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Erik Brouwer
Hana Budil-Nadvornikova
Alfred Kleinknecht

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ARE URBAN AGGLOMERATIONS A BETTER BREEDING PLACE FOR PRODUCT INNOVATION?
An analysis of new product announcements

by

Erik Brouwer, Hana Budil-Nadvornikova and Alfred Kleinknecht

corresponding author:
Alfred Kleinknecht, Boomkleverlaan 72, NL-1403 CD Bussum, North Holland

Abstract:
Compared to firms in rural regions, firms in urban agglomerations of the Netherlands dedicate a higher share of their R&D to product development. In our Hurdle Count Data estimate of determinants of new product announcements we find that, with a given product-R&D-intensity, firms in central regions have higher probabilities of announcing at least one new product in a journal and they also announce new products in larger numbers. Such support for the urban hierarchy/filter down hypothesis was not found when confining our analysis to standard R&D data.

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0 Introduction

Starting with THOMPSON's (1965) seminal contribution, there is now a considerable literature on the 'urban hierarchy/filter-down' hypothesis. Sometimes drawing on early work by KUZNETS (1930) and BURNS (1934) on industrial life cycles, the 'urban hierarchy' hypothesis predicts that large urban agglomerations will be a particularly favourable 'breeding place' for innovations. It is often argued that the breeding place function is due to specific agglomeration advantages, including the supply of qualified labour on highly diversified regional labour markets, positive externalities from knowledge centres such as universities or R&D labs of large firms, the availability of specialized commercial services, 'information density' and the physical proximity of business partners, allowing for direct face-to-face contacts which increase the quantity and quality of information exchanged and facilitate the formation of networks and more intensive subcontracting (EWERS & WETTMANN 1980, DE JONG 1987, LAMBOOY 1988, PERRIN 1988, SUAREZ-VILLA & FISCHER 1995).

To the extent that new industrial activities reach a more mature stage in their life cycle, emphasis may shift from product change to process change and from quality to price competition, and, in the course of time, the overall speed of technological change may slow down, implying that maturing industrial activities will gradually become less dependent on their original 'breeding place'. Moreover, entry by imitators may bring down profit margins and firms may then have an incentive to shift production to more rural areas where factor prices are lower. As a consequence, we expect the innovative activities of firms in large urban agglomerations to be 'biased' towards product innovation, whereas firms in rural areas may place stronger emphasis on process change. All this sounds plausible, and empirical studies by authors such as ERICKSON (1976), OAKEY ET AL. (1980), MARTIN ET AL. (1979) or EWERS & WETTMANN (1980) seem to support the hypothesis.

In addition to a severe theoretical criticism by TAYLOR (1986), however, empirical findings that seem to contradict the hypothesis are also reported (for example, by HOWELLS 1983). In an earlier contribution to this journal, moreover, KLEINKNECHT & POOT (1992) drew somewhat sceptical conclusions about the breeding place hypothesis. Judging from firm-level data on R&D for all manufacturing and service industries of the Netherlands, they concluded that the location of a firm within the country has little impact on whether it will undertake any R&D activities or on its R&D intensity. As far as differences in R&D-intensities of firms exist across regions, they can largely be explained by non-regional factors such as the sectoral or size composition of industry. While this seems to militate against the breeding place hypothesis, one remarkable finding seems to support at least the above-sketched life cycle hypothesis: compared to firms in peripheral areas, and after control for some other factors, firms in the more central regions of the Netherlands dedicate a significantly higher share of their R&D to ***product*** development (KLEINKNECHT & POOT 1992: 229-230).

