International Competitiveness

by

Jan Fagerberg*

Economics Department, Norwegian Institute of International Affairs, POB 8159 DEP, 0033 Oslo l, Norway

Abstract

This paper develops and tests a model of differing trends in international competitiveness and economic growth across countries. The model relates the development of market shares at home and abroad to three sets of factors: the ability to compete in technology, the ability to compete in delivery(capacity) and the ability to compete in price. The test, using data for 15 OECD countries for the period 1961-1983, shows that in the medium and long run, factors related to technology and capacity are very important for market shares and growth, while price- or cost competitiveness plays a more limited role than often assumed. These results are shown to be consistent with earlier findings by Kaldor and others of a "perverse" (positive) relation between export performance and growth in relative prices or costs.

----

* The ideas set forth in this paper owe much to discussions with Adne Cappelen, Bengt Åke Lundvall and Nick von Tunzelman. I am also indebted to Jens C. Andvig, Lennart Erixon, Wynne Godley, Kalle Moene and Anders Skonhoft for comments on various drafts, and to the editors and referees of this Journal for helpful comments and suggestions during the final stage of the work. Financial support from the Norwegian Research council for the Social sciences and the Humanities (NAVF) is gratefully acknowledged. An earlier version of the paper was presented at the second Annual Congress of the European Economic Association in Copenhagen August 22-24,1987.

Note: This is the accepted version of "Fagerberg, J. 1988 International competitiveness, Economic Journal, Vol. 98, No. 391, June 1988, pp. 355-374", which is available in final form at http://www.jstor.org/stable/223337.

Introduction

Measures of the international competitiveness of a country relative to other countries are frequently used, especially in mass media, governmental reports and discussions of economic policy. But, in spite of this, it is rather rare to see the concept of international competitiveness of a country defined. However, few would probably disagree with the view that it refers to the ability of a country to realise central economic policy goals, especially growth in income and employment, without running into balance-of-payments difficulties. Following this, what a theory of international competitiveness must do is to establish the links between the growth and balance-of-payments position of an open economy and factors influencing this process.

Even if there exist many measures of the international competitiveness of a country,[1] by far the most popular and influential is 'growth in relative unit labour costs' *(*RULC).[2] In the small open economies of Western Europe this measure seems to be as important for policy-making as certain monetary aggregates have been in the United States and the United Kingdom in recent years. If unit labour costs grow more than in other countries, it is argued, this will reduce market shares at home and abroad, hamper economic growth and increase unemployment. However, available empirical evidence shows that the fastest growing countries in terms of exports and GDP in the post-war period have at the same time experienced much faster growth in relative unit labour costs than other countries, and vice versa.[3] This fact, sometimes referred to as the 'Kaldor paradox' after Kaldor (1978), indicates that the popular view of growth in unit labour costs determining international competitiveness is at best too simplified. But why?

Section I discusses the main theoretical arguments in favour of a detrimental effect of growth in relative unit labour costs' on market shares and growth. It also considers an alternative, although closely related, approach advocated by Thirlwall (I979), which focuses on differences between countries in 'income elasticities of demand' as a possible source of international growth rate differentials. The common shortcoming of these approaches, we shall argue, is that they fail to take factors other than price competition and demand explicitly into account. Sections II and III of this paper, then, develop a model of international competitiveness which relates growth in market shares to three sets of factors: the ability to compete in technology, the ability to compete in price,

---

[1] These measures range from indicators of economic performance (market shares (Chesnais (1981), profitability (Eliasson, 1972)), single-factor indicators based on price or cost development, to complex composite indexes reflecting economic, structural and institutional factors (EMF, 1984).

[2] Unit labour costs (*ULC)* in manufacturing are wages and social costs for workers at current prices divided by gross product at constant prices. Relative unit labour costs *(RULC)* are *ULC* converted to an international currency and divided by the average *ULC* for the country's trading partners. *RULC* may grow (1) because wages and social costs for workers in national currency are rising faster than in other countries, (2) because the exchange rate is improving relative to other countries, or (3) because productivity growth is lower than in other countries

[3] Several studies, including Fetherston *et al.* (1977), Kaldor (1978) and Kellman (1983) have shown that the effects of growing relative costs or prices on exports or market shares seem to be rather weak and sometimes 'perverse'.

and the ability to compete in delivery (capacity). The remaining part of the paper presents a test of the model on pooled cross-sectional and time-series data from 15 OECD countries between I96I-83. The results indicate that factors related to technology and capacity are indeed very important for medium and long run differences across countries in growth of market shares and GDP, while cost-competitiveness plays a more limited role than commonly assumed. These results are shown to provide a reasonable explanation for the seemingly paradoxical findings by Kaldor and others.

I Traditional Wisdom Questioned

The most popular approach to international competitiveness is that which focuses on the detrimental effects of growth in relative unit labour costs *(RULC)* on market shares and growth. What are the theoretical arguments in favour of this view? First, it may be noted that this approach is incompatible with neoclassical equilibrium theory. In perfect competition, prices and quantities will always adjust, resources (including labour) be fully utilised and balance- of-payments equilibrium ensured. Thus, economists defending the hypothesis of the detrimental effects of growing relative unit labour costs, have always had to assume some degree of imperfect competition or disequilibrium.

For instance, let us assume that each country produces one good which is an imperfect substitute for the goods produced by the other countries. As a consequence, each country faces a downward sloping demand curve both at home and abroad. To bring unit labour costs into the picture, assume that prices are determined by unit labour costs with a mark-up (other cost factors than labour costs ignored), and that unit labour costs are determined outside the model. The model is closed by assuming balanced trade.

The following symbols will be used: Y = GDP (volume), X= Exports (volume), M = Imports (volume), W = World demand (volume), P = Price per nationally produced product (dollar), P_w =World Market price (dollar), U = Unit labour costs at home (dollar) and U_w = Unit labour costs abroad (dollar). The coefficients *a* and *b* are the price elasticities of demand on the world market and the national market respectively, while *c* and *h* are the corresponding income elasticities.

(1) $X = A (P_w/P)^a W^c$, where A, a and c are constants

(2) $M = B (P/P_w)^b Y^h$, where B, b and h are constants

(3) $XP = MP_w$ (The balance-of-trade restriction)

(4) $P_i = U_i(1+t)$, where t is a constant (i=home, world)

This way of modelling export and import growth has a long tradition in applied international economics, and examples may be found in many national and international macroeconomic models, including, for instance, the OECD INTERLINK model (Samuelson, I973). In its present version (1-3), it was first presented by Thirlwall (I979). The main lesson to be learned from the model is set out in equations (5)-(6) below.

