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OPERATIONAL MODELS ON INDUSTRIAL INNOVATION
AND SPATIAL DEVELOPMENT:
A CASE STUDY FOR THE NETHERLANDS

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OPERATIONAL MODELS ON INDUSTRIAL INNOVATION
AND SPATIAL DEVELOPMENT:
A CASE STUDY FOR THE NETHERLANDS *

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Abstract

Operational Models on Industrial Innovation and Spatial Development:
A Case Study for the Netherlands.

The central theme of this paper concerns the spatial dichotomy between innovative firms in the manufacturing sector. In this respect we will concentrate on the question whether and to which degree relatively innovative (especially small) industrial firms are spatially concentrated, and more in particular whether they are located in areas with a favourable selection environment. This issue is treated here from the viewpoint of the validity of the so-called urban symbiosis hypothesis and its complementary selective centrifugality hypothesis.

For this purpose we constructed three latent variables, viz. the concepts 'selection environment', 'innovation potential' and 'innovativeness' whose interrelationships will be estimated - on the basis of multiple indicators - by means of the Partial Least Squares method.

The first concept is related to the locational profile of the region in which the firm is located, while the latter two concepts refer to the intra-firm characteristics (number of R&D employees, number of innovations and so on), and more precisely to innovation input and innovation output indicators respectively. In analysing the relations between these three concepts our main research finding is that a great many (urban) regions in the central parts of the Netherlands (the so-called Rimcity or Randstad) appear to be in a rather unfavourable position regarding innovative capacity of small industrial firms, even for firms which on average are assumed to have favourable technological prospects. The results cast some doubt on the validity of the urban symbiosis hypothesis, whereas the selective centrifugality hypothesis appears to be more valid in the Dutch context.
1. Introduction

The revival of Schumpeterian views on current economic restructuring phenomena has increasingly induced a scientific interest in innovations (see Kleinknecht, 1986 and Vasko, 1987). Both the behavioural stimuli and the selection environment for the creation and adoption of technological and organizational change in firms have become a subject of intensive research. In this context a rich field of economic research has in recent years been developed, for instance, long wave tests, analysis of incubation hypotheses, impact studies on small and medium sized enterprises, neo-fordist approaches, labour market consequences, and the growth potential of high technology industries (see among others Clark et al., 1986, Freeman et al., 1982, Giaoutzi et al., 1988, Marshall, 1987, Nijkamp, 1986, Scott and Storper, 1986, and Thwaites and Oakley, 1985). It turns out that a great many studies have been devoted to the seedbed conditions of new technologies, especially in the context of small and medium size firms. Two particular lines of inquiry have called for much attention in the recent past, viz. the urban incubator hypothesis and the product life-cycle model.

In some recent studies (see Davelaar and Nijkamp, 1987a, 1988), the above mentioned two explanatory paradigms have been integrated in one coherent framework, the so-called innovation incubation hypothesis. Three key concepts were introduced here, viz. innovation potential (the capacity of industrial firms to generate and adopt innovations), innovativeness (the realized performance of industrial firms in terms of technology generation, diffusion or adoption) and selection environment (i.e., a set of indicators reflecting the regional production environment). The above mentioned innovation incubation hypothesis has been tested for an extensive Dutch case study on innovative behaviour of firms by means of log-linear and latent variable models.

One of the main empirical findings from the latter case studies regarding the impact of a firm’s favourable locational profile, (i.e. its production environment or selection environment), on the regional innovation potential vis-a-vis that on the regional innovativeness pointed to the strong dominance of the first type of effect. In the present paper an operational
causal framework for the innovative behaviour of small and medium size firms will be developed and tested, given the above mentioned results. This framework will mainly be based on the urban symbiosis hypothesis, which takes for granted that new technologies emerge from a favourable incubation environment regarding firms located in the urban or metropolitan milieu—especially during the initial phases of growth—because of the specific agglomeration economies in large cities (cf. Lambooy, 1973, and Malecki and Mijkamp, 1988).

The urban symbiosis hypothesis takes for granted centripetal forces and differs from a related hypothesis, viz. the selective centrifugality hypothesis, which takes for granted that the actual pervasiveness of technological innovations from central areas across different sectors and regions in a nation is non-uniform; in particular, it is assumed that small industrial firms having a relatively high innovation potential exhibit pronounced spatial spread patterns due to their specific selection environment, especially if a distinction is made between 'old-line' and 'new line' industries (cf. Keeble and Wever, 1986, Rothwell and Zegveld, 1982, and Storey et al., 1987). Clearly, by testing the urban symbiosis hypothesis, we also test indirectly the selection centrifugality hypothesis. In the paper we will pay attention to both hypotheses.

Thus in the present paper we will mainly concentrate on the causality relationship between the regional selection environment of small and medium size firms and the innovation potential of these firms. In this context, a set of measurable indicators for the explanatory latent variable 'selection environment' will be used in order to test whether or not regions (or urban areas) offering a favourable production environment possess the most innovative parts of the industrial firms considered in our analysis.

A judgement of the validity of the two hypotheses which are relevant in this context—viz. the urban symbiosis and the selective centrifugality hypothesis—requires an assessment of the indigenous potential of the areas under consideration. For this purpose, an outline of the research methodology based on a Partial Least Squares (PLS) approach will be given (section 2). Then in sections 3, 4 and 5 our estimation results concerning the
spatial pattern of selected classes of Dutch innovative firms - based on the above mentioned explanatory model - will be presented, while section 6 will provide some retrospective interpretative remarks.