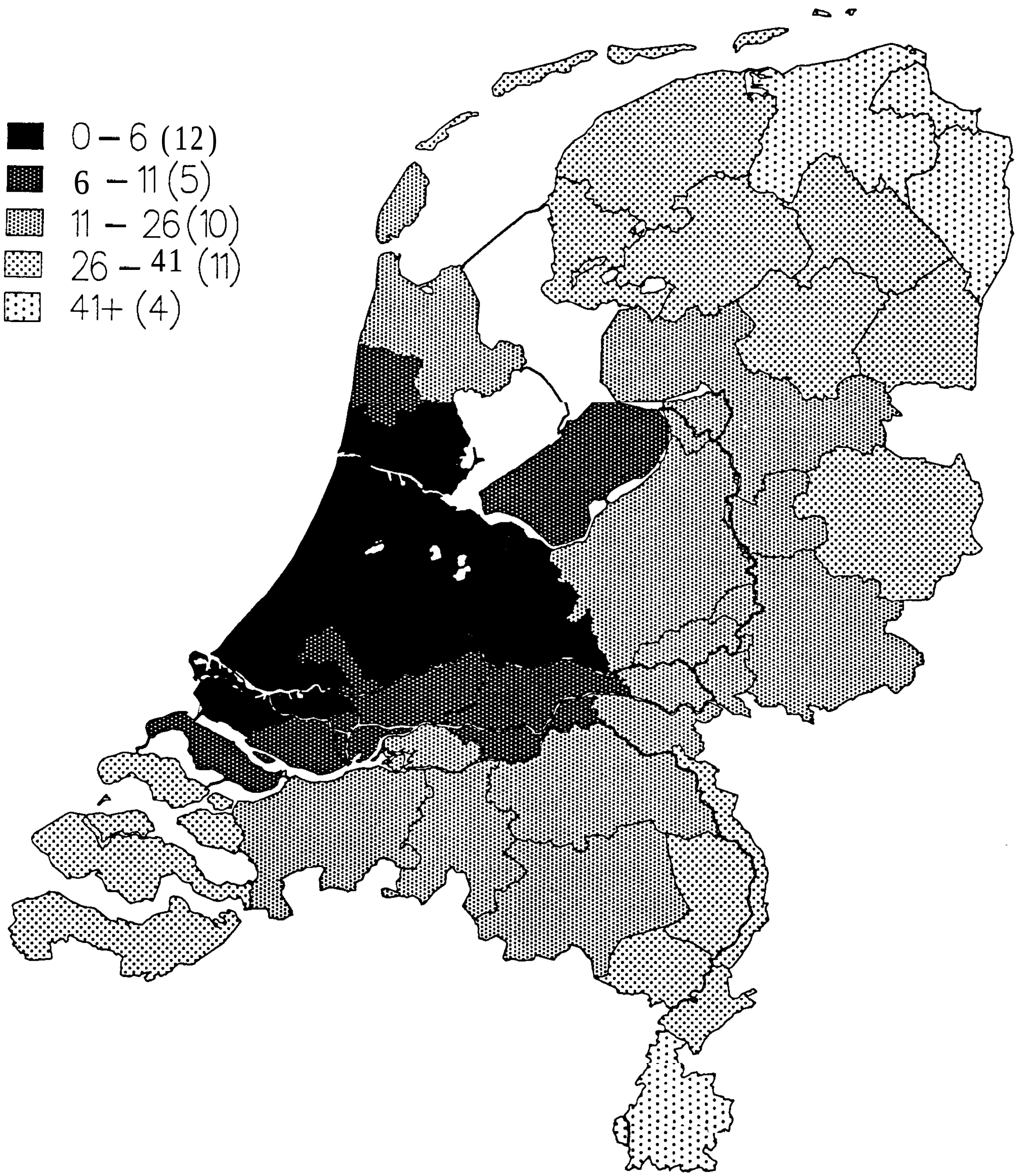
In addition to this finding, two new developments call for a re-examination of the breeding place hypothesis.
First, regional economists argue increasingly that, due to structural changes in the 1980s, the traditional subdivision of the Netherlands into core ('Randstad' or 'Rim City'), semi-periphery ('Halfweg-zone') and Periphery (as used by KLEINKNECHT & POOT 1992) may be somewhat outdated, and new schemes have been developed.
Second, a new type of innovation output indicator is now available consisting of all new product announcements in the 1989 volumes of 36 Dutch trade journals. This indicator is mainly one of product innovation, and the trade journals were selected to cover innovations in all sectors of manufacturing and services. A short outline of the data collection method can be found in KLEINKNECHT & REIJNEN (1993). Readers concerned about the reliability of the new indicators should be referred to the detailed discussion of the pros and cons of the data collection method in KLEINKNECHT & BAIN (1993, especially p. 190-195). It should be noted that sector level comparisons between the new indicator and existing innovation indicators are quite satisfactory (see KLEINKNECHT & BAIN 1993: 50-56).