(5) $dY/Y = [(1-(a+b))/h] (dP/P - P_w/dP_w) + c\, dW/W$

By substituting 4 into 5 we get:

(6) $dY/Y = [(1-(a+b))/h] (dU/U - dU_w/U_w) + c\, dW/W$

Thus, on these assumptions, economic growth may be written as a function of growth in relative unit labour costs and world demand. However, this model has given rise to rival interpretations. The most common is no doubt that higher growth in relative unit labour costs than in other countries decreases exports, increases imports and slows down economic growth. As is evident from equation (6) above, a necessary condition for this is that the Marshall-Lerner condition is strictly satisfied ($a+ b > 1$). This is often taken for granted, but, as noted in the introduction, several studies indicate that the effects of growing relative unit labour costs on exports or imports are rather weak. For instance, a report from the British Treasury points out:

"Recent experience suggests that cost-competitiveness may have a significantly less important or more delayed influence on export volumes than was thought a few years ago" (Treasury (1983), p. 4)

According to this report, the long-term elasticities of growth in relative unit labour costs in the Treasury model were as a result adjusted downwards to 0.5 for exports and 0.3 for imports. Consider, also, the following regression of growth in relative unit labour costs (RULC) and growth in OECD imports (W) on GDP growth (GDP) on a pooled cross-country time-series data set[4] for the period 196I-83 (95% confidence intervals in brackets):

[4] The data cover the IS industrial countries for which data on unit labour costs exist. Average values of the variables covering whole business cycles were calculated, using the 'peak' years 1968, 1973, 1979 and 1983 (final year) to separate one cycle from the next. For further information on data and methods, see Section IV and Appendix.

$$\text{GDP} = \underset{(-0.08/1.36)}{0.64} + \underset{(-0.07/0.20)}{0.06\text{RULC}} + \underset{(0.38/0.60)}{0.49\text{W}} \qquad \begin{array}{l} \text{R2=0.60(0.58) SER=1.36} \\ \text{DW(g)=1.23} \\ \text{N=60} \end{array}$$

Where R^2 in brackets is R^2 adjusted for the degree of freedom, SER is standard error of regression, DW(g) is the Durbin-Watson statistics adjusted for gaps[5] *and N is the number of observations included in the test.*

For the Marshall-Lerner condition to be strictly satisfied, the estimate of RULC should be negative and significantly different from zero at the chosen level of significance. The test suggests that this hypothesis should be rejected. Since serial correlation in the residuals of the cross-sectional units cannot be ruled out, an additional test was carried out including one dummy variable for each country. To test for the sensitivity of lags, a three year distributive lag of the RULC variable was introduced. However, neither of these additional tests changed the result.

The second interpretation (Thirlwall, 1979) starts off with the assumption that relative prices in the long run will be roughly constant,[6] so the first term can be neglected. On this assumption, equation (6) reduces to:

$$(7)\quad \frac{dY}{Y} = \frac{c}{h}\frac{dW}{W}$$

Or, alternatively:

$$(8)\quad \frac{dY}{Y} = \frac{1}{h}\frac{dX}{X}$$

In this case differences in economic growth between countries will be determined exclusively by differences in income elasticities of exports and imports (7), or, in the case of exogenously given export growth, by differences in income elasticities of imports alone (8). Using estimates of income elasticities from Houthakker and Magee (1969), Thirlwall (1979) showed that equation (8) gave fairly good predictions of the differences in growth rates between countries.

---

[5] This test, which is designed for first order serial correlation in the residuals within the cross sectional units, was suggested to me by Professor Ron Smith of Birkbeck College, London. For a more thoroughgoing discussion of serial correlation in regressions with pooled data sets, see Section IV. The difference between this test and the one commonly used in time-series analysis, is that the differences between the residuals of different cross sectional units, and the corresponding residuals, are left out from both the numerator and the denominator of the Durbin-Watson statistics. This reduces the number of observations in the test by one per country.

[6] This is a strong assumption which may be difficult to justify (and deserves to be tested). For a discussion of this point, see McGregor and Swales (1985, 1986) and Thirlwall (1986).

However, Thirlwall's conclusions have been subject to some controversy.[7] First, it is pointed out that the test carried out by Thirlwall, a nonparametric one, is rather weak, and that more appropriate tests question his results. Secondly, it is argued that since Thirlwall tests a reduced form of the model, his test cannot be legitimately quoted in support of the underlying assumptions. Thirdly, it is not clear what meaning should be attached to the 'income elasticities of demand' in equations (1)-(2). Why, for instance, is the estimated income elasticity for imports to the United Kingdom so much higher, and the estimated income elasticity for exports from the United Kingdom so much lower, than for other countries on approximately the same level of income per capita? One possible answer to this question is, as indicated by Thirlwall (Thirlwall, 1979, pp. 52-3), that UK producers did not manage to compete successfully on non-price factors during the period for which the estimation was carried out, and that the estimates of c and h capture the effects of this. This interpretation is also shared by Kaldor, who points out that the income elasticities of this model reflect “the innovative ability and adaptive capacity' of the producers in different countries (Kaldor, 1981, p. 603). However, if true, it would be preferable to include these factors in the equations for exports and imports instead of relying on estimated proxies (which may be subject to different interpretations).

II Technology, costs and capacity

In recent years, there has been an increasing awareness among economists, specially in the field of international economics, of the importance of technological competition. One of the early forerunners, Joseph Schumpeter, described the importance of this vividly as follows:

“Economists are at long last emerging from the stage in which price competition was all they saw. (...) But in capitalist reality, as distinguished from its textbook picture, it is not that kind of competition which counts, but the competition from the new commodity, the new technology, the new source of supply, the new type of organization (...), competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives.” (Schumpeter, 1943, p. 84)

A logical conclusion from this would be to include both technological competitiveness and price competitiveness in the exports and imports functions. However, even if a country is very competitive in terms of technology and prices, it is not always able to meet the demand for its products because of a capacity constraint. Similarly, lack of competitiveness in terms of technology or prices may sometimes be compensated by a high ability to meet demand, if some other country faces a capacity constraint. Thus, the growth in market shares for a country at home and abroad does not only depend on technology md prices, but also on its ability to deliver. We will assume that the rest of the world's ability to deliver is unlimited, i.e. that there is always some country which is able to deliver if the national producers face a capacity constraint.