2. The Explanatory Multivariate Model

One of the basic and well-known shortcomings in innovation research is the lack of a proper definition and measurement of innovations. Since there are various input and output indicators for innovation, it is more appropriate to regard innovation as a latent variable which can be approximated by a set of observable indicators. Such a multivariate approach brings us into the realm of latent variables models. In the framework of our analysis we are looking for an explanatory model in order to test the above mentioned hypotheses, and therefore we have used a rather powerful and appropriate path model, the Partial Least Squares (PLS) model (see Wold, 1982, 1985a).

The PLS model is a path model in which latent variables are estimated using a least squares oriented approach. In this model no distributional characteristics of variables have to be specified: "... in PLS modelling both estimation and evaluation (by means of the Stone Geisser test and the assessment of standard errors by means of Tukey's jackknife, EJD & PN) are distribution - and independence - free" (Wold, 1985a, p. 588).

The PLS method also calculates explicit case values for the latent variables under consideration. Case values are defined here as weighted aggregates of the constituent indicators of a latent variable. In general, the PLS estimates of the parameters tend to be more accurate than those for the case values (see Hui and Wold, 1982).

In the context of a multivariate causality analysis sometimes also a related path model, viz. LISREL, is being used. This model can be shown to have only small differences in parameter estimates in comparison to PLS, provided both methods (i.e., PLS and LISREL) have small residuals (Wold, 1985b, p. 241). The LISREL method is a maximum likelihood method in which the observable variables are assumed to have a multivariate distribution subject to independent observation (cf. also Folmer and Nijkamp, 1987).
The latter assumption is, however, somewhat questionable in the context of our analysis, since - in addition to the stringent distributional requirements - our investigation aims at providing a compound exploratory framework with many potentially meaningful indicators which are not by definition independent. Furthermore, in case of many observables the technical difficulty of LISREL increases rapidly with the size of the model, while also the specification of such a model can be seriously hampered by identification problems (cf. Apel, 1980). And finally, LISREL does not generate explicit case values of the latent variables. Consequently, in the context of our regional innovation analysis we have decided to use PLS.

PLS models are usually based on a conceptual arrow scheme depicting the relationships between latent variables (LV's) and their observable indicators or manifest variables (MV's). Then a PLS estimation procedure aims at estimating the various parameter values between LV's mutually and between LV's and MV's. Usually a three-stage procedure is used (see for technical details Wold, 1982):

- An iterative stage during which the case values of all LV's are estimated as a weighted average of their MV's (with the weights as auxiliary parameters).
- An intermediate stage during which the estimated case values form the input for an OLS regression procedure in order to estimate the parameter values for the relationship between the (estimated) LV's mutually and between the LV's and MV's.
- A final stage during which the location parameters are derived, taking into account the scale of the parameters (see Lohmoeller, 1984).

The PLS estimation procedure is usually followed by goodness-of-fit tests on the basis of blindfolding relevance measures (e.g., the Stone Geisser test and Tukey's jackknife approach).

In the framework of our analysis 3 LV's will be distinguished, viz. innovation potential, innovativeness and regional selection environment. The related conceptual PLS model - in an arrow scheme - is presented in Fig. 1, which also includes the set of relevant MV's. As a former analysis demonstrated (Davelaar and
Fig. 1. A PLS framework for SMS firms in a spatial context

Legend:

R : number of internal R&D employees of a firm
EXTRD: number of external R&D persons outside of a firm
RDO : dummy variable for growth of R&D expenditures in past 3 years
IN : dummy variable for expected growth of R&D in next 2 years
w : total number of persons employed in firm
EXPORT: dummy variable for firm's export orientation (export share higher than 25%)
OMZ1 : dummy variable for growth in sales (growth rate higher than 10%)
OMZ2: dummy variable for growth in export sales (growth rate higher than 10%)

I1 : number of product innovations new to the firm
I2 : number of process innovations new to the firm
I3 : number of combined product and process innovations new to the firm
R11 : number of firm's product innovations new to the industry
R12 : number of firm's process innovations new to the industry
R13 : number of firm's combined innovations new to the industry

V11 : average preparation time of product innovation
V12 : average preparation time of process innovation
V13 : average preparation time of combined innovations

BEVDCO: population density
NEIOPCO: average skill level of workforce
NEIZICO: distance to International Economic Gravity Centre
NEIDUM1: dummy variable for availability of knowledge centres
NEIDUM2: dummy variable for availability of communication infrastructure
NEIDUM3: dummy variable for access via waterways
NEIDUM4: dummy variable for availability of building sites
NEIDUM5: dummy variable for size of agglomeration economies
NEIDUM6: dummy variable for quality of environment indicator
DUM2: dummy variable for a firm's location in suburban area
NEIDUM7: dummy variable for availability of building sites
NEIDUM8: dummy variable for availability of policy/institutional framework
DUM3: dummy variable for a firm's location in urban area
Nijkamp 1987a) the parameter \( c \) appeared to be close to zero, while parameter \( a \) turned out to be positive. In this paper we focus our attention in particular on the link between the regional selection environment and the innovation potential of small and medium size (SMS) firms (i.e., firms with less than 100 employees).

