As has been shown in a survey paper in this journal by Koekkoek and Mennes (1984), there is still no clear evidence about the significance of the so-called 'neo-technology' hypothesis of international trade. In particular, the relevance of R&D efforts for foreign trade performance still appears to be obscure. Evidence of a significantly positive relationship between R&D and foreign trade performance has recently been reported in several studies, such as e.g. Wolter (1977), Hirsch and Bijaoui (1985), Hughes (1986) or Tuyt (1987); however, with reference to The Netherlands, Hulsman- Vejsová and Koekkoek (1980) found no evidence of a positive relationship between R&D and foreign trade.

One of the major problems in studying the neo-technology hypothesis is the lack of good innovation indicators, and in particular, the fact that data sets are available only at relatively rough levels of sectoral disaggregation. For example, Hulsman-Vejsová and Koekkoek (1980) had to run their cross-sectional regressions on only 17 sectors of Dutch industry, and the sample used by Hirsch and Bijaoui (1985) was restricted to 111 firms in Israel.

In view of today's sparse evidence, further examinations of the neo-technology hypothesis appear to be desirable. In this paper we shall draw upon a large-scale mailing survey among some 3000 Dutch manufacturing firms that was carried out in 1984. The response rate was 63.1% (1842 firms). The sample was drawn in such a manner that we have reason to be confident that the data are fairly representative for Dutch manufacturing industry (for more details, see Kleinknecht 1987). Our data are available at the firm level and therefore allow for an independent examination of the results by Hirsch and Bijaoui (1985). We also can group firms by sectors of main activity which allows us to estimate cross-sectional regressions comparable to those by Hulsman-Vejsová and Koekkoek (1980). Fortunately, we can handle a finer disaggregation by sectors, taking 31 sectors (instead of the 17 sectors in Hulsman-Vejsová and Koekkoek's study). As in the study by Hirsch and Bijaoui (1985) we have used man years of R&D as a percentage of total manpower of a firm or a sector, which is often considered to be less adequate than R&D expenditures as a percentage of sales (see e.g. Hirsch and Bijaoui 1985: 245). In Wolter's study, the former indicator usually yielded less explanatory power than the latter (see 1977: 258-9).

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It should be noted that a comparison of our R&D data with those from the survey by the Dutch Central Statistical Office showed that both surveys are fairly compatible as to R&D in larger firms (> 500 employees); however, our data differ from theirs in that we discover considerable amounts of small-scale and often informal R&D activities in small and medium-sized firms which seem to be insufficiently covered in the official survey (Klein Knecht 1987a).1 Having these peculiarities in mind, we can now proceed to present results.

In our survey, firms reported R&D man-years as well as the percentage shares of exports in their sales. Since both variables relate to the same year, we cannot handle time lags between R&D and exports. Moreover, exports are not given as a continuous variable. So we have to apply cross tabulation and rely on a χ² test (see Table 1). The χ² value calculated from Table 1 is significant at 99% level. We should add that we also checked the data for the influence of firm size on exports. Cross tabulation of classes of firm size and of exports revealed a significantly positive relationship, which is consistent with the findings by Hirsch and Bijaoui (1985: 245). In order to determine whether the positive relationship in Table 1 would still hold when the influence of firm size is eliminated, we repeated a cross tabulation between R&D and export performance for individual size classes, finding that the positive relationship remained when size was held constant. In order to economize on space, we restrict ourselves to documentation of Table 1.

From the above we can conclude that our observations taken from 1842 Dutch manufacturing firms confirm the results by Hirsch and Bijaoui (1985) from 111 firms in Israel. Let us now turn to cross-sectional regressions on R&D and foreign trade performance. Other than Wolter (1977) and Hulsman-Vejsova and Koekkoek (1980), we shall use as a dependent variable total exports, neglecting the distinction of exports by regions. Moreover, we restrict ourselves to the two neo-technology variables handled by Wolter (1977) and Hulsman-Vejsova (1980): R&D and scale economies, leaving aside a

**TABLE 1 - CROSS TABULATION OF R&D INTENSITY AND EXPORT PERFORMANCE IN 1842 DUTCH MANUFACTURING FIRMS**

<table>
<thead>
<tr>
<th>What percentage of your sales is exported?</th>
<th>R&amp;D intensities:</th>
<th>row totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>zero R&amp;D</td>
<td>0 to &lt; 2%</td>
</tr>
<tr>
<td>zero exports</td>
<td>263</td>
<td>78</td>
</tr>
<tr>
<td>less than 10%</td>
<td>172</td>
<td>153</td>
</tr>
<tr>
<td>10% to &lt; 25%</td>
<td>78</td>
<td>113</td>
</tr>
<tr>
<td>25% to &lt; 50%</td>
<td>46</td>
<td>106</td>
</tr>
<tr>
<td>50% and more</td>
<td>69</td>
<td>177</td>
</tr>
<tr>
<td>column totals</td>
<td>628</td>
<td>627</td>
</tr>
</tbody>
</table>

Notes:
* R&D intensity is defined as man years of R&D as a percentage of total manpower of a firm.
* χ² = 408.15 (20 d.f.), significant at 99% level.

1 It seems as if these measurement differences are not of crucial importance to our results. At a much rougher level of aggregation, Tuyt (1977) regressed Dutch export data on R&D figures from the official survey, obtaining results comparable to those presented in equations (5) and (6) below.
number of factor endowment variables, such as physical capital, raw material or human capital intensities.

