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CONSTRUCTION OF A SAMPLING METHOD FOR EQUIPMENT IN ISRAELI INDUSTRY [1]

by

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CONSTRUCTION OF A SAMPLING METHOD FOR EQUIPMENT IN ISRAELI INDUSTRY

A. Introduction

The present paper is part of a wider effort at developing a methodology for planning the engineering industries in developing countries. The purpose of this effort is to plan these as export industries relying at the same time on a firm basis of domestic demand established by systematic import substitution in this sector, with a view to attaining the necessary scale of output in each of the basic industries by almost simultaneously for the domestic as well as the foreign market.

The basic methodology of planning the production and exports in the metalworking industries was set out in a paper under that title, prepared by Prof. Thanos Victoris, of the Centre for Social research in New York, for UNIDO (1). This initial report started out from a presentation of the state of knowledge and the degree of development of the tools for planning this all-important sector and been found inadequate for the needs of the developing countries and attempted, for the first time, to cover this area which had so far remained intractable.

(1) The Planning of Engineering Exports in the Metalworking Industries, Centre for Economic Planning, New School for Social Research, New York, February 1967 - Report submitted to the United Nations Industrial Development Organization.

Although the effort made so far cannot be regarded as a definitive solution, and has not until now been put to the test of empirical application, there is no doubt that the methodological results obtained by this study represent a significant advance. What has been achieved so far, is primarily clarification of the issues involved, and a general conceptual orientation with regard to the problems raised in the course of any attempt to plan this sector methodologically. As stated in the foreword to that study, the experience gained so far now makes it possible to approach towards a technico-economic description of the key features of this sector as a whole, to attempt an overview of its developmental possibilities and the identification of the main lines of advantageous growth in individual countries.

The basic idea underlying the various studies initiated by UNIDO in this field is that, among the various industrial branches which are, on the basis of a variety of considerations, prime candidates for exploration, promotion and investment in developing countries, the metalworking sector represents a special case, both from the point of view of the potentialities inherent in it, and from the point of view of the difficulties of planning which it has presented so far. There is first of all, the fact that the engineering industries differ from nearly all other branches of

industry in that they produce the very elements of growth in the physical-technical sense, namely the bulk of the producers' goods - which determine the pattern and rate of economic development in general. Moreover, it is intuitively obvious that much of the potential of technical progress depends upon the degree to which an economy has developed it's own production of producers' goods, since these - more than anything else - incorporate the tangible manifestations of technical advance. It is generally the case that it is primarily the producer of the equipment who possesses, and moreover, develops and propagates technical knowledge and progress, not only in the production of the equipment itself, which is his direct economic activity, but also in those other economic sectors for the use of which the equipment is intended. The producer of textile machinery, for example, generally knows no less, and often more, about production processes in the textile sector than the actual producer of textile goods. The specialization of equipment production and the competition among producers which engenders, makes it necessary for each producer in this sector to try to improve the product which he sells directly, namely the machine or tool, by making it technically more efficient (*).

(*) For detailed discussion of this problem, see Meir Merhav, Technological Dependence, Monopoly and Growth, Pergamon Press, Oxford 1969, pg 33 & ff.

This feature is responsible for the key role of the engineering industries in economic development, in that it determines the capacity and the rate of progress. It is particularly significant that the developing countries generally, and for obvious reasons, lag behind the industrialized economies in this respect, and that they will hardly be able to close the gap, unless their advance in this field is even more rapid than in any other. For without a massive development of those industries which signify and embody the capacity for technical progress, the developing countries will remain dependent for their growth potential upon what the more developed countries will be willing and able to spare from the table of their own technical advance. These crumbs must of necessity, in any case, be few and late. Even under conditions of relatively free trade - which are far from being the rule in practice - it must be doubted whether the so-called "advantage of the late-comer", which has gained currency in development theory to the point of almost having become a generally accepted theorem, has in fact more than a strictly limited validity. As a rule, a developing country which relies in its endeavour of industrialization upon the supply of capital goods and the degree of technical advance that goes with them from what is commercially freely available in

the markets of the developed countries, will only rarely have access to the latest and most efficient techniques, will only in exceptional cases be able to avoid distortions caused by the nature of the equipment so obtainable in relation to its factor proportions and relative prices, and will almost always lag seriously in the development of its own technical know-how.

The importance of accelerating the development of the metal-working sector lies not only in the growth potential which is incorporated in it more than in any other line of economic activity, but also in the fact that a developing country must regard imports of capital goods as the most indispensible category of all imports. Consequently, developing countries are generally caught on the horns of a dilemma: if they wish to attain a rapid rate of growth, they must import capital goods; but if they do, they incur a heavy drain on their trade balance. In fact, the import of capital goods accounts for much of the balance of payments difficulties which are typical of the growth path of nearly all developing countries - even in those cases in which most other categories of imports have either been restricted by regulation or have been subject to substitution by domestic production.

Despite this almost obvious priority of the metal working sector as that branch of manufacturing which should be developed first,

both in point of time and in point of its share in the allocation of resources, it has paradoxically remained behind by comparison with other sectors of manufacturing industry. The reasons for this are not far to seek: The desire not to wait for the development of a domestic capital goods industry, but to push forward with the industrialization of other, more easily and more quickly developable industrial branches, by adopting an imported technology; the basic lack of the necessary skills and technical knowledge; the understandable preference of entrepreneurs for well-tried equipment from the highly advanced countries; and the lack of an adequate forecast or programme for the other sectors in the economy which would establish the extent of the anticipated demand for capital goods - these are only some of the more general reasons for the relative neglect of this sector.