The case study is based on an industrial survey among 1842 industrial firms (at the establishment level) in the Netherlands, in which a wide variety of questions regarding motives and consequences of innovative behaviour was raised (the response rate was approx. 60 percent) (see for details Kleinknecht, 1987). In this survey the standard OECD definitions (according to the Frascati manual) was used. From the responses we have only used the data on SMS firms (with less than 100 employees, i.e. about 1100 firms in the inquiry). The spatial scale of the country is based on a standard statistical demarcation of 40 nodal regions in the Netherlands. This geographical subdivision in our analysis is judged to be refined enough to deal with the spatial pervasiveness of technological innovation in the Netherlands. In addition, this subdivision is the only meaningful regional scale at which regularly geographical socio-economic data are provided by the national Central Bureau of Statistics.

Before presenting the results of the structural PLS model, we draw attention to the following points.

For each region we will estimate the case values of the latent variables (as depicted in figure 1) in which the LV's innovation potential and innovativeness are firm-specific while the LV regional selection environment is region-specific. We will make a distinction here between urban (DUM1), suburban (DUM2) and rural areas within each region. Thus we focus attention on intraregional differences in these case values (depending on whether a firm is located—according to its locational code—in urban, suburban or rural areas). The indicators DUM1 and DUM2 refer to all regions, so that the difference between urban and non-urban areas is the same everywhere. Consequently, the case value of the LV 'regional selection environment' is in all areas influenced to the same extent by a firm location in an urban area vis-à-vis a non-urban area.
As mentioned before, only SMS firms will be considered. We will make the following subdivision of SMS firms:

- **small new line industries** (e.g., chemics, metal, electronics instruments, etc.);
- **technologically promising small new line industries** (e.g., electronics, aircraft etc., based on a 4-digit SIC-typology developed by the Netherlands Economic Institute 1984);
- **small old line industries** (textile, wood processing and so on).

The estimated case value of all LV’s will be scaled toward a unit variance and a zero mean (this is to be taken into account while interpreting the results).

The results for these three classes of firms will be presented in a compact manner in order to avoid an excessive presentation of numerical results. Therefore, only the results of the ‘extreme’ (i.e.: positive and negative) areas will be given. A result is regarded as ‘extreme’ if the case value of the LV ‘regional selection environment’ exceeds 1 (in absolute value). Furthermore, we will also present all results of the two economic heartlands of the Netherlands, viz. the greater Amsterdam area and the greater Rotterdam area, even when their pertaining absolute case values are smaller than 1. In some cases, partial results of some other interesting regions will be given as well.

The results of the estimated case values of the LV ‘regional selection environment’ will be complemented with results indicating the number of firms scoring negative or positive on the (firm-specific) case value of the LV ‘innovation potential’ and the aggregate score of these firms on innovation potential within each selected region.

In the next section the results for small new line industries will be presented. Next, sections 4 and 5 will be devoted to a discussion of results for promising new line SMS firms and old line SMS firms, respectively.
3. **Regional Innovation Potential of 'Small New Line Industries'**

In this section the estimated outcomes of our PLS model with respect to 'small new line industries' will be presented. In Table 1 the results of the selected 'positive' regions (i.e. regions with a case value of the LV 'regional selection environment' higher than 1) are summarized, while Table 2 contains the outcomes for the 'negative' regions. It is worth mentioning that the estimated parameter value between the LV's 'regional selection environment' and 'innovation potential' (i.e. coefficient b in Figure 1) in Table 1 appeared to be negative, viz. -0.13, which is not in agreement with the urban symbiosis hypothesis. Regions expected (on the basis of their locational characteristics) to offer the most favourable environmental conditions do apparently not possess firms with a relatively high (intra-firm) innovation potential. Thus regions with negative scores on the LV 'regional selection environment' will (in general) lodge the more innovative firms. It is noteworthy that this negative relation between regional selection environment and innovation potential applies even to all types of firms distinguished in this paper.

In order to avoid confusion, we 'adjusted' both the signs of the parameter b and the case values with respect to the regional selection environment. In our original estimation, regions with negative scores on 'regional selection environment' are (because of a negative parameter b) expected to lodge the more potential firms. So, for example, in our 'original' model a region with a negative score of -1 on the LV 'regional selection environment' is expected to have a positive (-0.13 * -1 = 0.13) impact on the average (intra-firm) LV innovation potential. This minus-minus relation would be rather confusing. So in order to avoid this, in the following both the signs of the estimates of parameter b and the region-specific LV 'regional selection environment' will be adjusted (so in our example we would have: 0.13 * 1 = 0.13). Consequently, in this 'adjusted' form a higher (positive) score on the LV 'regional selection environment' means that firms located in these environments are expected (on the basis of the adjustment of the estimated PLS model) to possess a higher innovation potential.

For illustration purposes, also the aggregate scores of all
Table 1. Selected 'positive' regions with respect to 'new line' SMS firms.

