation, however, relies upon the perspective of the person who classifies it and, therefore, it contains a high degree of subjectivity. Researchers can approach either people who have introduced the innovations (i.e. managers or employees of the firms) or independent experts.

a. 1) *Firm level approach.* The innovation is classified by managers of the innovating firm. From the perspective of an individual firm, its new or improved goods which can be sold on the market are product innovations, while changes in their production techniques are innovations in processes. However, this approach does not say anything at the macro-economic level: an innovation which is considered a product for a firm could easily be a process for another firm: a robot produced by a machine tools manufacturer and used by a automobile firm is regarded as a product innovation by the former and as a process innovation by the latter.

Aggregation of the results obtained for individual firms can generate misleading results. Let us consider, for instance, the impact of technological change on the business cycle or on employment: an increase in the number of process innovations is expected to occur in a depression and to lead to a higher rate of unemployment.

However, according to the firm level approach, an increase in the number of process innovations would also occur as a consequence of a higher industrial concentration or vertical integration: according to our example, the robot would be identified as a process innovation if the machine tools and the automobile firms merged. Needless to say, neither industrial concentration nor vertical integration are necessarily associated with downswings of the business cycle or to increasing unemployment.

a. ii) *Expert approach.* Experts (i.e. engineers), rather than employees of the innovating firms, may be asked to classify innovations as products, processes or other. This approach is very similar to the former, but it is likely to generate different results because the assessment of independent experts does not necessarily coincide with firms' managers. This approach has been used to classify patents by *Scherer*[12] (see also *Lunn*[13]), and it is currently employed by the Canadian Patent Office.

b) *First users.* Since both firms and experts can offer a subjective judgement of the techno-economic nature of the innovations introduced, a more objective assessment might be obtained by asking whether the innovation has been used for the first time within the innovating firm, which would imply that it is a process. Thus, innovations which are for the first time used outside the producing firms may be labelled as products. This approach does not consider the engineering characteristics of the innovations focusing instead on their economic destination.

c) *Sectoral approaches.* A more sophisticated approach has been proposed at the sectoral level.[12, 14–16] However, it requires a more complex methodology since the innovations should be classified according to both their sector of production and their sector of use. Although it is seldom acknowledged, the sectoral approach should be split into two different categories, according to whether the unit of analysis is a *subject* (i.e., a firm, a university or another public institution which both produce and use the innovation) or an *object* (i.e., a technological innovation or a product in which the innovation is used).*

c. i) *Sectoral approach by subjects.* In some analyses (including *DeBresson* and *Townsend*[18] and *Pavitt*[15]), innovations have been classified according to the principal economic activity of both the producing and using organizations. This leads to a square matrix of sectors $n*n$ where each cell contains the number of innovations which have been produced in the sector j and used in the sector i. Denoting the sector of production as PROSEC (PROSEC$_j$ with j = 1, ..., n) and the sector of use as USERSEC (USERSEC$_i$ with i = 1, ...n), the process innovations are only those

* For a further discussion, see *Archibugi*.[17]

for which $PROSEC_j$ = $USERSEC_i$ (i.e. those appearing on the main diagonal of the matrix).

c. ii) *Sectoral approach by objects.* This approach differs from the former approach in that the firms (i.e., subjects) disappear: innovations are classified by their intrinsic technical characteristics rather than by the principal economic activity of the firms which have generated them. The sector of use takes into account the product on which the innovations are likely to be employed. This allows us to create a technological input-output matrix (see *Scherer*,[14] *Robson et al.*,[16] *Simonetti*[19]). If $TECSEC_z$ (z = 1, ...n) denotes the technological sector and $USERSEC_i$ (i = 1, ...n) the user sector, process innovations are defined as those for which $TECSEC_z$ = $USERSEC_i$, i.e., as in the previous case, those appearing on the principal diagonal of the matrix.

c. iii) *Sectoral approach by objects and subjects.* The two approaches can be merged in a more restrictive definition on process innovation, by applying the condition that the process innovations should not only be produced and used in the same firm, but they should also belong to same technological class as the firm's principal economic activity.[20] In a three dimentional space, process innovations would be those for which $PROSEC_j$ = $USERSEC_i$ = $TECSEC_z$. Process innovations would only include those which belong to the same sector of production, of technology and of use such as, for example, an innovation produced and used by chemical firms, and belonging to chemical technology.