Among the more immediate reasons which have made it extremely difficult to develop this branch to the degree which would have been justified on the basis of a priori considerations along the lines indicated above, two may be mentioned as particularly important:
a) The limited extent of domestic markets in the developing countries, which has important implications for the structure, as well as the absolute extent to which domestic industries of final products can feasibly be developed, imposes an acute limitation on the feasibility

of local production of the equipment needed for these final goods. For if the market for final products is limited by comparison with the scales of output which are the rule in the more industrialized countries, then that market is even more restricted with respect to the producers' goods needed to make the final products. b) In addition, there is the difficulty mentioned in the beginning of this paper, that the planning of this branch of manufacturing has so far presented almost insolvable difficulties.

Evidently, given the severe limitations imposed by the size of the domestic market, the development of the capital goods industry as the major component of the engineering industry in general must rely on the simultaneous promotion of import substitution and exports. In order to identify those branches of the industry and those lines of production in which development is feasible, given the technical and other difficulties in this branch, and in order to establish priorities among sub-sectors, it is in the first instance necessary to construct estimates of those components of demand which are relatively certain. The first among these is the demand represented by the renewal requirements of the existing capital stock.

At an early stage of the studies included in the UNIDO Project, of which the study mentioned earlier is the basic document, it became apparent that in the empirical investigations which would have to follow, the preparation of estimates of the existing stock of equipment in any given country selected for an empirical study would be one

of the first steps.

The present paper is an attempt to clarify the issues involved in the estimation of the capital stock which, together with data on depreciation rates and obsolescence, will provide the basis for projection of domestic demand for producers' goods in a sectoral detail that could permit the technical decomposition of the equipment involved in order to determine which lines of production, whether of final products or of sub-assemblies, could be feasible. Furthermore, by establishing the lower bound to demand for the main types of equipment, it would also become possible to define the volume of exports necessary in order to obtain a minimum scale of production that would make exports competitive and import substitution economical.

The clarification of the methodological problems involved in making such estimate of the capital stock, which are the subject of this paper, involved a detailed analysis of the existing statistical information for manufacturing industry in Israel. Detailed comparisons were made of the data contained in the various industry surveys carried out since 1951, and the methods used in making these surveys were examined in detail for the usability of the results for the present purpose. Other sources of data were also scanned, among them primarily the financial surveys of industry carried out by the Research Department of the Bank of Israel, the statistical and financial information available in the Industrial Development Bank and in the

Ministry of Commerce and Industry. No detailed description of these examinations are given here, and only the conclusions and results are presented.

B. The main problems of estimating replacement demand for equipment

In preparing estimates of future demand for equipment which arises from the replacement needs of the existing capital stock, the obvious solution is of course to make a complete inventory of that stock, to prepare detailed sectoral analyses of the technical composition of the capital goods in use, to establish their expected rate of renewal by estimating their useful life, and then to decompose each type of capital good into components and sub-assemblies such as to generate the kind of engineering information needed in order to facilitate the combination of the different demands into common processes and production lines. It is obvious that such a census is a very expensive and difficult undertaking.

Not only is it to be assumed that the absolute amount of the information required for such a purpose would be equal, if not greater, than that of an ordinary census of industry, but in addition it would involve large-scale field work by engineers and the collection of data which are not easily obtainable or readily available from industrial establishments. To mention but a few of the difficulties which such an undertaking would encounter; There is no commonly

accepted nomenclature for equipment which establishments would automatically use even if they were to be asked to do so; firms do not generally have readily available data on capacities and age of the equipment in their possession; equipment designed for the same purpose may differ in important respects and have subsidiary uses or be combined with other types of equipment in such a way as to make the direct collection of information in the field an unmanageable task.

A way was therefore sought to overcome these difficulties by relying on statistical methods of obtaining adequate estimates from the ordinary census data, at least as far as the basic information is needed. This would still not obviate the necessity for detailed analyses by engineers, but at least would save the extensive field work that would otherwise be required. In what follows the possibilities of pursuing this line of approach are explored, although the conclusion is that statistical methods of the kind initiated are not very likely to yield more than rude estimates which can at best be regarded as a first approximation. As will be shown, it will in practice probably be necessary to resort to a combination of a direct census of equipment for leading establishments in each branch, which account for the greater part of capital formation and for the bulk of the capital stock, together with indirect estimates for the rest of the industry on the basis of the cumulated investments of the smaller firms in past years.

The latter type of information happens to be readily available in Israel and the Industry Surveys conducted annualy since 1955 represent by now a series which is long enough to permit fairly good estimates of the existing capital stock, provided that adequate price indices for the revaluation of past investments to replacement values can be constructed.