The new data allow a more specific look at the relationship between innovation input (R&D) and innovation output (new and improved products). If the breeding place hypothesis is realistic, we would expect agglomeration advantages of firms to result in more efficient use of R&D inputs. In other words, firms in agglomeration regions are expected to achieve, with a given input of product-related R&D (and some other factors being kept constant), a higher innovation output. If this holds true, it would give strong support to the breeding place hypothesis, particularly against the background that firms in urban agglomerations dedicate more of their R&D to product development.

Figure 1 illustrates the new subdivision of the Netherlands developed recently by MANSHANDEN (1996). Figure 1 can be interpreted as an index of agglomeration advantages. It is based on physical distances (along main roads) from each central town in a ***Corop*** region to the central towns in all others. These distances are weighted with the population density of a ***Corop*** region (inhabitants per square kilometre), implying that a given distance towards a population-dense ***Corop*** region gives a higher score on the agglomeration index than the same distance towards a less population-dense ***Corop*** region. This index deviates in several details from the agglomeration index by DIEPERINK & NIJKAMP (1988), as well as from the traditional subdivision of the Netherlands into Rim City, Semi-Periphery and Periphery which were both used by KLEINKNECHT & POOT (1992: 224-225). The agglomeration index by DIEPERINK & NIJKAMP (1988) takes explicitly account of possible agglomeration advantages of medium-sized towns (100 000 to 200 000 inhabitants), besides big towns, whereas the new Manshanden index can be characterised as a bit more focused on the Rim City (Randstad).

The index can be used in two ways: (1) as a continuous variable, giving each firm the agglomeration value of its ***Corop*** region on a continuous scale; or (2) as a dummy variable, in which case ***Corop*** regions with similar agglomeration values are clustered. This is done in Figure 1. As a check of robustness, we used both versions in our estimates, finding that the results did not deviate substantially.

Figure 1: Manshanden's agglomeration index for the Netherlands



1 Analysis

1. I Does the new regional subdivision matter for R&D?

Before using the new innovation output data, we first re-estimated some of the equations in KLEINKNECHT & POOT (1992), using Manshanden's new agglomeration index. Three topics were principally examined:

1. Is the probability that a manufacturing or service firm will engage in R&D dependent on its location when using the Manshanden index (whereas, according to the old index, it was not)?
2. Is the R&D-intensity of a firm dependent on its location (whereas, according to the old index, there was only sparse evidence of this)?
3. According to the old index, firms in the periphery had a systematically higher share of process-related R&D in their total R&D: would this also hold when using the new Manshanden index?

Our findings can be summarised as follows: Questions (1) and (2) can be answered negatively apart from the fact that service firms in the cluster of regions with the highest degree of agglomeration (i.e. the black surface in Figure 1) have a 12% higher probability of engaging in R&D as compared to similar firms in the cluster of regions with the lowest degree of agglomeration (the brightest surfaces in Figure 1). In all other respects, our results with the new Manshanden index do not deviate from the earlier findings by KLEINKNECHT & POOT (1992). In other words, the probability that a manufacturing firm will engage in R&D, and the R&D-intensities of manufacturing and service firms, are not affected by the region in which the firm is located (for details see BUDIL-NADVORNIKOVA & KLEINKNECHT, 1993).