<table>
<thead>
<tr>
<th>Region</th>
<th>DUM 1</th>
<th>DUM 2</th>
<th>Regional Selection Environment</th>
<th>Positive Innovation Potential</th>
<th>Negative Innovation Potential</th>
<th>Aggregate Score Innovation Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zuidwest Overijssel</td>
<td>5</td>
<td></td>
<td>1.1</td>
<td>4</td>
<td>5</td>
<td>1.7</td>
</tr>
<tr>
<td>Leiden + Bollenstreek</td>
<td>4</td>
<td></td>
<td>1</td>
<td>8</td>
<td>7</td>
<td>5.7</td>
</tr>
<tr>
<td>Midden-Brabant</td>
<td>6</td>
<td></td>
<td>3.2</td>
<td>17</td>
<td>4</td>
<td>9.9</td>
</tr>
<tr>
<td>Den Bosch</td>
<td>7</td>
<td></td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>5.4</td>
</tr>
<tr>
<td>Den Bosch (REM)</td>
<td></td>
<td></td>
<td>1.3</td>
<td>8</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Noord-Limburg</td>
<td>6</td>
<td></td>
<td>1</td>
<td>16</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Midden-Limburg</td>
<td></td>
<td></td>
<td>1.2</td>
<td>11</td>
<td>7</td>
<td>4.7</td>
</tr>
<tr>
<td>Zijp</td>
<td></td>
<td></td>
<td>1.4</td>
<td>2</td>
<td>2</td>
<td>1.2</td>
</tr>
<tr>
<td>Delft + Westland</td>
<td>5</td>
<td></td>
<td>0.4</td>
<td>9</td>
<td>5</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Table 2. Selected 'negative' regions with respect to 'new line' SMS firms.

<table>
<thead>
<tr>
<th>Region</th>
<th>DUM 1</th>
<th>DUM 2</th>
<th>Regional Selection Environment</th>
<th>Positive Innovation Potential</th>
<th>Negative Innovation Potential</th>
<th>Aggregate Score Innovation Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oost-Groningen</td>
<td></td>
<td></td>
<td>-1</td>
<td>3</td>
<td>5</td>
<td>-1.6</td>
</tr>
<tr>
<td>Delfzijl</td>
<td></td>
<td></td>
<td>-1.4</td>
<td>2</td>
<td>2</td>
<td>0.7</td>
</tr>
<tr>
<td>Groot Amsterdum</td>
<td>23</td>
<td></td>
<td>-1.6</td>
<td>5</td>
<td>13</td>
<td>-7.4</td>
</tr>
<tr>
<td>Amsterdam (REM)</td>
<td>6</td>
<td></td>
<td>-2</td>
<td>6</td>
<td>10</td>
<td>-5.5</td>
</tr>
<tr>
<td>Rijnmond (Rotterdam)</td>
<td>32</td>
<td>11</td>
<td>-1</td>
<td>15</td>
<td>29</td>
<td>-9.8</td>
</tr>
<tr>
<td>Rijnmond (REM)</td>
<td>9</td>
<td></td>
<td>-1</td>
<td>4</td>
<td>9</td>
<td>-2.3</td>
</tr>
<tr>
<td>Gooi + Vechtstreek</td>
<td>1</td>
<td></td>
<td>-1</td>
<td>3</td>
<td>4</td>
<td>-1.1</td>
</tr>
<tr>
<td>Veluwe</td>
<td></td>
<td></td>
<td>-0.8</td>
<td>10</td>
<td>18</td>
<td>-5.1</td>
</tr>
<tr>
<td>Oost 2-Holland</td>
<td></td>
<td>6</td>
<td>-0.7</td>
<td>6</td>
<td>14</td>
<td>-5.2</td>
</tr>
</tbody>
</table>

Table 1. Selected 'positive' regions with respect to 'new line' SMS firms.

Legend

(1): number of firms in a region which are located in large urban (DUM 1) areas.
(2): number of firms in a region which are located in suburban (DUM 2) areas.
(3): estimated case value with respect to LV 'regional selection environment' (one value for each region).
(4): number of firms (within each region) having a positive case value with respect to the LV 'innovation potential'.
(5): the same, having a negative case value.
(6): aggregate score of the firm's case values with respect to innovation potential.

REM = municipalities that belong, in a socio-economic sense, to a large city.
firms in a region with respect to the case values for 'innovation potential' have been presented (in the last column of Table 1 and 2). Now we will briefly discuss some interesting results.

The region Delft + Westland has been included in Table 1 because of its high favourable score of its firms in the inquiry on the LV 'innovation potential'. It is noteworthy that this region was originally not selected because of its rather low (absolute) case value for the regional selection environment.

The regions Veluwe and Oost Z-Holland have been included in Table 2 because of their strongly negative aggregate score of the firms in the inquiry on innovation potential (although they also appear to be almost selected by the (absolute) case value criterion of 1 for the LV regional selection environment).

Columns 1 and 2 in Tables 1 and 2 indicate the number of firms in the inquiry which are located in DUM1 and DUM2 cities, while at the bottom of these columns the improvement in the 'adjusted' case values for the LV regional selection environment has been mentioned, when firms are located in DUM1 or DUM2 areas (thus leading to intra-regional discrepancies).