Before proceeding to the discussion of the various alternatives and possibilities presented by the available statistical data, it should be pointed out that in the case of Israel, the estimation of future replacement demand for equipment assumes a special significance, for the following reasons. Firstly, a large proportion of the installed equipment in manufacturing industry was put up in sizeable lumps within a very short period of time. The lumpiness of these investments in the past was largely conditioned by the Reparation Agreement between Israel and Germany, which provided for the payment of about $ 800 million within 10 years from 1954, mainly in the form of equipment and other producers' goods. In addition, the early period of massive industrialization in Israel relied on relatively heavy imports of capital goods within a very short period of time which to a large extent overlapped with the transfers on account of the reparations from Germany. Past investment has therefore been very lumpy and it is to be expected that the replacement of this equipment, the date of which will

approach in the near future, will also be highly concentrated in time. Since the structure of Israel's balance of payments has meanwhile undergone significant changes, the demand for foreign exchange represented by the foreseeable replacement needs of the existing capital stock may become a heavy drain on the country's foreign payment position, unless fairly large-scale import substitution in this area is undertaken. Secondly, the industrial development of Israel has by now reached the point where further import substitution in final goods has reached the limits of technical and economic feasibility, while at the same time enough technical know-how has been accumulated to lay the foundations for embarking upon the production of capital goods, both for the home market as well as for exports. In the preparation of forecasts of possible exports from this sector, it will have to be taken into account that given the specific conditions of Israel, it has been considered impractical to count on export possibilities unless a sizeable proportion of total production can find an outlet in the domestic market. The two major components of domestic demand for capital goods are obviously the requirements arising from net investment and those from replacement demand which are being with here. The latter component of demand is the more certain one, and less subject to fluctuations as a result of changes in business conditions. Obviously, net investment is more volatile than replacement of worn-out equipment. It can thus be seen easily

that the estimation of future demand for capital goods depends primarily on reliable forecasts for replacement demand.

C. The theoretical approach to the preparation of a forecast of replacement demand

We shall assume that each machine installed today (3) in industry will be replaced when worn out. The lifetime of the equipment under consideration is generally longer than 5 to 7 years, and in making a forecast for a not too distant future, the new machines which will be installed during the period of the forecast, and will in part also wear out within that period, can be neglected. Only presently existing machines are to be considered.

In order to estimate how many machines will wear out each year within the period of the forecast, we shall have to know the age distribution of each type of machine installed today and the expected lifetime of each machine. This, together with the information on the replacement value of the different categories of machines will give us estimates of the total money value of replacement demand each year.

C.1. Definition of the data entering into the calculations

Value of the equipment (at replacement cost) of type k and age m of establishment i in the base year (1960) $C_{i,m}^{(k)}$

(3) The term "machine" will be used for all types of fixed equipment excluding buildings, i.e., it corresponds to the census category of investment goods "Machinery, Plant and Equipment".

Lifetime of equipment of type k	l_k
Total value of anticipated demand for equipment of type k in year y in the future	$D_y^{(k)}$

The formula for estimating the demand for replacement of equipment of type k in year y, when the number of establishments is n, is as follows:

$$D_y^{(k)} = \sum_{i=1}^{n} C_{i,m*}^{k} \left\{ m* = l_k - (y - 1960) \right\}$$

The data $C_{i,m}^{(k)}$ and l_k which are necessary for forecasting the demand for equipment are unknown and in order to obtain them it would be necessary to make a census of equipment in industry. The principal problem encountered in the preparation of such a census are as follows:

C.2. The problem of classification. The usual classifications for industrial equipment (by branch) do not meet the requirement that the expected lifetime of the various items belonging to a given category should be uniform, or, more precisely that the variance of the lifetimes of the different items belonging to a given class of equipment should be significantly smaller than that of a larger group of equipment including items of different kinds of which the one under consideration represents only one type. For example, it is possible that we would not be able to reduce all electrical motors of 1 HP capacity in the same class, because the expected lifetime of

motors produced by firm A in year X is twice that of motors produced by firm B in year Y.

The conclusion is therefore that the appropriate classification would have to be very detailed and would have to be prepared by engineers who are closely acquainted with the types of equipment used in the various sectors.

C.4. The technical problems of taking a census. The total number of establishments in Israeli manufacturing industry exceeds 10,000, and even if only establishments with 10 employees and more are included, the number would still be about 4,000. The possibilities of relying on sampling methods are limited because of the great detail required in such a census or suvey as indicated above. Moreover, as stated earlier, the field work would have to be carried out by engineers or highly skilled technicians, because the classification and identification of the installed equipment in each establishment necessitates a close understanding of the technology of the branch. It is highly doubtful whether the staff necessary for such a survey could be mobilized. One alternative that comes to mind is the preparation of separate censuses or surveys for each branch, this suffers from the weakness that it would presumably take a very long time until a complete estimate for the manufacturing sector as a whole could be obtained. By the time of completion, the better part of the data would be obsolete and the very purpose of obtaining

a comprehensive estimate at a given point of time and for a specified future would be largely missed.

Another difficulty that has to be taken into account and which aggravates the problem with respect to assembling a qualified staff for carrying out such a census is the great variety of equipment existing in each branch. This has to do with the fact that in Israel, as in most developing countries, the greater part of the equipment is imported and comes from a multitude of different producers and different countries. This is probably equally true for all developing countries, and it is to be expected that there will be great heterogeneity of equipment in the different sub-branches, reflecting the preferences of individual establishments for equipment coming from a great variety of sources, and also reflecting the fact that the pressure of competition is probably less than in the more industrialized countries, so that the range of technologies which coexist side by side may be considerably greater.

For these reasons, the preparation of census of equipment, or even only a survey cover ng the larger establishments, will be very expensive and it is doubtful whether it would be feasible at all, given the availability of qualified staff.