All the sectoral approaches are heavily influenced by the level of aggregation of the classification adopted; in the absence of sectoral disaggregation (i.e. if all the economy is merged in one sector only) all the innovations appear as processes, while the number of product innovations increases with the level of disaggregation of the classification adopted.

d) *Final demand approach.* This approach distinguishes between innovations which are directly beneficial to consumers (classified as product innovations) and those which are used as either capital goods or intermediate products by other firms (classified as process innovations). Although all innovations have an impact on consumers in the long run, either in terms of lower prices or of the availability of new products,[21] their inducing mechanisms vary according to whether they are initially directed towards consumers or towards other firms. While both product and process innovations are strongly influenced by new technological opportunities, the former respond to exogenous shifts in demand, and the latter are subject to direct linkages between suppliers and users.

The definitions outlined illustrate quite clearly that the terms are not, at least conceptually, self-explanatory. On the contrary, considerable difficulty is encountered on attempting to divide technological change into innovations in products and those in processes. It therefore comes as no surprise to discover that empirical analyses show strong interrelation of product and process innovations at the firm level.[13, 22–24] It is, however, worthwhile measuring empirically the number of product and process innovations according to each definition supplied above, and to see to what extent individual innovations are classified into the same typologies.

Empirical evidence based on the SPRU innovation data base

The aims of this section are: i) to provide empirical evidence for the number and the balance of product and process innovations; ii) to test the quantitative differences between the various approaches; iii) to identify how many innovations cannot be univocally classified either as products or processes, but should be included in a 'grey zone'.

The SPRU innovation data base represents one of the most comprehensive attempt to monitor and classify innovations according to the widest number of criteria.[3] It is therefore the most appropriate empirical source upon which to test the approaches mentioned above. The innovation data on which the SPRU database is based was gathered in a survey involving experts both external and internal to the innovating firms.

We will not use all the 4378 innovations monitored by the SPRU data base, but only a sample of 620 innovations for which all the definitions required to measure the approaches listed in the former section are available. A focus on a comprehensive, though restricted, sample illustrates the different results obtained when the various definitions are adopted. Our purpose is only illustrative, so a large number of observations is not required.

The variables considered

Among the variables available in the database, we have used the following:

i) The variable FIRMTYPE indicates the type of innovation according to the opinion of the managers or employees of the firm. According to the SPRU innovation survey, the interviewed were asked to classify innovations into seven categories: 1) 'product', 2) 'combined product', 3) 'process', 4) 'several processes',

5) 'equipment system', 6) 'material', and 7) 'unknown'. We have merged 1) and 2) into the group 'products'; 3) and 4) into the group 'processes' and 5), 6) and 7) into the group 'others'.

ii) EXPTYPE assumes the same values as FIRMTYPE. The difference is that, in EXPTYPE, innovations are classified by independent experts. The same mergers as in the former variable have been made.

iii) FIRSTUSE indicates whether the innovating firm was the 'first user' of the innovation introduced or not. In the event of a positive answer, the innovation is classified as a 'process', as it was used in the production process of the innovating firm; otherwise it is classified as a 'product'.

iv) $PROSEC_j$ denotes the SIC* code (4 digit) of the principal economic activity of the innovating firm; i.e. it refers to the subjects of the technological change.

v) Since firms produce innovations in technological fields which do not necessarily coincide to with their principal economic activity, we have also considered the sector to which the innovation itself belongs. $TECSEC_z$ denotes the SIC code (4 digit) of the innovation, and it refers to the object of technological change.

vi) $USERSEC_i$ is the SIC code (4 digit) of the principal economic activity of the 'first user' of the innovation. It thus indicates the activity of the using subject. We believe that it is not too biased to consider that the activity of the using subject is the same as the SIC code of the 'productive segment' of the using subject which will employ the innovation (and therefore, USERSEC can alternatively refer to both subjects or objects).**

Five new variables have been created. PROSUBJECT differentiates between product and process innovations in the sectoral approach at the subject level: those produced and used by firms of the same sector (i.e. $PROSEC_j = USERSEC_i$) are process and all the others are products. PROOBJECT classifies innovations in the sectoral approach at the object level: those which are used into the same sector as that of their technological content (i.e. $TECSEC_z = USERSEC_i$) are considered processes, and all the others as products. This definition has already been adopted by *Scherer*,[14] *Pavitt*[15] and by *Robson et al.*[16] PROCUBE has the value 'process' for all innovations which have the same SIC codes ($PROSEC_j = USERSEC_i = TECSEC_z$) and 'product' for he rest. This definition was introduced by *Archibugi* in a study of the

* SIC stands for Standard Industrial Classification.