With respect to question (3), however, the Manshanden index makes some difference. Our new estimate of the regression which explains the share of process-related R&D in total R&D is documented in table 1. Use of the traditional index showed that the share of process-related R&D in total R&D was about 4% higher among firms in the semi-periphery, and about 7.5% higher among firms in the periphery (KLEINKNECHT & POOT 1992: 229). Using the new Manshanden index, these differences appear to be stronger. According to table 1, in the two clusters of regions with the highest degree of agglomeration, firms have an over 11 percent lower share of process-related (or a greater than 11 percent higher share of product-related) R&D in their total R&D when compared to the cluster of regions with the lowest agglomeration score (cluster 5). For firms in regions with a medium degree of agglomeration (cluster 3) the difference is still almost 7.5 percent. The coefficient for firms in cluster 4 is no more significantly different from the reference region (cluster 5). As expected, the coefficients and t-values decline almost continuously when we move from the cluster of regions with the highest agglomeration score down to that with the lowest agglomeration score.[1] While

[1] From an econometric viewpoint it may be argued that our estimates in Table 1 do not fully satisfy the requirements of a regression model since the dependent variable is confined to an interval between 0% and 100%. We therefore transformed the dependent variable and estimated the following regression: $\log (z / 1 - z) = a + xb$, where z is the percentage of process-related R&D and x represents the exogenous variables. However, with this

the results in table 1 basically confirm our earlier findings, they may be taken as an indirect indication that the new Manshanden index is likely to be a more adequate regional subdivision than the older subdivisions used by KLEINKNECHT & POOT (1992).

Table 1:
Factors explaining the percentage of process-related R&D in total R&D.
Summary of regression estimates with the new Manshanden index

variables:	coefficients:	t-values:
intercept	34,88	8,07***
log of R&D intensity	-4,33	-6,12***
dummy for high technological opportunity sectors[#]	-8,61	-4,94***
dummy for firms which are strongly dependent on the mother company when taking decisions about innovation	5,41	2,49**
dummy for firms in five types of agglomeration regions (firms in region type 5 are the reference group):		
region type 1 (*Corop* 17, 20-28, 41, 42)	-11,59	-3,37***
region type 2 (*Corop* 16, 19, 29, 30, 40)	-11,78	-2,94**
region type 3 (*Corop* 10, 11, 13-15, 18, 33-36)	-7,48	-2,28**
region type 4 (*Corop* 4-9, 12, 31, 32, 37, 38)	-5,00	-1,43*

Notes:
n = 1255, adj. R-square = 0.07
*** = significant at 99% level; ** = significant at 95% level; * = significant at 87% level.
Source: SEO National Survey on R&D and Innovation in the Netherlands, 1989.
[#] The division between high and low technological opportunity sectors is along the lines of Pavitt's (1984) taxonomy of sectors, taking his 'specialized suppliers', as well as his 'science-based' and 'production intensive' sectors as high technological opportunity sectors and his 'supplier-dominated' sectors in the low technological opportunity category.

The findings in table 1 are indeed favourable for the breeding place hypothesis: The theory of the industry life cycle predicts that industrial activities in an early stage of their life cycle are characterised by a stronger emphasis on product innovation, whereas, the emphasis may later shift to process improvements (see also UTTERBACK 1979). The above results suggest that activities in an earlier stage of the life cycle tend to be concentrated in regions that are likely to have the type of agglomeration advantages mentioned above.

model we obtained essentially the same results. Only the documentation and interpretation of outcomes becomes less convenient.

I. 2 Does the new regional subdivision mutter for innovation output?

1.2.1 Hypotheses and estimation procedure

As indicated above, the new innovation output indicator allows us to examine the relationship between R&D-input and innovation output, and to test which factors possibly influence this relationship. The compilation of indicators from Dutch trade journals resulted in a database of 1032 cases of product innovation announcements in 1989, stemming from 499 firms. Independent of this collection, we have a database from the SEO ***National Survey on R&D and Innovation.*** This survey was held in 1989 and covered mainly innovation input indicators (i.e. R&D), in the year 1988.