We use the following indicators of comparative advantage:

\[
CA_1 = \frac{(X_i/X_j)}{(M_i/M_j)} \times 100
\]

\[
CA_2 = \frac{(X_i - M_i)}{P_i} \times 100
\]

with: \(X = \) exports, \(M = \) imports, \(P = \) production; subscript \(i\) stands for the \(i\)-th sector and \(t\) for total manufacturing. Following Hughes (1986) we also define an indicator of trade performance based solely on exports:

\[
EXP = \frac{(X_i/P_t)}{100}
\]

All export, import and production data are taken from CBS (1987, 1988) and relate to the years 1984 and 1985. Our measure of R&D intensity refers to 1983, which allows us to handle a 1 and a 2 year lead of R&D on exports. As in Wolter (1977) and Hulsman-Vejsova and Koekkoek (1980), we use as a scale variable (SC) the percentage of employees in a sector who work in firms with more than 500 employees. R&D intensity is measured as above: R&D man years in 1983 as a percentage of total manpower per sector. The following cross-section regressions have been estimated (\(t\)-values in brackets):

\[
(1) \quad CA_{1(1984)} = 0.981 - 0.103 * RDI + 0.007 * SC; \quad R^2 = 0.02, \quad n = 31
\]

\[
(2) \quad CA_{1(1985)} = 1.050 - 0.120 * RDI + 0.008 * SC; \quad R^2 = 0.03, \quad n = 31
\]

\[
(3) \quad CA_{2(1984)} = -36.599 - 0.835 * RDI + 0.239 * SC; \quad R^2 = 0.00, \quad n = 31
\]

\[
(4) \quad CA_{2(1985)} = -35.221 - 1.042 * RDI + 0.178 * SC; \quad R^2 = 0.00, \quad n = 31
\]

\[
(5) \quad EXP_{1(1984)} = 45.411 + 3.767 * RDI - 0.050 * SC; \quad R^2 = 0.07, \quad n = 31
\]

\[
(6) \quad EXP_{1(1985)} = 46.422 + 3.928 * RDI - 0.056 * SC; \quad R^2 = 0.08, \quad n = 31
\]

In interpreting the above regressions, the following points emerge: First, in all six equations, the scale variable is insignificant. It is doubtful, however, whether this strongly negates the positive influence of scale economies on exports as discovered by Wolter (1977) and Hulsman-Vejsova and Koekkoek (1980). Remember that in our above-mentioned cross tabulation we found that size had a significantly positive influence on exports. It may well be that our measure of scale economies (SC) defined above is just too rough.

Secondly, the R&D variable proves to be insignificant in explaining 'net' export performance (if exports and imports are considered). So far equations (1) through (4) are consistent with the findings of Hulsman-Vejsova and Koekkoek (1980). However, equations (5) and (6) indicate that 'gross' exports as a share of sectoral production seem
to be significantly influenced by R&D intensity. This is consistent with the findings by Hirsch and Bijou (1985) as well as with our above cross tabulation of 1842 firms (Table 1).

There remains the question of how to explain the negative outcomes in equations (1) through (4), which seem to contradict Wolter's (1977) finding of significant parameters from comparable regressions in West German industry. A possible explanation might refer to indications that the Netherlands are technologically lagging behind their most important trading partners such as West Germany or Japan, or, to a lesser extent, the USA. This seems to be illustrated by the R&D figures in Table 2. Moreover, there is evidence reported by Kockkock (1987) of a declining share of the Netherlands in highly R&D intensive (as opposed to medium R&D intensive) high-tech products since 1970 (1987: 161), and of a declining Dutch export specialization coefficient for high-tech products from 1963-1983 (1987: 163).

<table>
<thead>
<tr>
<th>Year</th>
<th>USA</th>
<th>JPN</th>
<th>FRG</th>
<th>GB</th>
<th>NL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>1.79</td>
<td>2.08</td>
<td>2.27</td>
<td>1.55</td>
<td>1.84</td>
</tr>
<tr>
<td>1980</td>
<td>1.89</td>
<td>2.21</td>
<td>2.30</td>
<td>1.55</td>
<td>1.85</td>
</tr>
<tr>
<td>1981</td>
<td>1.88</td>
<td>2.35</td>
<td>2.38</td>
<td>1.71</td>
<td>1.85</td>
</tr>
<tr>
<td>1982</td>
<td>1.96</td>
<td>2.45</td>
<td>2.47</td>
<td>1.68</td>
<td>1.85</td>
</tr>
<tr>
<td>1983</td>
<td>1.97</td>
<td>2.65</td>
<td>2.46</td>
<td>1.58</td>
<td>1.86</td>
</tr>
</tbody>
</table>


The technology gap argument implies that, at least in the countries which are lagging behind, one should use indicators of relative innovativeness when trying to assess the impact of technology on foreign trade performance. Hughes (1986) did so by taking besides British domestic R&D the difference between domestic and foreign R&D intensity. Soete (1981) also obtained an indicator of relative innovativeness when taking the shares of 40 industries from some 20 OECD countries in foreign patenting in the USA. Hughes and Soete both found a significant relationship between their indicators of relative innovativeness and foreign trade performance.

In conclusion, we can say that in Dutch industry there is strong evidence that 'gross' export performance seems to be significantly positively related to R&D. However, Wolter's (1977) finding of a significant influence of R&D on 'net' export performance measures for West Germany (as a technologically advanced country) does not show up either in the work by Hulsman-Bejsova and Koekkoek (1980) or in the present paper (see equations (1) through (4)). This may be explained by the technology gap argument: In Dutch industry, R&D performance seems to serve as an entre to export markets. However, since major foreign competitors spend more on R&D, domestic R&D spending cannot deter substantial import penetration.

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Bart Verspungen
REFERENCES