[7] See McCombie (1981), Thirlwall (1981,1986) and McGregor and Swales (1985, 1986).

Let the technological competitiveness of a country be T/Tw, price competitiveness P/Pw and capacity C. How these variables may be measured vill be discussed in section IV. Let the market share for exports be S(X) = X/W. In the usual multiplicative form, S(X) may be written:

(9) $S(X) = AC^{v}(T/T_{w})^{e}(P/P_{w})^{-a}$,

where A, v, e and a are positive constants. By differentiating with respect to time his may be written:

(10) $dS(X)/S(X) = v\, dC/C+e(dT/T-dT_{w}/T_{w})-a(dP/P-dP_{w}/dP_{w})$

We will assume that growth in the ability to deliver depends on three factors: (a) the growth in technological capability and know-how that is made possible by diffusion of technology from the countries on the world innovation frontier to the rest of the world (dQ/Q), (b) the growth in physical production equipment, buildings, transport equipment and infrastructure (dK/K) and (c) the rate of growth of demand (dW/W). Demand enters the function because capacity at any given point of time is given, while demand may vary.[8] If demand outstrips the given level of capacity, exports will remain constant, but the market share for exports will decrease, because other countries will increase their exports. If we assume a multiplicative form as above, the growth in the ability to meet demand may be written:

(11) $dC/C = z\, dQ/Q+r\, dK/K+l\, dW/W$

where z, r, l are positive constants.

As is customary in the literature on diffusion, we will assume that growth in free knowledge follows a logistic curve:

(12) $dQ/Q = f-f\, Q/Q^*$

Where f is a positive constant, and Q/Q* is the ratio between the country's own level of technological development and that of the countries on the world innovation frontier. This contribution will be zero for the frontier countries. By substituting (11)-(I2) into (10) we finally arrive at the following:

(13) $dS(X)/S(X) = vzf-vzf\, Q/Q^*+vr\, dK/K-vl\, dW/W+e(dT/T-dT_{w}/T_{w})-a(dP/P-dP_{w}/dP_{w})$

For the sake of exposition, this exercise was carried out for the market share for exports only. But exactly the same logic applies to the import share, or the 'rest of the world's' market share in a specific country's home market, with the exception that the demand variable in this case is GDP(Y). However, all effects now enter the equation with the opposite signs of those in (13). For instance, growth in relative prices decreases the export share, but increases the import share etc. Carrying out the same exercise for the import share S(M), using bars to distinguish the coefficients in the two equations, leaves us with the following

[8] Since these constraints (or critical levels of demand) vary across the different export sectors, the relation between *S(X)* and *W* is likely to be continuous, as in equation (11) below.

equation:

(14) $dS(M)/S(M) = -\overline{vzf}+\overline{vzf}\ Q/Q^*-\overline{vr}\ dK/K+\overline{vl}\ dY/Y-\bar{e}(dT/T-dT_w/T_w)+\bar{a}(dP/P-dP_w/dP_w)$

Thus, equations (13-14) state that growth in the market shares for exports and imports depends on technological factors (scope for imitation, growth in technological competitiveness), growth in physical production capacity, growth in relative prices and growth of demand.

III Competitiveness and growth

This section focuses on the relation between market shares for exports and imports and economic growth. First, how do changes in market shares affect economic growth? Secondly, how does economic growth feed back on market shares?

The first question relates to the assumption of balanced trade made in section I:

(3) $XP = MP_w$

Following the previous section, define the export share as $S(X) = X/W$ and the import share as $S(M) = M/Y$. By substituting these expressions into (3), differentiating with respect to time and rearranging, (3) may be written:

(15) $dY/Y = dS(X)/S(X) - dS(M)/S(M) + (dP/P-dPw/Pw) + dW/W$

Basically, what is assumed is that countries do not wish, or are not able, continually to increase debts or claims to the rest of the world, so that the balance-of-payments, with the exception of short run fluctuations, will have to balance through its current account.[9] This implies that, in the medium and long run, actual growth has to adjust to the balance-of-trade equilibrium growth rate, or the growth rate 'warranted' by the current account, to use a Harrodian term. We will assume that the government plays an important role in this process by adjusting fiscal and monetary policies towards this end.

The second question refers to the possible feedbacks of economic growth on factors influencing the growth of market shares for exports and imports. For instance, higher economic growth is likely to lead to higher growth in both wages and productivity. However, with respect to unit labour costs, these effects tend to counteract each other. The net effect will crucially depend on the institutions and the working of the national system of income distribution, which we in the present context have chosen to regard as exogenously determined.

Furthermore, economic growth may influence technological competitiveness through demand-induced innovation (Schmookler, 1966). The importance of demand-induced

---

[9]It should be noted, though, that the United States is in a special position because of the demand for dollars for international monetary transactions.

relative to supply-induced innovation has been subject to much debate in recent years. The available evidence shows that there is no easy link between changes in demand conditions and innovative activity. Clusters of innovations have appeared in booms as well as in slumps, and on the whole innovative activity seems to depend more on technological opportunity and the quality and quantity of the resources devoted to innovation than on demand conditions (Freeman et al., 1982).

Finally, economic growth may affect the ability to compete in delivery. An increase in domestic demand may lead to a situation where demand outstrips capacity in certain sectors, and as a consequence domestic suppliers may lose market shares to foreign suppliers, and vice versa. This has already been taken into account in the import share function (I4). But the effect of increased demand on capacity utilisation may also have a secondary effect on the ability to deliver, by stimulating investments in new productive capacity. This effect is supported by economic theory and should be taken into account in the model. For instance, the effect of growth in demand on investment may be represented by a simple accelerator mechanism:

(16) $dK/K = dY/Y$

However, viewed as an explanation of differences between countries in investment behaviour, this model will not do, because investment behaviour is also influenced by other factors. Some of these will be highly country specific, others of a more general nature. Among the latter, many emphasise the 'crowding out' mechanism: the higher the share of output devoted to governmental activities, it is argued, the less the scope for investments in new production capacity. However, this argument rests on the assumption of a supply constraint, an assumption which, while certainly relevant in some cases, cannot be said to be generally valid.