C.4. <u>The conceptual problem of uniformity of expected lifetimes</u>. The connexion between the type of classification system required and the problem of defining the lifetime of machines of a given category has

already been mentioned earlier. In addition, it must be pointed out that, even if a perfect classification system were at our disposal, that is to say, if we were able to classify all machines so as to be technologically identical, we still would not have any assurance that this would enable us to define their expected lifetimes meaningfully.

The first difficulty that arises in this respect is the conceptualization of measuring the life time. There is no possibility of measuring the lifetime of a given machine unless we wait until the end of its economic life. We may be satisfied with measurements made in the past for machines of the same category, but even if such measurements have been carried out they are generally obsolete. The measurement itself, by definition, refers to a category of machines produced at a much earlier period, say, ten, twenty or even thirty years ago, and during that period it must be expected that the obvious technological changes that have occurred have also affected the lifetime of the equipment.

Even if we could find a way to present a meaningful estimate of the lifetime of a given class of equipment, this would in fact be a central value of the frequency distribution of lifetimes for the various items belonging to the same category. We may have an average, a median or a modal lifetime and the efficiency of using such a central value for the purpose of forecasting the

demand for replacement depends, as always in such cases, on the distribution of the individual values around the central value chosen. In technical terms - it depends on the variance, the range etc. There is no possibility to evaluate, in advance of carrying out actual field work, the degree of dispersion of the individual data around any central value, but we may indicate some of the factors affecting it. Among these are: random factors which influence the quality of the different items belonging to a certain class. A developing country will often buy equipment from one source or the other on the basis of commercial conditions which are not directly connected with the efficiency criteria of choice between different types of machine or different sources of supply. Thus, it may happen that a certain kind of equipment will be bought from a country or from a firm for which offer particularly favourable credit terms are offered, but which it is necessary to buy because the purchase is financed from tied aid. Many other factors of this kind could be mentioned. Another fact explaining the dispersion of actual lifetimes around the central value is the intensivity of use of the equipment by the enterprise in which it is installed. Obviously, a given machine will have a different lifetime according to whether it is only partially used or whether it is operated continuously in three shifts. To some extent, these differences in the rate of utilisation are offset by obsolence, which is a function of time,

technical and economic change. A third important factor is the quality of the maintenance of the equipment, which of course differs highly from plant to plant. Other factors are the climate and other environmental conditions, the degree of specialization in the use of the equipment (for example, the frequency with which operatives using the same machine are changed), and so forth.

It is possible to reduce the variance of the estimate of expected lifetimes by using the following approach: the expected lifetime for each class of machines will not be determined in advance, but in the course of collecting the data in each establishment, each machine will be examined by experts who will assign it a life expectancy according to its specific technical condition and the circumstances in which it is operated. This approach obviates the need for obtaining data on the age of the machine (which then becomes part of the technical information implicitly used by experts in assigning a life expectancy) but it obviously requires a much higher degree of expertise in carrying out the field work. The formula for calculating the forecast of replacement demand according to this method would be as follows:

$$D_y^{(k)} = \sum_{i=1}^{n} C_{i,l}^{(k)} \left\{ l = y - 1966 \right\}$$

where the value of equipment at replacement cost of type k in establishment i, of life expectancy l, is $C_{i,l}^{(k)}$.

Another way of reducing the error of the estimate arising from

the variance of lifetimes is as follows: On the one hand, one could include in the calculations a defined life expectancy or lifetime for each type of equipment, but on the other hand, the resulting estimate would be considered a relation to a period significantly longer than one year - say, three to five years. For example, one would add up the forecast results obtained for each of the years 1971, 1972 and 1973 and would consider the total as the expected replacement demand for the whole of the period 1971 to 1973. It seems that if such a method is resorted to, it would appear the most practical approach, since although detailed time-phasing is probably neither necessary nor could it be considered reliable, given the many technical and statistical difficulties of additional forecasting. In any case, it would be preferable if forecasts of the kind considered here were for planning purposes, and relatively long plans can only rarely be broken down into sub-sections without losing much of their operational significance.

The conclusion is that a detailed census of equipment could in principle achieve the purpose of providing the data for a forecast of replacement needs but its feasibility is highly doubtful in view of the very high cost involved and the difficulties of obtaining the necessary staff of experts. In what follows, an attempt will be made to examine to what extent it is possible to use a method of approximation, by relying on data already available

from the ordinary industry censuses.

D. The method of cumulated investments

Instead of examining the existing stock of equipment of an establishment one might use the cumulation of the series of investments carried out currently by the establishment in the course of a number of years in the past. If the period for which such data are available is long enough, it can be assumed that almost any machine operating today was purchased in one of the years covered by this series of data on investment. As previously, we shall assume that a machine bought new by the establishment in year x, and which has a lifetime l_k, will be replaced with a new machine in the year $x+l_k$.

It appears at first sight that there is no difference between the approach described in the previous section and the present one, but as will be seen from what follows, the approach indicated here makes it possible to rely much more on existing data, or on data which are relatively easy to calculate on the basis of reports obtained from establishments in the past for different purposes.

D.1. The data needed for the estimate and sources

a) The series of past new investments in each establishment. For

the establishments employing 20 workers and more, data are generally available on the money value of their new investment in plant and equipment for each year from 1955 onwards (4). These data were collected within the framework of the industry surveys carried out annually by the Central Bureau of Statistics. In 1965, a complete census of industry was taken instead of the usual sample survey.