It can now easily be seen from Table 1 that the 'positive' regions (i.e., those which in the adjusted form have positive case values on the LV 'regional selection environment') indeed possess the more innovative firms (i.e., on the basis of the firm's case values with respect to innovation potential) in the small new line industries. More than one half (56%) of the firms in our survey are at the positive side of the case value with respect to innovation potential, while the aggregate score of 44.9 (i.e., the summation of the individual firm's scores on innovation potential appears to be clearly positive). As to the 'negative' regions, the reverse conclusion can be drawn, viz. on average only one out of three firms has a positive innovation potential, while the aggregate scores are clearly negative (-37.3).

Concerning the 'positive' regions, one of the most interesting results of the analysis is the 'good' performance of the firms located in the Southern parts of the Netherlands: the regions 330, 351, 352, 370 and 380 are all located in the Southern part of the country! All regions in the Southern provinces of Noord-Brabant and Limburg appear to have positive case values with
respect to the LV regional selection environment. In the central (Western) part of the Netherlands only two positive regions (250 and 270) can be identified, while none of the regions in the three Northern provinces can be placed in the 'positive' group. The central areas of the Netherlands belong apparently mainly to the group of the 'negative' regions. In this context, the performance of the two large metropolitan areas Amsterdam and Rijnmond (the greater Rotterdam area) appears to be very poor indeed (a result also found in Davelaar and Nijkamp, 1987a).

It is interesting to observe that the DUM1 variable increased in (positive) importance when the three largest metropolitan areas were eliminated. Especially firms located in the region Amsterdam (231) performed relatively poor (less than one out of four firms had a positive score on the innovation potential variable), although the performance of the Rijnmond region is not favourable either. The inclusion of the two peripheral regions Oost Groningen and Delfzijl within this negative set is less astonishing. Although the regions Veluwe and Oost Z-Holland just fell outside the case value criterion, the actual performance of their firms (with respect to the intra-firm LV innovation potential) appeared to be rather poor.

As a general conclusion, we find that especially the Southern parts of the Netherlands appear to be well equipped in terms of the indigenous potential of new line SMS industries, while the Western (central) parts of the Netherlands (and especially the two large metropolitan areas Amsterdam and Rotterdam) appear to be far less well endowed. Thus the urban symbiosis hypothesis turns out to be less relevant for new line SMS firms in the Netherlands. It also turns out that the selective centrifugality hypothesis is more relevant in the Dutch context, as the usual distance decay pattern of innovations from a central area onward does apparently not hold for small new line SMS firms. Whether these results are robust with respect to those small (industrial) firms which are expected to have favourable technological prospects and which may be considered to be of utmost importance for the future innovation potential of regions, will be tested in the next section.
4. **Regional Innovation Potential of 'Small New Line Industries with Favourable Technological Prospects'**

A special subset of the 'small new line industries' has been constructed by the Netherlands Economic Institute (1984) on the basis of detailed (4-Digit) SIC-codes for firms which were expected to be technologically promising. Also with respect to these firms, the same research strategy as employed in the foregoing section was applied.

Tables 3 and 4 contain again the 'positive' and the 'negative' regions, respectively. It is possible that, due to the relatively low number of observations, the aggregate scores on the innovation potential variable in some regions are biased (i.e., generating a positive score where we would expect a negative score on the basis of the case value with respect to the LV 'regional selection environment' and vice versa).

It is worth mentioning that the 'adjusted' (i.e., after a change of the signs of both the parameter b and the LV 'regional selection environment') estimated inner coefficient between the LV's 'innovation potential' and 'regional selection environment' appeared to be equal to .29. The improvement of the LV 'regional selection environment' caused by DUM1 (i.e. in case a firm is located in a city larger than 50,000 inhabitants) in Table 3 points to the existence of large intra-regional differences between urban and non-urban areas. The general trend identified in the foregoing section with respect to new line SMS firms is not contradicted by the results in Tables 3 and 4. Although the region Utrecht just falls outside the case value criterion, we included this region because it may be interesting to note the favourable position of this relatively metropolitan-oriented region vis-à-vis the other three metropolitan areas (The Hague, Rijnmond and Amsterdam) (although one should be aware of the fact that the region Utrecht is larger in size than the city of Utrecht itself).

Although the regions Veluwe and IJmond do not meet the absolute case value criterion of 1, they are included because their actual firms' score on the LV innovation potential is quite negative.

Also in line with the results of the foregoing section is the
Table 3. Selected 'positive' regions with respect to technologically promising 'new line' SMS firms.

<table>
<thead>
<tr>
<th>Region</th>
<th>Case Value</th>
<th>Positive Score</th>
<th>Negative Score</th>
<th>Aggregate Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twente</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>-2.0</td>
</tr>
<tr>
<td>Haarlem</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>-1.0</td>
</tr>
<tr>
<td>Greater Amsterdam</td>
<td>11</td>
<td>-2.2</td>
<td>2</td>
<td>-4.8</td>
</tr>
<tr>
<td>Amsterdam (REM)</td>
<td>5</td>
<td>-1.2</td>
<td>0</td>
<td>-2.2</td>
</tr>
<tr>
<td>The Hague</td>
<td>2</td>
<td>-2.1</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Zijp</td>
<td>-</td>
<td>0.5</td>
<td>2</td>
<td>-5</td>
</tr>
<tr>
<td>Veluwe</td>
<td>1</td>
<td>0.6</td>
<td>2</td>
<td>-2.1</td>
</tr>
<tr>
<td>Diamond</td>
<td>2</td>
<td>-0.8</td>
<td>-</td>
<td>-1.3</td>
</tr>
<tr>
<td>Rijnmond</td>
<td>15</td>
<td>-0.3</td>
<td>0</td>
<td>-0.3</td>
</tr>
<tr>
<td>Rijnmond (REM)</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>-2.1</td>
</tr>
</tbody>
</table>

Table 4. Selected 'negative' regions with respect to technologically promising 'new line' SMS firms.