According to the approach of this paper, investment in physical production capacity should be analysed as one of several factors necessary for generating technological capability. This implies that growth of physical production capacity should be seen as complementary to the growth of other resources such as the number of scientists and engineers, R & D facilities, advanced electronical equipment etc. Some of these are scarce, and to the extent that the government succeeds in attracting these at the expense of the market sectors of the economy, this may hamper investment in physical production capacity too. As pointed out by Kaldor et al. (1986), the probability for this to happen is much larger for the military than for other types of governmental activities. Thus, following Smith (1977) and Cappelen et al. (1984), we have chosen to include the shares of output devoted to military and non-military governmental expenditures ('welfare state expenditures') in the accelerator-based investment function. What we should expect, then, is that military expenditures have a significantly more negative effect on investment behaviour than welfare-state expenditures.

Let us take a brief look at the model as developed so far. It consists of five equations:

(15) $dY/Y = dS(X)/S(X) - dS(M)/S(M) + (dP/P-dPw/Pw) + dW/W$,

(13) $dS(X)/S(X) = vzf-vzf\ Q/Q^{*}+vr\ dK/K-vl\ dW/W+e(dT/T-dT_w/T_w)-a(dP/P-dP_w/dP_w)$,

(14) $dS(M)/S(M) = -\overline{vzf}+\overline{vzf}\ Q/Q^{*}-\overline{vr}\ dK/K+\overline{vl}\ dY/Y-\overline{e}(dT/T-dT_w/T_w)+\overline{a}(dP/P-dP_w/dP_w)$,

(17) $dK/K = -g\ MIL-h\ WELF+dY/Y$,

where MIL and WELF are the shares of military and non-military governmental expenditures in total output, respectively.

From (4) we have:

(18) $dP_i/P_i = dU_i/U_i$ (i =home, world).

The working of the model is as follows: growth in relative prices is determined by growth in relative unit labour costs (18). Together with technological factors, growth in physical production and demand, growth in relative prices determine the growth in market shares for exports and imports (13)-(14). Growth in market shares, growth in relative prices and growth of world demand jointly determine the balance-of-trade equilibrium growth rate, to which the actual growth rate is assumed to adjust (15). The actual growth rate then feeds back on the import share (14) and the growth of physical production equipment etc.(17).

The actual outcome of the adjustment process depends on the relative strength of the two feedback effects, since they counteract each other. For example, let us assume that the balance-of-trade equilibrium growth rate, Y_t, is below the actual growth rate, Y_a and that the government seeks to adjust the actual growth rate to the balance-of-trade equilibrium growth rate by successive incremental cuts in demand of given size until a new equilibrium ($Y_a = Y_t = Y^{*}$) is reached.[10] 10 The new equilibrium Y* will be between the initial values of Y_a and Y_t, provided that the positive effect on the balance-of-trade of reduced imports outweighs the negative effect of reduced capacity, or formally:

$$0 > [(vr+\overline{vr})-\overline{vl}] \qquad (19)$$

If on the contrary the negative effect of reduced capacity outweighs the positive effect of reduced imports, we will have a 'vicious' circle, with the new equilibrium below the initial value of Y_t, or formally:

$$1 > [(vr+\overline{vr})-\overline{vl}] > 0 \qquad (20)$$

[10] The condition for a stable solution is:

$$1 > [(vr+\overline{vr})-\overline{vl}]$$

IV Testing the model

(a) Data

The model was tested on pooled cross-country and time-series data for the period I960-83 covering the 15 industrial countries for which data on unit labour costs exist. Average values of the variables covering whole business cycles were calculated, using the 'peak' years 1968, 1973, 1979 and 1983 (final year) to separate one cycle from the next. In principle, it would have been preferable to begin by estimating the model for each country and test whether pooling is appropriate or not, but because of lack of annual data for the technology variables, this was not possible.

The following variables were used:

GDP_i =Growth of gross domestic product in country i at constant prices,

ME_i = Growth in export market share (volume) for country I on the world market,

MI_i = Growth in import share (volume) in country i,

$TERMS_i$ = Growth in terms of trade for country i,

$RULC_i$ =Growth in relative unit labour costs in common currency for country i,

W = Growth of world trade at constant prices,

TL_i = Technological level of country i relative to the most advanced country of the sample(=1),

TG_i = Growth in country i's technological competitiveness,

$WELF_i$ = Non-military governmental consumption as percentage of GDP in country i,

INV_i =Gross fixed investment as percentage of GDP in country i,

MIL_i = Military expenditures as a percentage of GDP in country i.

Most of these variables, with an exception for the technology variables, are self-explanatory (the reader is referred to the appendix for details on sources and methods).

The major problem in testing the model was to find proxies for the technology variables. Many other studies have used GDP per capita, measured in various ways, as a proxy for the level of technological development. While defensible for countries on very different levels of development as, for instance, developed and less developed countries, this practice becomes more questionable for a sample of developed countries. Contrary to less developed countries, developed countries also regularly publish data on technological activities which could be used to construct a proxy for the level of technological development.

Data on technological activities may roughly be divided in two groups, 'technology input' and 'technology output' data (Soete, 1981). Among the former, expenditures on research and development (R&D) may be mentioned, among the latter, patenting activity. The advantages and problems of different types of data on technological activities are discussed in more detail elsewhere (Fagerberg, 1987) and will not be repeated here. However, both R&D and patent statistics are imperfect measures in the sense that they neglect important aspects of technological activity. Some sectors of the economy do a lot of R&D, but do not patent, while others patent a lot without being especially R&D-intensive. At the national level, however, cross-country studies show a close correlation between levels of R&D and levels of patenting activity (Soete,1981; Fagerberg, 1987). If both variables were to be included in the same model, a high degree of multicollinearity should be expected. These considerations seem to suggest that the best measure of technological activity would be a weighted average of R&D-based and patent-based measures. In principle we would have given the two variables an equal weight, but since the variances of the two variables differ substantially, we used weights that adjusted for these differences.