For the smaller establishments, these industry surveys represent a sample which was changed every two years. As a result, only a small proportion of the smaller plants was included in all the samples since 1955. The available data permit a statistical estimate of the value of new investments in the small establishments only for fairly large classes, such as main branches of industry at the 2-digit level of the standard classification. For the bigger establishments, however, the surveys were actually censuses, and with few exceptions, the series of data available for them gives a fairly complete coverage.

b) Price movements of industrial equipment. As mentioned above, the data available from industry surveys are in current values, stated in Israeli Pounds. Evidently, these do not yield adequate information on the replacement value of the existing stock, since prices have changed

(4) With the exception of 1962, in which no industry survey was carried out

both abroad, from where most of the equipment is imported, and within the country which has been subject to strong inflationary tendencies throughout these years. Since 1955, when the first survey was taken, there have been two devaluations of the Israeli pound, one in 1962, from IL 1.80 per US $ to IL 3 per US $, and the other in 1967 from IL 4 to IL 4.50 per US $. In addition, in the early sixties, customs duties began to be imposed on equipment of various kinds, which had in previous years been exempt. All this complicates the problem of arriving from the money values of investments given by the census data at replacement values, and the difficulty is compounded by the fact that under the conditions of the Israeli Law for Encouragement of Investments, a so-called "Approved Enterprise" is exempt from customs duty on imported equipment. It follows that the money values of investment of two different establishments, one of which is an approved enterprise while the other is not, cannot be added up together.

Nevertheless it is possible to overcome these difficulties by relying on partial price indices for industrial equipment, both of domestic production and of imports, in order to obtain a fair correction for price changes during the period. The available facilities for approved enterprises should also permit to treat them separately, although there is no doubt that this would involve considerable and detailed analyses of individual data.

c) The value of equipment of establishments before the period covered by the surveys. The first industry survey was, as noted above, carried out in 1[illegible] and was still of an experimental nature, so that it cannot claim a high degree of reliability. The last survey for which results have been published to-date is that of 1[illegible]. For practical purposes we thus have a series covering 11 years, out of which 1957 is missing so that interpolation of some kind will be necessary. Even so, the period covered by the surveys is too short to permit the merging of the stock of equipment in existence prior to 1955. It will therefore be necessary to supplement the estimates provided by the cumulated series of investments since 1954 with an estimate of the initial stock of capital. The information contained in the surveys includes the year in which each establishment started production. This permits the separate treatment of the older establishments. Data on the balance sheet value of the assets of the latter are available from a number of sources - the Registrar of Companies in the Ministry of Justice, the Research Department of the Bank of Israle which has carried out studies on the financial structure of manufacturing establishments, and the Central Bureau of Statistics.

Because of different rates of depreciation, differences of type, and probably also significant differences in expected lifetimes, it is necessary to distinguish between sub-classes of the total new investment inplant and equipment for which data are availble from

the industry surveys. These dat, in most of the years covered by the surveys, lump together investment in new assets of local production, new imported capital goods, investment in used equipment, and investment in capital assets built by the establishment itself, as well as installation expenditures and running-in costs. In the industry survey for 1963 these different kinds of investment were distinguished from each other, and the same detail is available from the industry census of 1965. Since the first set of these data is close to the beginning of the period, and the second close to its end, a comparison between the two dates would reveal whether a constancy of ratios could justifiably be assumed for other years. It can be expected that at least for certain sectors, the proportion of domestic versus imported equipment will be fairly constant for technical reasons; and similarly, the proportion of installation expenditures is also likely to be fairly constant, with regard to the ratio between used and newly produced equipment, but it can be argued on a priori grounds, although the general trend has probably been towards a reduction in the share of used equipment in total investments. This expectation is based on the fact that government policy, which was, through its development loans and other support of new investment, a powerful influence, has been against the purchase of used and obsolete plant. Against this, a rising trend of investments from the own production of establishments can be expected, because normal the experience

and the existence of a maintenance staff, which in many cases is not fully employed, makes it plausible to assume that more establishments may have produced more of their own capital goods.

d) Composition of investments in each sector by type of equipment. Data of this kind have not been collected systematically and it may be necessary to estimate them on the basis of more general information such as reports of the Customs and Excise Division of the Ministry of Finance on imports of industrial equipment; data on local production of industrial equipment which were collected in fairly great detail in the industry surveys and censuses for 1958, 1961 and 1965, as well as specific technical information obtainable from experts in the various Ministries and other institutions such as the Productivity Institute, the Israel Institute of Technology and others.

e) Estimates of the life expectancy of equipment by classes. The problems encountered in this respect have already been described above and it remains to add that, given the information listed in the previous paragraphs, and particularly in para d), it should be possible to prepare engineering estimates of average life expectancies of the different types of equipment used in each sector of industry, at least for the key components, and, taking into account the years of installation as revealed by the survey data, to estimate the remaining years of useful life for each type of plant and equipment.

E. The computation of the forecast

In the actual preparation of the forecast we shall use the following rule as a guiding principle: If **A** ($=\sum_{i=1}^{n} A_i$) is a statistic referring to a group of establishments, and we have no information on the composition for each of the A_i's in addition to what we know about **A** in general, then we shall gain nothing by decomposing **A** into any component parts it may have and it will be better to make all the estimates for **A** taken as a whole.