As a first step we examined which of the 499 firms identified as 'innovators' (according to the trade journal search project) were also present in the much larger database (4352 firms) from the national postal survey. These proved to total 127, in line with our expectations, given the sample selection principles of the national survey (for details see E. BROUWER & KLEINKNECHT 1994). It would certainly be inadequate to characterise as 'non-innovators' the approximately 94% of firms in the national survey that had no innovations according to the trade journal search project. Many of them do perform R&D but have no new product announcements which can have three reasons. First, the trade journal search identifies mainly ***product*** innovations. ***Process*** innovations appear only occasionally in the collection; in any case, the journal search method does not pretend to give a comprehensive account of ***process*** innovation. Secondly, a number of firms may have been busy with innovation projects but happened to introduce no innovation during our search period (1989); third, a number of firms may have had product innovations that were not 'heavy' enough to be published in a trade journal.

The combination of the two databases has the advantage that we can use the full information of the postal survey when analysing factors which influence the probability that a firm from the 1988 postal survey will appear as an innovator in 1989 according to the journal search procedure. For the analysis of innovations from trade journals, we use a Hurdle Geometric Count Data model which consists of a logit part (identifying factors which influence the probability that a firm will have at least one new product or service announcement) and a positive truncated negative binomial part, identifying factors that influence the numbers of announcements (see MULLAHY 1986). The Hurdle model is quite similar to a TOBIT model, but it is more suitable when the dependent variable is not a continuous but a discrete count variable.

We test the influence of various factors which play a role in the more recent literature on determinants of innovation (see e.g. STONEMAN, ed., 1995; KLEINKNECHT, ed. 1996). Not surprisingly, we expect a high product-R&D intensity to have a positive impact on innovation output. The same is assumed to hold for firms in 'high technological opportunity' sectors. According to the famous Schumpeter hypothesis, one can expect firms which have market power to invest more into R&D since they can appropriate innovation benefits more easily. However, it is questionable whether this also translates into a higher innovation output, given a certain R&D input. The argument about a better appropriation of innovation benefits and the possibility of economies of scale from large-scale R&D efforts would lead one to expect market power to be related to a higher innovation output. An obvious counter-argument is about managerial diseconomies of scale in large and comlex organisations. In order to test which of the two types of argument is more powerful, we include, as a measure of market power, a C-4 concentration ratio which measures the market share of the four largest sellers in a firm's sector of principal activity, leaving the expected direction of causality open.

Further, we expect firms which engage in R&D collaboration to produce a higher innovation output since they can take advantage of the complementary knowledge of their partners. The impact of firm size is not clearly determined. Evidence from R&D data suggests that larger firms generally have a higher probability to perform some R&D (although this probability does not need to increase proportionately with firm size). However, given that a firm has some R&D, smaller firms may, in many cases, have a higher R&D intensity (see KLEINKNECHT & POOT 1992). A similar pattern may hold with respect to new products announced in trade journals. We also control differences between firms which are part of a group and which are strongly dependent on the mother company when developing new products. The latter are often branch plants which are supposed to have a lower propensity to innovate. However, if they innovate, they may have a relatively high innovation output (with a given R&D input and other characteristics held constant), since such firms often take over products developed in some other part of their group.

COHEN & LEVINTHAL (1989) argued that a firm's R&D department may have a double function: (1) the production of knowledge; and (2) the function to observe the firm's technological environment. This implies that firms which have a regular R&D function may be more capable in identifying innovative options available and to benefit from technological spill-overs which makes them more successful in producing a certain innovation output with a given R&D input. Moreover, given the cumulative nature of technological progress (DOS1 1988), firms which have a continuous R&D function may be better in accumulating knowledge than those which perform R&D only as an occasional and informal activity. In order to capture such effects, we include a dummy variable for firms which organise their R&D in a formal R&D department. The model and the expected signs of coefficients are summarised in table 2.