Thus, the proxy for technological development, TL, is a weighted average of (a) civil R & D as percentage of GDP, and (b) external patent applications per capita adjusted for differences in the openness of the economy.[11] Following the discussion in section II, both variables were divided by the highest value found in the sample in each period. The index, then, varies between 1 (the country on the world innovation frontier) and 0 (a hypothetical country with no technological activity). In a similar way, a proxy for growth in technological competitiveness, TG, can be constructed as a weighted average of (a) annual percentage growth in civil R&D[12] for country i, less the average growth for the countries in the sample, and (b) annual percentage growth in external patent applications for

---

[11] Civil R & D is total R & D less military R & D. Military R & D was excluded because, if included, it would bias the measure in favour of countries with a large military sector, and because several studies show that the economic spin offs of military R & D are small (Kaldor et al., 1986). The number of external patent applications of country i is the total number of patent applications filed by residents in country i in all other countries than country i. To arrive at a patent based index of technological development, we adjusted for the size and openness of the economy (the number of patent applications filed abroad reflect both the size of the country and the importance of foreign markets relative to the domestic market (Fagerberg, 1987)). In general, changes in international patent regulations have made it difficult to compare data from years prior to 1978-9 with data from later years. However, in the present context, this does not represent a serious problem, because we have used 1979 to separate the third cycle from the fourth and, in the case of growth of external patent applications, adjusted for the common within-period trend.

[12]Annual data for R&D were available for a few countries only, so we had to use a proxy for growth in civil R&D. In general, R&D efforts (as a percentage of GDP) and income per capita tend to be closely correlated (Soete, 1981; Fagerberg, 1987). If the R&D efforts of a country are much above what should be expected from the level of income in the country, this may be interpreted as an effort by the country to upgrade its technological level, and vice versa. Following this, the proxy chosen is the difference between actual R&D (as a percentage of GDP) and what should be expected assuming a linear relation between R & D and income per capita. It was calculated as the ratio between civil R&D per capita and GDP per capita, subtracted by the average value of the ratio (for all countries) in each period.

country i, less the average growth for the countries in the sample. This index, then, has a zero average in each period.

Regarding the growth of 'physical production equipment, transport equipment and infrastructure', we would have preferred a proxy based on some measure of physical capital, but unfortunately no such measure was available for all the countries concerned and for sufficiently long time spans. As a number of other studies, therefore, we chose to use gross investment as a percentage of GDP as a proxy.

(b) The empirical model

The model tested is the one set out in the previous section subject to a few modifications.

First, in order to test the assumption of a one-to-one correlation between actual growth and the balance-of-trade equilibrium growth rate (BAL), we have introduced a separate equation for this (in addition to the balance-of-trade equilibrium growth rate identity). Second, in actual practice growth in relative prices (terms of trade) is influenced by a number of factors, many of them country specific, that do not relate to the price- or cost-competitiveness of firms. Since we believe growth in relative unit labour costs to be a better measure of price- and cost-competitiveness of firms than growth in terms of trade, we have substituted growth of relative unit labour costs into the two equations for growth in market shares, and introduced a separate equation where growth in terms of trade is set out to be a function of growth in relative unit labour costs, country dummies (see later) and a POST-73 dummy. The POST-73 dummy is supposed to catch the effect of the loss in terms trade that most of these countries experienced because of the oil price shocks.

The empirical model, then, is the following:

(21) $GDP = a_{10} + a_{11} BAL$, where we expect $a_{10} = 0$, $a_{11} = 1$,

(22) $BAL = ME - Ml + TERMS + W$,

(23) $TERMS = a_{31}RULC - a_{32}POST73 + DUMMIES$,

(24) $ME = a_{40} - a_{41}TL + a_{42}1NV - a_{43}W + a_{44}TG - a_{45}RULC$,

(25) $MI = a_{50} + a_{51}TL - a_{52}INV + a_{63}GDP - a_{64}TG + a_{55}RULC$,

(26) $INV = a_{60} - a_{61}MIL - a_{62}WELF + a_{63}GDP$.

Since all coefficients are defined as positive, the expected signs are the ones above. Note, however, that since we use a proxy for growth in physical production capacity, we cannot any longer make inferences from the theoretical model about the expected signs of the constant terms in (24)-(26).

(c) Estimation

To avoid simultaneous equation bias, the two stage least squares method (2SLS) was adopted. To test for first-order serial correlation within the cross- sectional units, we used the Durbin-Watson statistics adjusted for gaps, to test for heteroscedasticity, we applied a Glejser test. Furthermore, to test for the possibility of structural change, a Chow test was used.

There is a special problem involved in estimation on pooled cross-country time-series data. For instance, assume that there is one time-invariant omitted variable for each country, representing country-specific factors such as differences in culture, institutions, composition of output etc. In this case we would expect least-squares methods to produce results where the residuals of each country are serially correlated. If this type of serial correlation is a serious one, more efficient estimates may be obtained by methods that adjust for the part of the total variance which can be attributed to country-specific factors.

Several methods are available. The most widely used is to introduce country dummies (the LSDV method). This method automatically leaves out the part of the total variance which refers to differences in country-variable means, and is therefore not applicable in cases where these differences are considered to be relevant. Another class of methods treats the country specific effects as random variables[13] (random effects method). The problem in this case is that the' true' variances are not known and have to be estimated.

---

[13] In the case of a linear relation between a dependent and an independent variable, let the dependent variable be denoted by Yjt (country j, period t), the independent variable by Xjt, the "adjustment-factor" by c (1>c>O) and let "bar" denote within-country mean of a variable. It is suggested, then, that estimates obtained by estimating the equation

$$(Yjt - c\,\bar{Y}j) = b\,(Xjt - c\,\bar{X}j)$$

will give more efficient estimates than estimates obtained by ordinary least squares. Let the disturbance term be u(j,t) = b(j) + w(j,t), where b(j) is the country-specific "random effect", and let the expected variance of the country-specific effects and the rest of the disturbance term be V(b) and V(w), respectively. The adjustment factor may then be written:

$$c = 1-[V(w)/(V(w)+T\ V(b))]^{0,5},$$

where T is the number of time periods (Maddala(1971, 1977), Johnston(1984)). The limiting cases c=1 and c=0 correspond to LSDV and ordinary least squares, respectively(Johnston(1984)).The problem is that the true variances are not known and have to be estimated. Several methods are suggested in the literature, but Monte Carlo studies show that the differences between the estimates obtained by the various methods are small (Nerlove(1971), Maddala(1973)). The estimates of V(b) and V(w) used in this paper are based on the 2SLS residuals, with

$$V(b) = (Sum(j)\ \bar{u}(j)^2)/(n-1) \text{ and}$$

$$V(w) = [Sum(j,t)(u(j,t)-\bar{u}(j))^2] / [n(T-1)],$$

where n is the number of countries and $\bar{u}(j)$ within-country means of the observed residuals u(j,t).