** See *Archibugi*.[20] Note that the classification adopted to classify PROSEC, TECSEC and USERSEC, is the same, i.e. the 4 digit Standard Industrial Classes (classes are available on request). As we have stated above, to employ the same classification is a necessary condition to identify process innovations according to the sectoral approach.

issues linked to measurement of innovation,[20] but it has never been used empirically. It is the narrowest definition of process innovation at the sectoral level, since it includes only the innovations classified as processes in both sectoral analyses by subjects and by objects. The variable FINDEM indicates whether the destination of the innovation is either the Final Demand, in which case it is a 'product', or manufacturing and service sectors, in which case it is a process.

Finally, the variable ZONE has been created taking into account the values of all the other variables. ZONE assumes the values 'pure product' and 'pure process' when an innovation is classified as product (or process) according to *all* the approaches considered. When innovations are classified under different headings (e.g., an innovation could be a process in PROSUBJECT, as it is used in the same industry of production, but as a product in FIRSTUSE, since it is not used by the innovating firm) they fall into the 'Grey Zone'.

The number of product and process innovations

Table 1 shows clearly that the number of product and process innovations (and their ratio) can vary dramatically according to the definition used. The share of product innovations ranges from 72%, according to the PROCUBE definition, to 4.5%, when the definition of Final Demand is adopted, whereas, in the case of process innovations, the Final Demand approach shows the highest number of innovations at 95.5%, whilst the interviewing approach, both according to firm employees and experts, registered process innovations at only about 15%.*

From the comparison of the variables PROSUBJECT, PROOBJECT and PROCUBE, the importance of the distinction between analyses based on subjects or objects becomes clear, as the results obtained are almost opposite. The number of processes is much higher in an analysis by subject (almost 60%) than by object (only 33%). The combination of these two restrictions in the variable PROCUBE, however, does not significantly lower the number of process innovations with respect to PROOBJECT.

* The definition of Final Demand adopted includes 'Defence' and 'Government' besides 'Mass Consumer Market'. If only the 'Mass Consumer Market' is considered, the share of product innovations is only 0.3%.

Table 1
The share of product and process innovations.
Percentage distribution of innovations by approach

	Variable	Approach	Products	Processes	Other
a.i	FIRMTYPE	Firm level approach	55.5%	15.6%	28.9%
a.ii	EXPTYPE	Expert Approach	46.0%	16.8%	37.3%
b	FIRSTUSE	First users	32.7%	67.3%	n.a.
c.i	PROSUBJECT	Sectoral approach by subjects	41.1%	58.9%	n.a.
c.ii	PROOBJECT	Sectoral approach by objects	67.4%	32.6%	n.a.
c.iii	PROCUBE	Sectoral approach by objects & subjects	72.3%	27.7%	n.a.
d	FINDEM	Final Demand approach	4.5%	95.5%	n.a.

Source: Elaborations on SPRU innovation database.
Rows add up to 100%.
n.a.: Not applicable.

Table 1 quantifies the number of product and process innovations, but does not say much about the consistency between the various definitions for each innovation. It is possible that even the few innovations classified as products by FINDEM would be classified as processes according to another definition or, vice versa, the 15.6% of processes identified by EXPTYPE might become products according to other approaches. In order to answer this question, the innovations have been split into three groups in Table 2: 'pure' processes, 'pure' products and those which fall into the 'grey zone'; the latter include all innovations which have been classified differently in at least one of the approaches mentioned. The result are striking. For 96.9% of the innovations the classifications are not consistent: they may appear as either products or processes according to the approach adopted. Only 2.6% innovations are 'pure' processes, and 0.5% 'pure' products.

Table 2
'Pure products', 'pure processes' and the 'grey zone'.
The number and the percentage of 'pure' product and process innovations and the size of the 'grey zone'

Zone	#	%
Grey zone	601	96.9%
Pure processes	16	2.6%
Pure products	3	0.5%
Total	620	100.0%

Source: Elaborations on SPRU innovation database.