Finally, we include dummies for firms which reported that they concentrated their R&D effort in technology fields that, in recent years, are often considered as particularly fruitful field of innovative endeavour: information technology, biotechnology and new materials technology.

Table 2
Hypotheses about factors influencing (1) the ***probability*** of announcing a new product and (2) the ***numbers*** of new product announcements in trade journals

	expected signs:	
exogenous variables:	probability:	numbers
product-related R&D intensity	+	+
firm size	+	-/?
firm has a formal R&D department	+	+
firm is strongly dependent on mother company when taking decisions about innovation	-	+
firm belongs to a high technol. opportunity sector.	+	+
firm belongs to the service sector	-	-
firm concentrates its R&D effort to:		
- information technology	-	-
- biotechnology		
- new materials technology		
firm operates in a highly concentrated market	?	?
firm has a high export intensity	+	+
firm collaborated on R&D	+	+

1.2.2. Results and interpretation

We first included all variables mentioned in table 2 in our estimate and then, step by step, excluded insignificant variables. Table 3 includes only variables which were significant in various rounds of our estimates. An exception is the dummy for branch plants which is strictly spoken insignificant, but still has a remarkable t-value when explaining numbers of innovations. Let us first comment on those variables which proved insignificant in earlier rounds of our estimates and which are omitted from table 3.

First, the innovation output of firms that indicated that information technology, biotechnology or new materials technology were particularly important to their innovative efforts does ***not*** differ from firms active in other technology fields. This suggests that the named fields are not particularly 'fruitful' for R&D efforts.

Second, the innovation output of firms that operate in highly concentrated markets does not differ from the output of firms in markets with a low seller concentration. In our model, the C-4 concentration ratio is insignificantly negative. In a study with similar indicators in the US, ACS & AUDRETSCH (1993) report even a significantly negative sign of the concentration coefficient.' This sug-

[2] 'Most studies have generally found positive relationships to exist between market concentration and R&D, providing support for the Schumpeterian hypothesis that market power promotes technological change. However, when the direct measure of innovative output is related to market concentration, . . . [we] find . . . that market

gests that possible economies of scale to large-scale R&D and greater ease in appropriation of innovation benefits are, in any case, not more powerful than managerial diseconomies of scale. Moreover, equally insignificant was a measure of 'small business presence'. This is the share in the total number of firms taken by firms with less than 50 employees in a firm's sector of principal activity. It measures the intensity of competition by smaller firms and can be considered as a counterpart of market concentration.

Third, export intensive firms do not differ from firms which are oriented to national and regional markets. It should be noted that there is evidence in the literature of a positive relationship between R&D and export (HUGHES 1986). In other words, our estimates do not prove that exports are irrelevant for innovation. However, we can conclude that, with a given R&D intensity, export-intensive firms are not more successful with respect to innovation output.

Forth, the perhaps most surprising outcome is that firms which collaborate on R&D do not differ from firms which do it alone. As outlined above, one would expect that collaborators can exploit the complementary knowledge of their partners and should therefore be more successful with respect to innovative output. This is not confirmed by our estimates. A possible explanation can be found in the work by TEECE (1988) who argued that firms do not wish to become dependent on third parties with respect to crucial assets. If an innovation is considered crucial for the future of the firm, one will try to do it alone rather than sharing profits with collaborators. Only firms which lack an adequate knowledge base are likely to collaborate.

concentration exerts a negative influence on the number of innovations made in an industry' (ACS & AUDRETSCH 1993: 24).