The choice of estimation method depends crucially on the nature of the hypothesis under test. Consider, for instance, the relation between growth in terms of trade and growth in relative unit labour costs (23). Ordinary least squares implies a test of the hypothesis that growth in terms of trade is determined by growth in relative unit labour costs (and the POST-73 dummy) only. To apply the LSDV method implies a test of the hypothesis that growth in terms of trade is determined by country-specific trends, reflecting differences in specialisation patterns and other time-invariant factors, but that deviations from these trends are determined by growth in relative unit labour costs (and the POST-73 dummy). Since we, as pointed out in the previous subsection, hold the latter to be the most likely, the LSDV method is the most appropriate method in this case.

Similar arguments may be put forward for the relation between actual growth and the balance-of-trade equilibrium growth rate (21). To use 2SLS without dummy variables implies a test of the hypothesis that the balance-of- trade equilibrium growth rate and the actual growth rate are identical. This is a strong hypothesis, that may be contested. For instance, the United States is in a special position, because of the demand for dollars for international monetary transactions. Furthermore, large, unexpected changes in the balance-of-trade position may lead to very long adjustment processes, as the experiences of the major oil-producing countries suggest. The use of two-stage LSDV, then, allows for the existence of stable, country-specific deviations from the balance- of-trade equilibrium growth rate. This implies a test of the weaker hypothesis that a change in the balance-of-trade equilibrium growth rate will be accompanied by an equal change in the actual growth rate. Since both hypotheses are interesting, we report both estimates.

In the case of the equations for growth in market shares for exports and imports (24-25), the hypotheses under test suggest a different procedure. For instance, would we consider a large scope for imitation, or a high investment share, compared to other countries throughout the period to be irrelevant to the growth in market shares? Certainly not. To apply the LSDV method in this case would mean wrongly attributing a large part of the effects of these variables to unknown country-specific factors. A similar argument may be put forward in the case of the investment equation (26). In these cases, if serial correlation in the residuals within the cross-sectional units is considered to be important, it is better to re-estimate the equation by the random effects model discussed above.

(d) Results

Table 1 reports results from the test. For the sake of space, we do not report the estimates of the country dummies.

Table 1. The model tested (n=60)

(21) 2SLS GDP = 0.96 +0.67BAL (2.13) (6.43)	R2 = 0.31 (0.30), SER = 1.76 DW(g) = 1.62 DF=58
(21) 2SLS-LSDV GDP = 1.16BAL +DUMMIES (4.01)	R2 = 0.41 (0.19), SER = 2.66 DW(g) = 2.47 DF=44
(22) 2SLS-LSDV TERMS= 0.23RULC -0.92P0ST73+ DUMMIES (3.02) (-2.45)	R2 = 0.50 (0.30) SER = 1.45 DW(g) = 2.03 DF=43
(24) 2SLS ME= -2.03 -2.70TL +0.24INV -0.35W +0.27TG -0.29RULC (-1.16) (-2.31) (3.56) (-4.56) (4.49) (-3.14)	R2 = 0.55 (0.51), SER = 1.81 DW(g) = 2.09 DF=54
(24) 2SLS-WLS ME= -3.25 -2.64TL +0.30INV -0.36W +0.25 TG -0.34RULC (-2.25) (-2.98) (5.01) (-5.42) (4.68) (-4.59)	R2 = 0.67 (0.63), SER = 1.10 DW(g) = 1.97 DF=54
(25) 2SLS MI = 2.65 +3.47TL-0.27INV + 1.22GDP -0.17TG+0.23RULC (1.47) (2.75) (-3.39) (7.20) (-2.55) (2.45)	R2 = 0.47 (0.42), SER = 1.85 DW(g) = 1.85 DF=54
(25) 2SLS-Random effects MI= 0.88+3.46TL -0.23INV + 1.25GDP -0.21 TG+0.21RULC (0.62) (1.84) (-2.00) (7.72) (-2.34) (2.38)	R2 = 0.54 (0.49), SER = 1.59 DW(g) = 2.33 DF=54
(26) 2SLS INV= 28.52 -1.48MIL -0.23WELF +0.75GDP (13.01) (-6.95) (-2.34) (3.60)	R2 = 0.65 (0.64), SER = 2.48 DW(g) = 0.75 DF=56
(26) 2SLS-Random effects INV= 9.21 -1.32MIL -0.29WELF+0.50GDP (12.47) (-4.33) (-2.78) (3.09)	R2 = 0.55 (0.52), SER = 1.45 DW(g) = 1.89 DF=56

R2 in brackets = R2 adjusted for degrees of freedom.
SER = Standard error of regression.
DW(g) = Durbin-Watson statistics adjusted for gaps.
N = Number of observations included in the test.
DF = Degrees of freedom.
The numbers in brackets below the estimates are t-statistics.

The test suggests that even though the balance-of-trade equilibrium growth rate and the actual growth rate are strongly correlated, the assumption of strict equality between the two does not hold. However, the introduction of two dummies, one for the United States and one for Norway, the 'Kuwait' of the North, is enough to challenge this (95% confidence intervals in brackets):

GDP = 0.21 + 0.87 BAL+ 2.00US- 1.96 NORWAY, (2SLS)
(-0.97/1.39) (0.59/1.15)

Furthermore, the test suggests that we can accept the weaker hypothesis of a one-to-one correlation between changes, or deviations, in the balance-of-trade equilibrium growth rate and changes, or deviations, in the actual growth rate.

In the case of the equations for growth in the market shares for exports and imports, all coefficients turned up with the expected signs, most of them significantly different from zero at the 1 % level.[14] Furthermore, the estimates of the coefficients in the two equations did not differ significantly, except for the demand variables. The latter result is in accordance with the fact that world trade in the post war period has grown more than twice as fast as GDP. In the case of the equation for growth in the export market share, the Glejser test indicated violation of the assumption of homoscedasticity. To check the implications for the estimates, we re-estimated the equation with weighted least squares, but this did not change the result significantly. For the equation for growth in the import share, the test for serial correlation was inconclusive, so we re-estimated the equation with the random effects method to check whether this would affect the estimates (it did not).[15]

For investment, 2SLS produced serial correlation between the residuals within each cross-sectional unit. The random effects method gave a lower estimate of the feedback of economic growth on investment. In both cases military expenditures had a significantly larger negative effect on investments than welfare state expenditures.