It is also important to note how the interview approach can provide very different results. In Table 3 the classification of the innovations by type provided by the experts and by the employees of the innovating firms are compared. The innovations on the diagonal, namely the cases in which experts and firms agree, amount to only 58.9%. In 8.5% of the cases, moreover, firms classify an innovation as a product while experts define it as a process and *vice versa*.

Table 3
The interviewing approach by firm and by expert.
The classification of innovations by type according to the managers of the innovating firms and to external experts interviewed

FIRMTYPE	EXPTYPE			
	Products	Processes	Others	Total
Products	213	22	50	285
Processes	31	50	23	104
Others	100	25	106	231
Total	344	97	179	620

Source: Elaborations on SPRU innovation database.

Innovations 'first used' in the innovating firm

The variable FIRSTUSE allows us to compare a) the 'micro' versus the 'sectoral' level (FIRSTUSE vs. PROSUBJECT) for approaches focussing on the economic destination of the innovations, and b) the 'interviewing' (FIRSTUSE vs. FIRMTYPE) versus the 'economic destination' criterion at the firm level.

Table 1 shows that, when the economic destination is considered, the results are quite consistent both at the micro and at the sectoral level (i.e., PROSUBJECT and FIRSTUSE have similar shares of product and process innovations). The differences between FIRSTUSE and FIRMTYPE shown in Table 4, on the other hand, tell us that a classification made by interviewing produces a share of process innovations much lower than a classification focusing on the economic destination. This may arise because experts tend to describe commodities as product innovations even though they are used in the innovating firm itself (and therefore they are processes according to an economic classification). One of the explanations for this outcome is that some innovations are multi-use products, which are both marketed and used internally by

the innovating firm. According to Table 4, this situation is quite frequent (191 out of 389 cases; i.e., 49%), showing to what extent the empirical results obtained depend upon the definition used.

Table 4
FIRMTYPE by FIRSTUSE
The classification of innovation by economic destination and by engineering characteristics

FIRSTUSE	FIRMTYPE		
	Products	Processes	Subtotal*
Products	94	28	122
Processes	191	76	267
Total	285	104	389

Source: Elaborations on SPRU innovation database.
*Subtotal only includes the innovations classified in FIRMTYPE either as 'products' or 'processes'.

Conclusions

Product and process innovations are important concepts in the vocabulary of studies on technological change and this paper is an attempt to specify their nature and characteristics. Quantitative evidence on their number, according to each of the approaches described, has been provided. It should be stressed, however, that the data employed comes from the same source, the SPRU innovation data base, and therefore the variations encountered stem from the different approaches and viewpoints adopted.

The results can be summarized in three points:

i. The finding that 96.9% of the innovations fall into the 'grey zone' (i.e., they can be products or processes according to the type of definition adopted) indicates that almost all innovations can be classified as either products or processes on the basis of the chosen definition. This result, thus, supports our initial remark that the definition of product and process innovations is neither self-explanatory nor straightforward.

ii. Nearly half of the innovations categorized as products by the innovating firms are actually used within the firms themselves (and therefore they are process innovations if they are classified according to their economic destination), suggesting that a 'black or white' categorization of innovations is risky. A classification based

upon the economic destination of the innovations neglects the fact that they can be used in many different ways and by several agents.

iii. This does not mean that a classification based upon interviewing criteria should be preferred. As Table 2 showed, the interviewing approach contains a very high degree of subjectivity related to the perspective of the person who classifies the innovations. In fact, in less than 60% of the cases did the definitions provided by independent experts converge with those of the employees of the innovating firms.

This study may suggest that it is useless to analyse technological change in terms of product and process innovations. Technology is very complex and systemic and often new products, especially when they are radical innovations, require new equipment and capital goods, i.e. they imply the introduction of process innovations. On the other hand, new processes can alter the characteristics of a good to a such extent that it can be considered as a new product. These considerations can explain why product and process innovations appear strongly interrelated in empirical analyses.[13, 23, 24]

Are then product and process innovations so closely interrelated that it is impossible to separate them empirically? Or, taking it even further, does it make sense to distinguish between product and process innovations? As we have shown in section 2, a large number of studies have split technological change into product and process innovations, and there is little doubt that scholars in this field will continue to do so for a long time to come. Probably, the best approach is to acknowledge that, on one hand, the distinction between product and process innovations can be a useful tool for analysis, but, on the other hand, it should be recognized that their definition and measurement have fuzzy boundaries and practical difficulties. If it is acknowledged that various definitions of product and process innovation exist, it would be good practice for those who employ these terms to explain very clearly which meaning they attach to them.