Table 3:
Factors which influence a firm's announcement of new products or services in a trade journal.
Summary of Hurdle Count Data estimates

3a) Factors which influence ***the probability*** that a firm will have at least one new product announcement in 1989 (logit part)

exogenous variables:	coefficients:	t-values:
intercept	-9,02	-7,95***
product-related R&D intensity in 1988	0,05	2,45**
firm size (log of employees), manufacturing firm	0,48	5,44***
firm size (log of employees), service firm	0,49	4,51***
dummy: firm has a formal R&D department	0,45	1,94*
dummy: firm is strongly dependent on mother company when taking decisions about innovation	0,26	1,16
dummy: firm belongs to a high technological opportunity sector in manufacturing	0,94	3,55***
dummy: firm belongs to the service sector (reference group: low technol. opportunity manufacturing firms)	-0,25	-0,33
Manshanden's agglomeration index	2.98	2,63***

Notes:
Number of observations: 4296
R-square: 0,16
loglikelihood model: -496,6
loglikelihood baseline: -572,3
*** = significant at 99% level
** = significant at 95% level
* = significant at 90% level

3b) Factors which influence the ***numbers*** of new product announcements (positive truncated negative binomial regression)

exogenous variables:	coefficients:	t-values:
intercept	-6,31	-4,28***
product-related R&D intensity in 1988	-0.06	-1.69*
firm size: (numbers of employees), manufacturing firm	0,48	6.65"*
firm size (numbers of employees), service firm	0,01	0,04
dummy: firm has a formal R&D department	-0,05	-0,17
dummy: firm is strongly dependent on mother company when taking decisions about innovation	0,46	1,63
dummy: firm belongs to a high technological opportunity sector in manufacturing	0,83	2,13**
dummy: firm belongs to the service sector (reference group: low technol. opportunity manufacturing firms)	2,77	2,27**
Manshanden's agglomeration index	3,81	2,43**

Notes:
Number of observations: 127
R-square: 0,20
loglikelihood model: -6714,1
loglikelihood baseline: -8357,4
*** = significant at 99% level
** = significant at 95% level
* = significant at 90% level

Let us now turn to the findings documented in table 3. There are important differences between factors which influence the ***probability*** that a firm will announce at least one new product and factors which determine the ***numbers*** of new products announced. As expected, product-related R&D intensity[3] has a highly significant positive impact on the probability that a firm will have at least one new product announced in a journal. However, the actual number of announcements is even slightly negatively related to R&D intensity. In various alternative specifications, the negative coefficient of R&D intensity varied between a 90 % and a 95 % level of significance. This outcome may be caused by a very small number of big firms in our database which have quite substantial R&D intensities, but only modest numbers of new product announcements; in other words, they have lower numbers of innovations per unit of R&D input (see also KLEINKNECHT and BAIN, 1993: 67), and this effect may not be fully captured by the firm size variable.[4] It should be noted

[3] Definition: man years of R&D related to new product or service development as a percentage of the firm's total labor force. Note that roughly two thirds of all R&D is related to new product and service development while a bit less than one third is related to new processes. The remainder cannot be classified by either category since product and process development are too much intertwined (see E. BROUWER and KLEINKNECHT 1994).

[4] Experiments with other non-linear specifications of the firm size variable (besides the log version) did not contribute to clarify this point.

that our outcome on R&D intensity comes quite close to the result achieved by LOVE & ASHCROFT (1997) who, in a study of innovation in Scottish firms, conclude that 'plant level [R&D] facilities are of great importance in making a plant an innovator, but play a much less important role in enhancing innovativeness once the initial threshold has been overcome' (1997: 18).

It comes as no surprise that the probability that a firm will announce at least one new product increases with firm size. Simple simulations show that this probability increases even *more* than proportionately with firm size, both in manufacturing and in service firms. However, given that a firm announces at least one new product, the ***numbers*** of new product announcements behave differently. They increase (less than proportionately) with firm size in manufacturing but do not differ between larger and smaller firms in services. One should mention here that service firms in our sample are, on average, much smaller than manufacturing firms and even the larger service firms are still quite small, probably due to the different importance of scale economies in the two sectors.