<table>
<thead>
<tr>
<th>Region</th>
<th>Case Value</th>
<th>Positive Score</th>
<th>Negative Score</th>
<th>Aggregate Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twente</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Haarlem</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>Greater Amsterdam</td>
<td>-</td>
<td>2.3</td>
<td>3</td>
<td>4.4</td>
</tr>
<tr>
<td>Amsterdam (REM)</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>The Hague</td>
<td>2</td>
<td>6</td>
<td>6</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Improvement with respect to regional selection environment: 0.8, -0.2.
favourable position of the Southern part of the Netherlands reflected in the regions 330, 370 and 380. Thus with respect to those small industrial firms which are expected to offer favourable growth impulses in the future (because of technological possibilities), the Southern part of the Netherlands seems to be in a rather favourable position. This confirms once more the relevance of the selective centrifugality hypothesis.

The regions Veluwe, IJmond and Twente appear to be far less well endowed with firms of this promising type that have a strong potential to innovate. In Twente only one of the nine firms in the survey appears to have a positive case value with respect to the LV 'innovation potential', while for the region Veluwe this applies to two out of nine firms (besides, the aggregate score on this latent variable is more strongly negative than in Twente).

As to the three metropolitan regions Amsterdam (231) (and also the immediate surroundings of the agglomeration Amsterdam as reflected in the rather poor performance of region 232 consisting of municipalities that belong, in a socio-economic sense, to the Amsterdam region), Rijnmond (291) and The Hague (260), the indigenous potential appears to be rather poor. Thus also in this respect the general results of the foregoing section appear to be robust. The case values with respect to the regional selection environment are here definitely negative in the regions 231, 232 and 260, while the 'actual' results with respect to the individual firms' scores on the innovation potential appear to be in agreement with this observation. In Rijnmond (291) the actual situation with respect to the firms' case values of innovation potential seems to be (even) more devastating than could be expected on the grounds of its regional characteristics (reflected in a case value for the selection environment of 0.3). Although the region The Hague was not included in the negative set of 'small new line industries' in general (see the foregoing section), with respect to the 'technology subset' this region is also belonging to the lagging subset of regions.

In conclusion, we may state that also with respect to those small firms which are expected to offer important growth impulses
in the future, our results suggest that for the relatively innovative firms the Southern part of the Netherlands scores reasonably well compared to the remaining part of the Netherlands.

The three metropolitan areas on the other hand appear to belong quite clearly to the lagging category. These results are in line with the general trends identified in the foregoing section with respect to small 'new line industries' in general. Thus the urban symbiosis hypothesis does not appear to be extremely relevant in the Dutch context.

It is now time to concentrate on another group of small firms which are to a certain extent associated with preceding 'technological waves' ('small old line industries'), and to disentangle the regional pattern concerning the innovative components of these firms.

5. Regional Innovation Potential of 'Small Old Line Industries'

As stated before, we would expect that 'old line' SMS firms exhibit more the impacts of former 'technological waves' than the firms discussed in the two foregoing sections. As a matter of fact the locational behaviour of innovative 'old line' firms may be different from the (innovative) firms discussed before, for example, because of differences between regions as to their 'linkage' to different 'technology waves'. The analysis of this research issue will be the subject of the present section.

For this aim we have constructed Table 5, which comprises those regions which are expected (on the basis of their case values concerning the LV 'selection environment') to accommodate relatively innovative 'old line' SMS firms, while Table 6 provides those regions that appear to be poorly endowed.

It should be noted that the 'adjusted' (after changing signs, like before) estimated inner relationship between innovation potential and selection environment in Table 5 appeared to be equal to 0.25.

Tables 5 and 6 also show that with respect to the 'positive'
<table>
<thead>
<tr>
<th>Region</th>
<th>DUM 1</th>
<th>DUM 2</th>
<th>Positive Score</th>
<th>Negative Score</th>
<th>Aggregate Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Oost-Groningen</td>
<td>-</td>
<td>-</td>
<td>0.6</td>
<td>0.3</td>
<td>8.8</td>
</tr>
<tr>
<td>40. Noord-Friesland</td>
<td>1</td>
<td>-</td>
<td>0.5</td>
<td>0.4</td>
<td>1</td>
</tr>
<tr>
<td>50. Zuidwest-Friesland</td>
<td>-</td>
<td>-</td>
<td>0.3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>60. Zuidoost-Friesland</td>
<td>-</td>
<td>-</td>
<td>0.0</td>
<td>3</td>
<td>-3</td>
</tr>
<tr>
<td>90. Zuidoost-Drente</td>
<td>-</td>
<td>-</td>
<td>0.2</td>
<td>1</td>
<td>-0.3</td>
</tr>
<tr>
<td>90. Zuidoost-Drente</td>
<td>-</td>
<td>-</td>
<td>2.3</td>
<td>3</td>
<td>-0.3</td>
</tr>
<tr>
<td>120. Twente</td>
<td>11</td>
<td>-</td>
<td>1</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>160. Zuidwest-Drentland</td>
<td>-</td>
<td>-</td>
<td>1.5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>220. Zaanstreek</td>
<td>15</td>
<td>1</td>
<td>1.2</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>281. Rijnmond</td>
<td>14</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>370. Noord-Liitburg</td>
<td>5</td>
<td>-</td>
<td>1.1</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>330. West N-Broabant</td>
<td>-</td>
<td>-</td>
<td>0.3</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>292. Rijnmond (REM)</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Improvement with respect to regional selection environment = vironment = -0.4