A next analytical step will be to check the consistency of the results obtained by different surveys which have applied the same or comparable definitions of product and process innovation. This issue will be explored in future research.

References

1. J. A. SCHUMPETER, *The Theory of Economic Development*, English translation, Harvard University Press, Cambridge, Mass., 1934, Original German edition 1911.
2. M. BLAUG, A survey of the theory of process innovations, *Economica*, 30 (1963) 13–32, p. 13.

3. J. TOWNSEND et al., *Science and Technology Indicators for the UK. Innovation in Britain since 1945*, SPRU Occasional Paper no. 16, SPRU, University of Sussex, Brighton, 1981.
4. C. FREEMAN, L. SOETE, J. TOWNSEND (Ed.), *Fluctuations in the Numbers of Product and Process Innovations 1920–1980*, OECD, Paris, 1982.
5. J. UTTERBACK, W. ABERNATHY, A dynamic model of process and product innovation, *Omega*, 3 (1975) 639–656.
6. C. FREEMAN, L. SOETE (Eds), *Technical Change and Full Employment*, Blackwell, Oxford, 1987.
7. Y. S. KATSOULACOS, Product innovation and employment, *European Economic Review*, 26 (1984) 83–108.
8. S. HOLLANDER, *The Sources of Increased Efficiency: a Study of Du Pont Rayon Plants*, The MIT Press, Cambridge, Mass., 1965.
9. E. MANSFIELD, M. SCHWARTZ, S. WAGNER, Imitation costs and patents: An empirical study, *Economic Journal*, 91 (1981) 907–918.
10. R. LEVIN, A. KLEVORICK, R. NELSON, S. WINTER, Appropriating the returns from industrial research and development, *Brookings Papers on Economic Activity*, 3 (1987) 783–831.
11. R. SIMONETTI, *The Definition of Product-Innovation and Process-Innovation*, MSc dissertation, Science Policy Research Unit, University of Sussex, Brighton, 1991.
12. F. M. SCHERER, Demand pull and technological invention: Schmookler revisited, *The Journal of Industrial Economics*, 30 (1982a) 225–237.
13. J. LUNN, An empirical analysis of process and product patenting: A simultaneous equation framework, *The Journal of Industrial Economics*, 34 (1986) 319–329.
14. F. M. SCHERER, Inter-industry technology flows in the United States, *Research Policy*, 11 (1982b) 227–245.
15. K. PAVITT, Sectoral patterns of technical change: Towards a taxonomy and a theory, *Research Policy*, 13 (1984) 343–373.
16. M. ROBSON, K. PAVITT, J. TOWNSEND, Sectoral patterns of production and use of innovations in the UK: 1945–1983, *Research Policy*, 17 (1988) 1–14.
17. D. ARCHIBUGI, In search of a useful measure of technological innovation, *Technological Forecasting and Social Change*, 34 (1988) 253–277.
18. C. DEBRESSON, J. TOWNSEND, Notes on the inter-industrial flow of technology in post-war Britain, *Research Policy*, 8 (1978) 48–60.
19. R. SIMONETTI, *Flussi tecnologici intersettoriali in Italia. Un'analisi su dati brevettuali*, Laurea thesis, University 'La Sapienza', Rome, 1989.
20. D. ARCHIBUGI, *The Sectoral Structure of Innovative Activities in Italy. Results and Methodology*, D. Phil. Dissertation, University of Sussex, Brighton, 1989, pp. 33–38.
21. M. TRAJTENBERG, *Economic Analysis of Product Innovation*, Harvard University Press, Cambridge, Mass., 1991.
22. J. LUNN, An empirical analysis of firm process and product patenting, *Applied Economics*, 19 (1987) 743–751.
23. L. KRAFT, Are product- and process-innovations independent of each other?, *Applied Economics*, 22 (1990) 1029–1038.
24. D. ARCHIBUGI, S. CESARATTO, G. SIRILLI, Innovative activity, R&D and patenting: The evidence of the survey on innovation diffusion in Italy, *Science Technology Industry Review*, 1 (1987) 135–150.