Since the greatest detail of the estimates which can be obtained with respect to the composition of the stream of investments for each establishment is at the level of the sub-sector (at 4-digit level of the Israeli Standard Industrial Classification, which distinguishes approximately 100 sub-sectors in manufacturing industry) for each year or group of years, we shall prefer to deal with a unit of investment defined as "the total value of investments in new equipment in sub-sector A in year x". To the extent that a distinction is desired in the forecast between equipment from domestic production and from imports, the just-mentioned information can be broken down into these two components. However, the main purpose of preparing these forecasts, it should be remember, is to arrive at a quantitative framework for possible import substitution. Therefore, it would seem that the separation of total investment into domestic versus imported equipment is of limited value, particularly so because that breakdown is available

only for two years out of the 11 survey years covered.

For the purpose of establishing the probable size of demand for the various categories of capital equipment, it will be more necessary and useful to carry out engineering analyses for each branch, with a view to deciding which types of capital goods could feasibly be produced domestically provided that the addition of the demand arising from new investment and from a certain proportion of exports would make it possible to attain a reasonable scale of production.

In fact, one of the main efforts of the methodological study by Vietorisz, mentioned above was directed towards finding ways of identifying similar production processes involved in the different products of the engineering industry, so as to be able to determine the scale of production which the foreseeable demand could sustain.

A review of the industry surveys shows that the data on current investments in plant and equipment have in the past already been tabulated at the sub-country level of detail. A decision whether to renew these tabulations or not depends on the one hand on the degree to which data need to be supplemented (especially for establishments which started production after 1966 and which did not report on the investments they made up to the date of starting production), and on the other hand on the costs involved in re-tabulating these adjusted data.

It should be pointed out for completness' sake that the industry surveys yield information only on the date at which production in a given plant started and on its annual investments from that point onwards. What is missing is the initial investment, which in many cases presumably accounts for the bulk of the existing capital stock. This is therefore a serious gap in the available data but it should not be unduly difficult to fill it by supplementary information obtained from the financial surveys carried out by the Bank of Israel which cover practically all of the larger establishments.

F.1. <u>The estimation of future demand.</u> In order to illustrate the formula for computing the forecast we shall refer to a single sub-sector and dispense with subscripts denoting the sub-sector. Let the notation be:

Total value of equipment in the branch in 1955 ..... I_{55}

Total investment in new equipment in the year x ..... I_x

Total value of the investments in new equipment ..... $W_x^{(k)}$
($\sum_{k=1}^{m} W_x^{(k)} = 1$ when there are m types of equipment in the branch)

The life time of equipment of type k ..... l_k

Price index of equipment of type k in 1968 on the base of year x ..... $p_x^{(k)}$

Forecasts of the replacement value of the equipment of type k in the branch in the year y, at 1968 prices ..... $D_y^{(k)}$

The formula for our estimate of future demand will then be:

$$D_y^{(k)} = \begin{cases} I_x \, W_x^{(k)} \, P_x^{(k)} \; ; & \left\{ \begin{array}{l} x = y - l_k \\ x > 1955 \end{array} \right\} \\ \frac{1}{5} \cdot I_{55}^{(k)} \, W_{55} \, P_{55}^{(k)} ; & \left\{ \begin{array}{l} x = y - l_k \\ 1951 \leq x \leq 1955 \end{array} \right\} \\ 0 & \left\{ y - l_k < 1951 \right\} \end{cases}$$

F. Analysis of the Alternative Assumptions and an Evaluation of the Probable Result

F.1. We have implicitly assumed that the age distribution of the equipment in 1955 was distributed between 1951 and 1955. This is an arbitrary assumption and may be seen as a compromise between two extreme approaches: a) to assume that all the equipment which existed in 1955 was bought in the same year; and b) to assume that the age of the equipment was distributed over a longer period - say, 10 years. Assumption (a) would result in a forecast higher than what must be regarded plausible for equipment of type k in the year 1955 l_k and a lower forecast for the years before the terminal date 1955 l_k. Assumption (b) will yield an over-estimate of the investment made before the fifties, since we know that in the early fifties investments in manufacturing industry were much heavier than at the end of the forties. As a result, we would under assumption (b) obtain an over-estimate for the forecast with respect to the near future and

a downward bias for the more distant future.

One should not exaggerate the importance of the compromise assumption we have made, since, considering the usual lifetimes of industrial equipment and the concrete nature of the developments which have taken place in Israeli industry since 1955, it is safe to assume that the share of equipment bought and installed prior to 1955 in the total existing capital stock is by now already very small.

The above discussion, although relating to the specific case of Israel, may have some value in the more general case of developing countries by indicating the kind of considerations that enter into the preparation of estimates of this kind.

F.2. We further assume that each machine bought in the past by a manufacturing establishment will be replaced with a new one at the end of the machine's useful economic life, irrespective of whether the establishment which bought it initially is still in operation or whether that particular firm has closed down. The meaning of this assumption is that if an establishment has ceased operations, then any machine which could have continued to operate if that establishment had not closed down, has been sold to some other firm and continues its economic life there. The following weakness of this assumption should be pointed out: a) many types of equipment are almost impossible to transfer from one productive set-up to another, and alternatively, if technically possible, such a transfer often involves considerable additional investment. It is therefore possible that a machine which

could technically have continued to operate in the establishment which closed down, may have been sold for scrap; b) certain categories of equipment are not specific to industry and may be sold by a manufacturing establishment to other sectors in the economy, such as construction or services. Examples that come to mind are tractors used for internal transport, and other conveying equipment, office equipment as well as directly productive machinery.