Table 5. Regions 'well endowed' with innovation potential for 'old line' SMS firms.
set of regions some of them, which are expected to be in a favourable position concerning the 'innovation potential' (on the basis of their regional characteristics reflected in the estimated case value of the LV 'regional selection environment'), do not 'behave' accordingly. More in particular, this applies to the regions 60 and 160 (Zuidoost-Friesland and Zuidwest-Gelderland respectively). Whether this is a coincidence (because of the low number of observations in those regions) or whether these regions indeed deviate from the 'average' pattern, cannot be detected from the present analysis. Consequently, one has to be careful in drawing conclusions in this respect.

In fact, some of the Northern parts of the Netherlands have rather high positive case values with respect to the LV 'regional selection environment'. As stated above, because of the rather low number of observations in some of the Northern regions, it is difficult to determine whether this 'regional potential' (i.e., the characteristics of the regional environment) is also reflected in the case values with respect to the intra-firm LV 'innovation potential'. In any case, 'old line' SMS firms in the Northern part of the Netherlands do not seem to be in a disadvantaged position concerning their intra-firm innovation potential. For the sake of illustration we have calculated the aggregate score (case values) on innovation potential of all (39) Northern old line SMS firms in the survey. This aggregate score appeared to be indeed close to zero (1.2), i.e. an average score with respect to the whole of the Netherlands (as all LV's have been scaled to zero mean and unit variance).

One of the most remarkable results of Table 5 is the inclusion of the regions Rijnmond (291) and Twente (120) in the positive set of regions, whereas in the foregoing section (5) these regions belonged to the negative set of regions. Quite clearly the (regional) innovation potential of these regions appears to be more closely linked (biased) to former 'technology waves'. Their indigenous innovation potential with respect to the 'small new line industries' - and (especially) those innovative components of these firms expected to offer favourable technological perspectives in the future - is rather poor, while with respect to the indigenous (innovation) potential of 'small old line industries' they appear to score reasonably well.
As to the Southern part of the Netherlands, the general trends with respect to 'old line' SMS firms do not differ very much from the pattern identified in the foregoing sections. Also with respect to the regional innovation potential of 'small old line industries', some Southern regions (notably regions 330 and 370) appear to be in a favourable position. In this respect it should also be noted that, although they are not included in Table 5, also the regions Midden- and Zuid-Limburg appeared to have positive case values with respect to the regional selection environment (0.5) and the (aggregate score of) of their firms on the LV 'innovation potential' (2.5).

On the other hand the case value of the IJmond region with respect to the LV 'regional selection environment' is strongly negative. Although only two 'old line' SMS firms in the survey are located here, the performance with respect to the innovation potential of these firms does not contradict this negative case value for the LV 'selection environment'.

One of the most interesting results from our analysis is the very poor performance of the Amsterdam region (regions 231 and 232). Only 1 out of 21 firms in this region appears to have a positive case value with respect to the firm specific LV 'innovation potential'. So, in contrast to the Rijnmond regions, this region also performs rather poor with respect to the innovation potential of firms linked to former technologies. Consequently, the conclusion seems warranted that the Amsterdam region appears to possess the weakest components (in the sense of their potential to innovate) of small industrial firms in general.

It is also noteworthy in this context that the region Arnhem-Nijmegen has a very poor performance (perhaps even more than might expected given their negative score on the region specific LV 'selection environment'). Only 2 out of 18 'old-line' SMS firms in the survey located in this region are on the positive side of the firms' case values for the LV 'innovation potential'. Like before, the regions in the central (Western) part of the country appear to be overrepresented in the negative set of regions (200, 231, 232, 250, 210). As a whole, only 6 out of 37 firms in these central 'negative' regions have a positive score.
on the innovation potential variable. Thus in conclusion the urban symbiosis hypothesis is not supported by the above mentioned results. A selective centrifugal process toward Southern regions has taken place.

6. Conclusions

In this paper we have made an attempt at gauging the importance of the regional selection environment for the innovation potential of SMS firms. For this purpose, we have formulated the urban symbiosis hypothesis. In this framework we have studied in detail the individual position of Dutch regions as to their indigenous innovation potential with regard to three types of small industrial firms. For these purposes we incorporated a set of measurable regional indicators in one LV 'regional selection environment', and determined the case values of these regions for this variable (all latent variables are scaled to a unit variance and a zero mean). In this way the regional production environment of a region is reflected in one score on a latent variable. As the adjusted estimated coefficient between the LV's 'selection environment' and 'innovation potential' is positive (for all types of firms studied in this paper), regions having a positive case value for their selection environment are expected to accommodate the more potential firms (with regard to their capacity to innovate). On the other hand, regions scoring negatively on this case value are expected (on the basis of the estimated PLS model) to be poorly (in a relative sense) endowed with firms having a relatively high innovation potential. Consequently, we have selected those regions which had absolute case values larger than one on the LV 'regional selection environment' and we complemented these results with those regions which were not initially selected by the case value criterion, but appeared to 'behave' quite exceptional concerning the actual scores of their firms on the firm-specific LV 'innovation potential'. In fact, there appeared to be a quite strong variation in outcomes.