Finally, to test for the possibility of structural change, we tested the assumption that the 15 post-1979 observations are not generated by the same model as the entire data set, using a Chow test. Table 2 reports the results of the test for the regressions in Table 1 above (except the additional WLS and random-effects tests). The test suggests that in all cases, the assumption of structural change can be rejected at the 1% level of significance.

Table 2 Chow Test of Structural Change (F-statistics)

GDP	GDP (lsdv)	TERMS (lsdv)	ME	MI	INV
1.73	2.48	2.01	0.74	1.80	0.47
(*)	(*)	(*)	(*)	(*)	(*)

** denotes rejection of the assumption of structural change at the 1 % level of significance.*

[14] Except for the constant terms, for which no assumptions could be made, due to the introduction of proxies.
[15] Note that since these additional tests imply a transformation of the whole data set, the estimate of the constant term cannot be compared to 2SLS.

V The Kaldor paradox once more

We will now return to the seemingly paradoxical findings by Kaldor and others. What Kaldor (1978) did was to compare growth in relative unit labour costs and growth in market shares for exports, when measured in value, for 12 countries over the period 1963-1975. He found that for some of these countries, the relation between growth in relative unit labour costs and growth in market shares seemed to be positive, or the opposite of what is commonly assumed ('perverse'). Table 3 reproduces Kaldor's findings for three countries[16] for which he found a strong 'perverse' relationship, Japan, the United Kingdom and the United States, and compares these findings with the same relationship as predicted by the model.[17]

Table 3. The Kaldor paradox

	Kaldor 1963-75		Our 1961-73	
Country	RULC	Growth in market share (value)	RULC	Growth in market share (value, predicted)
JAPAN	27.1	72.0	31.0	103.3
UK	-21.4	-37.9	-25.7	-16.2
USA	-43.7	-17.8	-33.9	-29.8

Thus, in these cases, the model actually predicts a strong 'perverse' relationship between growth in relative unit labour costs and market shares for exports (value). To see how this may be explained, consider Table 4 below. The decomposition suggests that Japan's large gains in market share during this period should be explained by a combination of (a) a rapid increase in technological competitiveness, (b) a large scope for imitation, and (c) a high level of investment. Note, also, that since the estimated (negative) effect of growth in relative unit labour costs on ,the market share for exports measured in volume, is not significantly different from the estimated (positive) effect of growth in relative unit labour costs on relative prices (terms of trade), the net effect of growth in relative unit labour costs on the growth of market shares for exports measured in value turns out to be negligible.

[16] Kaldor found four examples of a strong 'perverse' relationship: Japan, Italy, the United Kingdom and the United States. Our model does predict this for all but one (Italy). A closer look at the export performance of Italy shows a very erratic development (an export boom in the early mid-sixties followed by a weak performance in the late sixties and early seventies) which our model fails to replicate.

[17] The predicted growth in the market share for exports measured in value was obtained as the sum of the predicted growth in the market share measured in volume and the predicted growth in the terms of trade (country dummies not included). The coefficients were taken from the 2SLS-estimates given in Table 1. Note that the predictions are for total exports, while Kaldor reported data for manufacturing only. For these and other reasons, predicted and actual export performance (as reported by Kaldor) should only be expected to show a similar pattern, not coincide.

In the case of the United States, it may be argued that a certain loss in market share would have been difficult to avoid, given the cost of being close to the world innovation frontier in a number of areas. This is also partly confirmed. However, for both the United States and the United Kingdom, the main factor behind the losses in market shares during this period seems to have been slow growth in productive capacity caused by the unusually low shares of national resources devoted to investments. The model (equation (26)) suggests that the main factor behind the low investment shares in these two countries is the high share of national resources used for military purposes.

Table 4. An explanation of the Kaldor paradox

	1+2+3	**1**	**2**	*(Of which)*		**3**	*(Of which)*	
	Growth in market share, value	Techno-logy	Costs	*Through volume*	*Effects on terms of trade*	Delivery	*Diffusion*	*Invest-ment and demand*
Country	(predicted)	(TG)	(RULC)	(ME)	(TERMS)	(total)	(TL)	(INV,W)
Japan	103.3	66.9	-0.9	-7.8	6.9	37.4	20.9	16.5
UK	-16.2	6.9	0.8	7.9	-7.1	-23.9	15.9	-39.8
USA	-29.8	-0.6	1.6	12.4	-10.8	-30.8	7.3	-38.2

VI Concluding remarks

The most commonly held approach to international competitiveness focuses on differences in the growth of relative unit labour costs (RULC) as the major factor affecting differences in competitiveness and growth across countries. However, as several studies have pointed out, this view is at best too simplified. The results of this paper suggest that the main factors influencing differences in international competitiveness and growth across countries are technological competitiveness and the ability to compete on delivery. Regarding the latter, this paper especially points out the crucial role played by investments, and factors influencing investments, in creating new production capacity and exploiting the potential given by diffusion processes and growth in national technological competitiveness. Cost-competitiveness does also affect competitiveness and growth to some extent, but less so than many seem to believe.

References

Cappelen, A., Gleditsch, N. P. and Bjerkholt, O. (1984) 'Military spending and economic growth in the OECD countries.' *Journal of Peace Research,* vol. 21, no. 4, pp. 361-73.

Chesnais, F. (1981). *The Notion of International Competitiveness.* Discussion Paper DSTI/SPR/81.32 Paris:OECD.

Eliasson, G. (1972). *International Competitiveness- an Empirical Analysis of Swedish Manufacturing.* Federation of Swedish Industries, Mimeographed Series B3, September. Stockholm.

EMF (1984). *Report on International Industrial Competitiveness.* Geneva: European Management Forum.

Fagerberg, J. (1987). 'A technology gap approach to why growth rates differ.' *Research Policy,* vol. 16, nos. 2-4, pp. 87-99·

Fetherston, M., Moore, B. and Rhodes, J. (1977). 'Manufacturing export shares and cost competitiveness of advanced industrial countries.' *Cambridge Economic Policy Review,* no. 3, pp. 87-99.

Freeman, C., Clark, J. and Soete, L. (1982). *Unemployment and Technical Innovation.* London: Frances Pinter.

Houthakker, H. S. and Magee, S. P. (1969) 'Income and price elasticities in world trade.' *Review of Economics and Statistics,* vol. 51, no. 2, pp. 111-25.