We could have assumed alternatively that only machines bought by establishments still in operation today would enter into the calculations. This assumption would oblige us to take into account also the investments made in used machinery. The difficulty here would be that the lifetime of used equipment could not be determined except by direct collection of data of a technical nature. Moreover, we would probably be unable to define the replacement value of used equipment because it stands to reason that this replacement value - assuming that an old machine would be replaced by a new one - would be much higher than the original price given to us. There is also a further operational difficulty in regard to this assumption. The data at our disposal include the establishments which have closed down in the interval between the survey year and the present, and the exclusion of these establishments from the calculation would require a new tabulation of the entire set of data on investments for the whole series of years. Finally, it should also be pointed out that in many cases, establishments which are still in operation

have in the course of the years changed their production set-up so as to involve the closing down of departments and the discontinuation of use of part of their equipment. The census data do not reveal such processes, and it therefore seems that the best assumption is the one adopted here.

F.3. We have further assumed that the replacement value of a machine, at 1968 prices, is given by its original purchase price multiplied by the appropriate price index for 1968. Let us assume that we have such an appropriate price index. Nevertheless, it is possible that the forecast will have a downward bias, for the following reason: our basic assumption is that a machine is replaced, that is to say demand for a new machine is generated, as soon as it reaches the end of its economic life. But since the purchase of the machine, a number of years has passed and generally the replacement will take the form of installing a newer model of the machine - even if there is no major change in the technology of the establishment or the sector. The price index by which we try to adjust the original investment values to present purchase values reflects, theoretically, only nominal price changes, which should already be defeated by changes due to technical improvement, i.e. quality changes. In practive however, it is well known that there is no way of adjusting the index fully for changes in quality because of difficulties of measurement. It is plausible

to assume that part of the qualitative changes would involve a higher real cost of investment and to some extent this offsets the downward bias indicated above.

A further difficulty of a statistical nature is that it is doubtful whether detailed price indices for each type of equipment can be constructed. Generally, the available indices are averages for broad groups of capital goods. For specific types of equipment, this may create a strong bias in unpredictable directions if price movements for these kinds of equipment are considerably different from those of the broader category in which they are included. In practice, however, this problem could probably be ignored because in many categories of equipment the similarity of the basic processes which enter into their production, and the interrelationships between the latter, tend to even out many of the differences in the price movements for specific types of equipment.

Perhaps the major difficulty with regard to the estimation of replacement values lies in the fact that technological change is being ignored. This must be considered as the major weakness of the entire method suggested here because it is obviously unrealistic to assume mere replacement of worn-out equipment, even if allowing for quality improvements as mentioned above, in any economy, and least of all in industrializing country in which the rate of adoption

of new technologies is probably more rapid then in the highly advanced industrial countries. This, however, is a difficulty which cannot be overcome by relying on the readily available statistical information and would require completely different techniques of forecasting, indluding the difficult, and still very new, task of technological forecasting.

F.4. We further assume that the investments in equipment made in a given year by a given branch are homogeneous. This is of course a highly arbitrary assumption, even if the technical experts who will have to estimate the composition of the equipment in the branch on the basis of their knowledge of the production processes involved and of the average level of technology should arrive at a statistically efficient estimate.

The variance of estimates of this kind is necessarily great, and if we further suppose that the variance of the lifetimes of the different types of equipment is also great, we shall necessarily have large errors in estimating the total expected demand for the sector in a given year. Obviously, the margin of error for specific types of equipment will be even greater.

If it should be possible to obtain data on the actual composition of equipment in a given branch at the present time (such surveys of equipment are carried out from time to time by various

agencies (5)), it should be possible to make an estimate of the order of magnitude of the errors contributed by the set of assumptions described above, and particularly by the homogeneity assumption which is the most extreme of all. Such a direct survey of the capital stock would enable us to calculate our future demand by both of the two methods, and the difference between the results would indicate the magnitude of the errors involved.

F.5. Sampling Problems. All the available data for current investments in manufacturing industry are derived from sample surveys and therefore have a certain sampling error. The largest sample was that of the industry census of 1965, tape B, and in that survey the sampling errors are minimum. Before entering into the sampling problems connected with the method of preparing the forecast, we shall have to analyse the nature of the sampling errors of the estimates for investments, taking into account the sampling methods used in the various annual surveys and in the 1965 census.

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(5) One such survey, for the engineering industry itself, based on a sample of 80 establishments, is now being carried out by the Israel Institute of Technology for the Ministry of Commerce and Industry in Israel and for IDB's. This survey is another part of the same project in the framework of which the present paper has been written. The purpose of both is to examine the difficult problem of preparing forecasts of replacement demand for equipment from both sides simultaneously - 1) by direct data collection and detailed technical analysis in the field; and 2) by investigating the possibilities of using available statistics for the same purpose.

These surveys relied on stratified samples in which the strata were determined by sub-sector and by size of establishment. The sampling fraction in each sector was approximately proportional to the size of the establishment by employment, and the large establishments (in the annual surveys those emplying more than 20 or 50 workers, according to sector; and in the 1965 census those which had more than 10 employees) entered into the sample with certainty, that is to say, the sampling fraction of these establishments was 1.