In particular the regional dispersion of the 'positive' and 'negative' set of regions was surprising. The results are visualized in table 7 in which our specific and detailed outcomes
have been presented succinctly and which can be considered as a synthesis of our preceding analysis. To this purpose we 'amalgamated' the various regions studied in the foregoing sections into three, well-known, aggregates, viz. central, intermediate and peripheral areas. In this respect the central zone largely consists of the regions in the Rimcity (in total 13 in our analysis). The intermediate zone can be considered as a 'band' around the Rimcity (consisting of 15 regions in our analysis), while the peripheral zone largely consists of the (rural) regions (15) in the Southern, Eastern, and Northern parts of the Netherlands. In this table we included the absolute number of regions within these three zones, selected in the foregoing sections, which belonged to the (extreme) 'positive' or 'negative' set of regions (on the basis of the 'regional selection environment' criterion, i.e. an absolute case value on this LV exceeding 1).

As can be derived from this table, the central zone possesses only a few regions which, in our analysis, could be designated as a 'positive' region, whilst the number of 'negative' regions clearly exceeds the number of 'positive' regions concerning all three types of firms distinguished. The opposite pattern can be observed in the intermediate and peripheral zone.

So as a general result, we found that the central (Western) regions are overrepresented in the negative set of regions. Now we will briefly return to the specific region scores. In this context, especially the position of the region Amsterdam appeared to be rather unfavourable with respect to all types of firms distinguished in our analysis. Consequently this region seems to be poorly endowed (in a relative sense) with small industrial firms which are capable of generating innovations (which is often considered to be of utmost importance to regional growth perspectives). This conclusion does not necessarily imply, however, a negative growth perspective for the Amsterdam economy, as we have only considered small industrial firms. The 'performance' of this region with respect to large industrial firms and (especially) the service and quaternary sector may be more flourishing (as is indeed indicated by recent research results; see Davilaar and Nijkamp, 1987b). In this respect our results are essentially more indicative of a structural
transformation process in which the Amsterdam region has taken
the lead.

<table>
<thead>
<tr>
<th>type of firm</th>
<th>zone</th>
<th>number of selected 'positive'</th>
<th>number of selected 'negative'</th>
</tr>
</thead>
<tbody>
<tr>
<td>small new</td>
<td>central</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>line firms</td>
<td>intermediate</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>peripheral</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>technological</td>
<td>central</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>ly promising</td>
<td>intermediate</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>small new</td>
<td>peripheral</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>line firms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>small old</td>
<td>central</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>line firms</td>
<td>intermediate</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>peripheral</td>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 7 'Extreme' regions within central, intermediate and peripheral zone

With respect to the 'small new line industries' and the subset of these firms having favourable technological prospects, the Rijnmond and Twente region appear to lag behind. If we consider the innovation potential selected for 'small old line industries', however, these regions perform above average. This could be an indication of the fact that the innovation potential of these regions is more or less linked to former 'technology waves'. Since none of these 'old line industries' are designated as having favourable technological prospects (according to the 4-digit SIC-classification made by the Netherlands Economic Institute), this might endanger the future (industrial) innovation potential of these regions when they do not succeed in restructuring their (industrial) economic base.

Concerning the Northern parts of the Netherlands it is more
difficult to reach a definite conclusion. To a certain degree, this is caused by the rather low density of observations in these regions. With respect to the 'small new line industries', the negative score on the selection environment of Oost-Groningen is indeed confirmed by the aggregate (negative) score on the firm-specific LV 'innovation potential', but this does not hold with respect to Delfzijl (as stated before, this may be due to the low number of observations). Concerning the innovation potential in 'small old line industries', the three Northern provinces as a whole do not appear to be in a lagging position. In fact, the case value for the LV 'regional selection environment' in several Northern regions is not extremely low.

In general, the Southern part of the Netherlands appears to be well endowed with the innovation potential of small industrial firms. The high case values of several Southern regions are indeed confirmed by their aggregate firms scores on the LV 'innovation potential' variable. This holds for all types of small (industrial) firms considered in our analysis, but especially with respect to the more technologically promising types of firms. The fact that none of the regions in the Southern provinces Noord-Brabant and Limburg has a negative score on the region-specific LV 'regional selection environment' (with respect to 'small new line industries') may be illuminating in this respect.

In light of these results, the clear conclusion may be drawn that the central part of the country is by no means more innovative than remaining - and sometimes peripheral - parts (at least as far as the innovative behaviour of small and medium size industrial firms is concerned). This implies that the urban symbiosis hypothesis does not have a high degree of validity in the Dutch context (anymore). Instead, the selective centrifugality hypothesis is at present more relevant, as the spatial distribution of innovation potential firms tends to show a (relatively irregular) spatial spread pattern from the economic centre of the country toward intermediate and border areas.
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