Johnston, J. (1984). *Econometric Methods.* New York: McGraw-Hill.

Kaldor, M., Sharp, M., and Walker, W. (1986). 'Industrial competitiveness and Britain's defence.' *Lloyds Bank Review,* no. 162.

Kaldor, N. (1978). 'The effect of devaluations on trade in manufactures', In *Further Essays on Applied Economics.* London: Duckworth, pp. 99-118.

-- (1981). 'The role of increasing returns, technical progress and cumulative causation in the theory of international trade and economic growth.' *Economie Applique (ISMEA),* vol. 34, no. 4, pp. 593-617.

Kellman, M. (1983). 'Relative prices and international competitiveness: an empirical investigation'. *Empirical Economics,* vol. 8, nos. 3-4, pp. 125-38.

Maddala, G. S. (1971). 'The use of variance components models in pooling cross-section and time-series data.' *Econometrica,* vol. 39, no. 2, pp. 341-58.

-- (1977). *Econometrics.* New York: McGraw-Hill.

--and Mount, T. D. (1973). 'A comparative study of alternative estimators for variance components models.' *Journal of the American Statistical Association,* vol. 68, no. 342, pp. 324-8.

McCombie, J. S. L. (1981). 'Are international growth rates constrained by the balance of payments? A comment on Professor Thirlwall.' *Banca Nazionale del Lavoro Quarterly Review,* vol. 34, no.139, pp. 455-8.

McGregor, P. G. and Swales, J. K. (1985). 'Professor Thirlwall and balance of payments constrained growth'. *Applied Economics,* vol. 17, no. 1, pp. 17-32.

-- (1986). 'Balance of payments constrained growth: a rejoinder to Professor Thirlwall.' *Applied Economics,* vol. 18, no. 12, pp. 1265-74·

Nerlove, M. (1971). 'Further evidence on the estimation of dynamic economic relations from a time series of cross sections.' *Econometrica,* vol. 39, no. 2, pp. 359-82.

Samuelson, L. (1973). *A New Model of World Trade.* OECD Occasional Studies, December. Paris: OECD.

Schmookler, J. (1966). *Invention and Economic Growth.* Cambridge, MA.: Harvard University Press.

Schumpeter, J. (1943). *Capitalism, Socialism and Democracy.* London: Unwin.

Smith, R. (1977). 'Military expenditure and capitalism'. *Cambridge Journal of Economics,* vol. 1, no. 1, pp. 61-76.

Soete, L. (1981) 'A general test of technological gap trade theory'. *Weltwirtschaftliches Archiv,* vol. 117, no. 4, pp. 639-59.

Thirlwall, A. P. (1979). 'The balance of payments constraint as an explanation of international growth rate differences.' *Banca Nazionale del Lavoro Quarterly Review,* vol. 32, no. 128, pp. 45-53.

-- (1981). 'A reply to Mr McCombie'. *Banca Nazionale del Lavoro Quarterly Review,* vol. 34, no. 139, pp. 458-9.

-- (1986). 'Balance of payments constrained growth: a reply to McGregor and Swales.' *Applied Economics,* vol. 18, no. 12, pp. 1259-63.

Treasury (1983). 'International Competitiveness', *Economic Progress Report* no. 158, July.

Appendix

1. Definitions and methods

Growth rates are calculated as geometric averages for the periods 1960-1968, 1968-1973, 1973-1979 and 1979-1983, while levels and shares are calculated as arithmetic averages for the periods 1960-67, 1968-1973, 1974-1979 and 1980-1983, or the nearest period for which data exist.

The growth of the export market share of a country is defined as the growth of exports less the growth of world trade (OECD imports), both in constant prices.

The growth of the import share of a country is defined as the growth of imports less the growth of GDP, both in constant prices.

The data on exports and imports used in this paper comprise both goods and services.

The technological level of a country i (TL_i) is defined as the weighted average of a patent-based index (P_i) and a R&D-based index (R_i), using the standard deviations as weights:

$$TL_i = (std(R)/(std(P)+std(R)))P_i + (std(P)/(std(P)+std(R)))R_i$$

The patent-based index(P) is defined as the number of external patents application(PAT), divided by the number of inhabitants in the country(POP) and the degree of the openness of the economy, measured through exports as a percentage of GDP(XSH), $P_i = PAT_i/(POP_i * XSH_i)$. The R&D-based index (R) is defined as civil research and development expenditures as a percentage of GDP. Each index is normalized to the range 0,1 by dividing all observations from period t with that observation from period t which has the highest value.

The growth in country i's technological competitiveness relative to other countries(TG_i) is defined as the weighted average of a patent-based index (PG_i) and a R&D based index (RG_i), using the standard deviations as weights:

$$TG_i = (std(RG)/(std(PG)+std(RG)))PG_i + (std(PG)/(std(PG)+std(RG)))RG_i$$

The patent-based index (PG) is defined as growth in external patent applications for country i, less the average growth rate for all countries. The R&D based index (RG) is defined as the ratio between civil R&D expenditures as a percentage of GDP (RD) and GDP per capita (T) for country i, less the average ratio for all countries in each period. Let "bar" denote within-period mean. Then

$$RG_i = RD_i/T_i \; \overline{-(RD_i/T_i)}$$

The TG index, then, has a zero average in each period.

2. Sources

Growth in relative unit labour costs in common currency: IMF International Financial Statistics and OECD(Finland).

External patent applications: OECD/STIIU DATA BANK and World International Property Organization(WIPO):Industrial Property Statistics

The R&D data are estimates based on the following sources:

OECD Science and Technology Indicators, Basic Statistical Series
(vol. B(1982) and Recent Results(1984)).

Military R&D expenditures were, following the OECD, assumed to be negligible in all countries except the US, France, Germany, Sweden and the UK. The R&D data for these countries were adjusted downward according to OECD estimates. The estimates were taken from OECD, Directorate for Science, Technology and Industry: The problems of estimating defence and civil GERD in selected OECD member countries(unpublished). For other countries, civil and total R&D as a percentage of GDP were assumed to be identical.

Military expenditure as percentage of GDP: SIPRI Yearbook

Non-military governmental consumption as percentage of GDP: SIPRI Yearbook and OECD Historical Statistics

Other variables: OECD Historical Statistics and OECD National Account

3. Supplementary tables

A set of supplementary tables is available on request from the author at the following address:
NUPI, Box 8159 DEP, 0033 Oslo 1, Norway.