It remains doubtful whether our estimates support the hypothesis by COHEN & LEVINTHAL (1989). The presence of an R&D department seems indeed to have a positive impact on the probability that a firm will announce at least one new product. However, an R&D department has no influence on the actual number of new product announcements. The most negative interpretation of this outcome would be that the monitoring hypothesis by COHEN & LEVINTHAL is irrelevant and that the positive impact of an R&D department on the probability of having a new product rests upon a misspecification: given that larger firms have more often an R&D department, the latter variable may capture some effects of size, scale and scope which may be insufficiently covered by the firm size variable.

There is little support for the hypothesis that branch plants (being strongly dependent on their mother companies) will have less frequently an innovation. While the sign is in the 'right' direction, the t-value is just 1,16. On the other hand, our expectation that such firms will have higher numbers of new products (given that they have at least one new product) finds some support, although the coefficient just fails to be significant at a 90% level.

As expected, firms in high technological opportunity sectors of manufacturing industry have higher probabilities of announcing new products as well as higher numbers of products announced than firms in low technological opportunity manufacturing sectors. Compared to firms in low technological opportunity manufacturing sectors, service firms also have higher numbers of new product announcements, although they do not differ with respect to the probability of announcing new products.

Finally, the most important outcome in the context of this paper is the highly significant score of the regional location index. In Figure 1, the darkest regions are the most agglomerated. As we move from the darker to the brighter regions, both the probability that a firm will announce at least one new product as well as the actual numbers of new product announcements will significantly diminish (all other factors such as R&D intensities, firm size etc. held constant). As opposed to the earlier results on the regional distribution of R&D intensities by KLEINKNECHT & POOT (1992) these findings on innovative output are favourable to the urban hierarchy/filter down hypothesis. In fact, we find that there is no straightforward relationship between R&D input and innovative output. The relationship between the two is moderated by a number of factors which seem to influence the more or less efficient use of inputs. Location in an agglomerated region appears to be one of them.

We should add here that, besides the model documented in table 3, we also estimated a model using 'slope dummies', taking degree of agglomeration times R&D intensity (and other company characteristics). It turned out that almost all of these slope dummies were insignificant. In other words, across the various agglomerations, there is a significant difference in intercepts, but not in slopes in the relationship between R&D and innovation output.

Against our results, one may object that in the case of multi-plant conglomerates the place of the new product announcements is biased towards central regions. A product developed in a plant in the country's periphery may be introduced into the market by a more centrally located (principal) establishment since this may be more advantageous from a marketing view. There are indeed some multi-plant conglomerates in our database. We tried to control such effects by including a dummy variable which indicates whether the firm is strongly dependent on its mother or sister companies when taking decisions about product or service innovation. However, against our expectations, this variable proves insignificant.

In conclusion, we would maintain that, in spite of this objection, the above outcomes may be interpreted as support of the breeding place hypothesis. For innovation researchers, it is important to emphasise that the distinction between R&D input data and the new innovation output data does matter. Had we confined our judgement to standard R&D data, our conclusions about the urban hierarchy/filter down hypothesis would have been rather negative. Moreover, a recent refinement in the measurement of R&D, subdividing R&D into product and process R&D, is rewarding. Analysis of these two parts of R&D in a regional perspective caused IUEINKNECHT & POOT (1992) to be cautious in rejecting the life cycle hypothesis in an earlier contribution to this journal. Our above re-estimate, using a more recent agglomeration index, confirms the outcome that peripheral regions tend to have a bias towards process innovation. It is interesting to note that this finding is consistent with work by HARRIS (1988) on Great Britain who elaborated on quite a different database (i.e. the SPRU database on significant innovations).

The above findings are remarkable since it is often argued that the Netherlands is a small country with a densely developed communication and transportation infrastructure in which regional differences are of minor importance. Although our results refer to one (small) country only, they should encourage researchers in other countries to collect and use novel innovation indicators. The recently introduced subdivision of R&D into product and process R&D and the collection of novel innovation output indicators from trade journals obviously allow for new insights into regional (and non-regional) determinants of innovation that could not have been achieved with already long existing R&D data.

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