The characteristics of the data for investment which are of interest for the present discussion are: a) only part of the establishments make investments in a given year, and in most of them investment in that year is 0; b) by comparison with the number of employees or the value of sales, the share of the larger establishments in total investments of the sector is high. This could have been assumed on a priori grounds, because capital formation in the larger establishments is generally greater and because they tend to be more capital-intensive.

Whereas characteristic (a) has the result that the sampling error with respect to the estimates of investment is large even for broad classes of establishments such as main branches in which considerable investments have been made in a given year, the sampling error is reduced because most of the investments were made by those establishments which entered into the sample with certainty.

As far as the series of data available from the industry surveys of 1955 onwards is concerned, it must be realized that for most sub-sectors the data for a given year are likely to have a very large sampling error and this would seriously impair any forecast made on the basis of these data.

To some extent the problem of sampling errors can be overcome by dealing separately with two sub-populations: one, the population of the large establishments for which the surveys really represented a complete census every year, and the other the smaller establishments. This incidentally would require a re-tabulation of the data because the distinction between large and small establishments with respect to investments does not exist in the available tabulations. As already stated, it is likely that for practical purposes the relevant population will be that of the larger establishments for which both the existing estimates, and consequently also the forecasts made on their basis, are more reliable. It would in any case be unrealistic to assume that forecasts of this kind can be very precise and biases due to sampling errors will probably still fall within the tolerable limits of these estimates. It should also be borne in mind that the purpose of the exercise is to arrive at a forecast for what is no more than a fraction of the total expected future demand for capital goods - the other two main components being net

investment, which can be forecast with even less certainty, and the other, an estimate of exports which in the nature of things is fairly arbitrary target figure.

One way of dealing with the smaller establishments would be to draw a new sample for them, for example a sub-sample from the 196[illegible] industry census, and to investigate the establishments included in the sample with respect to their investments in previous years. This is probably a costly undertaking and it is also doubtful whether establishments would be able to report on their past investments with any degree of accuracy, since most of them do not have a proper accounting system. In view of this it may be preferable, if the smaller establishments are to be sampled anew, to obtain data for the existing capital stock and to make a separate forecast for them by the method indicated earlier in this paper for such a case.

A more simple approach towards dealing with these small establishments is to calculate their share of the investments in equipment, separately for each branch, on the basis of the survey and census results and to blow up the forecast estimates obtained for the larger establishments in the same ratio.

A further correction will have to be made with regard to the smaller establishment that relates to under-reporting. Approximately 10% of their number do not fill out the questionnaires for the industry surveys. In order to correct for the errors that would arise from this

source in the estimate of the surveys, the branch estimates are adjusted by imputation of the missing data for non-reporting establishments, on the basis of reports received from other establishments in the same branch and of the same size group. This imputation method is of course not very reliable, particularly with respect to an irregular variable such as investments. It might be possible to overcome this difficulty by renewed attempts to obtain the missing data from the non-reporting firms, but it is doubtful whether the effort is worthwile in view of their small weight in the totals, the difficulties of getting the actual data, and the cost involved in re-tabulating the entire survey results.

A more serious problem is represented by the fact that there is a gap in the series because no survey was conducted in 1957. There seems to be no way of correcting the cumulated investment data for this missing year without obtaining direct information from sources other than those available from the Central Bureau of Statistics. The information at the disposal of other agencies, such as the Ministry of Commerce and Industry, may be of help in bridging this gap. The Ministry, because of the generally large share of governmental loans in the investments currently made by industrial firms, processes about 30% of the total investment

made each year. Fairly detailed information is available, but would require a significant effort to make it consistent with the survey data of the Central Bureau of Statistics. The main problem that is likely to arise in such an effort seems to be that most of the information available from this source relates to investment projects, not to actual investments already made, and there is no systematic follow-up to these projects once the Ministry has approved the project and granted its loans.

G. SUMMARY AND CONCLUSION

This paper has attempted to survey three possible approaches towards forecasting that component of future demand for industrial equipment which is represented by the expected replacement requirements of the existing stock of its industrial capital goods. The first approach was a census of equipment intended to obtain the data needed for such a forecast directly. The second approach was to supplement the existing data for the series of new investments by establishment since 1955 (mainly for the larger establishments) and to re-tabulate them so as to get a series in the sub-sector detail needed for the forecast. The third approach was to make the forecast on the basis of the existing data on total investments in plant and equipment by sub-sectors.

These three approaches are listed in descending order of the effort involved in preparing them and the degree of precision of the forecast that can be expected to result from each. It would be possible to use a combination of the different methods suggested. For example, one might take a census of equipment only for the very largest establishments, selected either on the basis of their size by employment or, preferably, on the basis of their share in the cumulated investment in the past. For the rest of the industry, the method would then be to make the forecast on the basis of the cumulated investments since 1955. Another possibility is to use the available data on the investment series for each branch only in those cases for which a preliminary technical analysis shows that a high degree of similarity of production processes and of homogeneity of equipment is characteristic of the sub-sector. For other sectors there would then remain the possibility of making the forecast on the basis of total investment for each branch, or of cumulated individual investment as suggested.

It would seem that, as so often in such cases, there is no easy short-cut to solving on one relatively simple approach. Any effort in this direction will probably involve at least some direct field work and in all cases, quite extensive technical analysis.

Nevertheless, the existing statistical information could be of great help in reducing the size of the problem, in identifying the critical areas in which direct data collection and detailed technical analysis would be indispensable, and in all cases, it would help in providing a check on the orders of magnitude of sector estimates obtained by other methods.


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