The Griliches-Regev Longitudinal Panel

of Israeli Manufacturing Firms, 1955 - 1999.

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INTRODUCTION

The panel of firms which is documented in this paper is the result of 12 years of cooperation, from 1988 to his death in 1999, between the late Professor Zvi Griliches of Harvard University, who defined the methods and definitions of the panel, and Haim Regev of the Israel Central Bureau of Statistics (CBS), who built it. In its final version, the panel will cover almost a jubilee, from 1955 to 2002, and will include 6,000 firms with close to 50,000 yearly observations. Previous versions of the panel, covering shorter periods and with fewer variables, have already been studied and the results published.

This paper provides the basic information needed to use the panel for research. It describes the creation of the panel, the variables which were constructed and the sources of the data.

Considerable effort and resources were invested in the creation of the capital and technology variables, which are reported in Chapters 6 -8. The construction of the fixed capital estimates are described in Chapter 4, the R&D capital estimates are presented in Chapter 5 and the human capital measure is described in Chapter 6. The life cycle variables, including the establishment year, age and cohort, also play a major role in our work, and are described in Chapter 7. The market variables are presented in Chapter 8. We conclude with a new and interesting variable of Merger and Acquisition (M&A).

1. Background[i]

Statistical bureaus collect large sets of data on an ongoing basis {monthly and annually) related to the activity of industrial establishments, such as production, employment, wages, investment, etc. The main purpose for carrying out sample based surveys of industrial firms is to provide policy makers with indicators of current trends in this sector, its structure and input-output relationships.

These data, available in the files of statistical bureaus and covering extended periods of time, can also serve as data sets for sophisticated economic research and analysis. Cumulative data covering individual firms ("panels") over the long term offer researchers a very important added dimension - changes over time - which can enhance industrial structural research. The creation of such establishment panels, however, poses a number of problems and difficulties, such as matching data from various, and often different, sources for the same firm, creating the appropriate variables, filling gaps in the data, etc.

The methodology for the creation of such panel data sets and their use in econometric research has developed over the past decade. This has opened new paths leading to a better understanding of the factors underlying productivity changes, profitability, failures and

closures, etc. A number of statistical bureaus have already begun arranging these data sets into panels, as is the case at the U.S. Bureau of the Census (McGuckin,1993). Subsequently, these panels have been made available to researchers outside the statistical bureaus, sometimes as joint ventures between bureau and university researchers.

This concept was the basis of the cooperation between Professor Zvi Griliches, who led the research into productivity at the National Bureau of Economic Research (NBER) and Haim Regev at the CBS. The longitudinal panel was designed for the study of productivity changes (development) over time, at a firm level, and its impact on the firm distribution by productivity. Related topics are survival (continuity of firms) over a long period, and the age effect on firm productivity during its life cycle.

1.2 Description

A longitudinal panel data set on manufacturing firms provides data for estimating production function and related models. This panel is based on data that was collected from Industrial Surveys carried out regularly by the CBS from 1955, augmented with data from other surveys needed for our production function and related analyses: fixed capital services, R&D expenditures, quality of labor, detailed output and input price indices, and firm age and mortality. The data was organized into a time series panel, thus making it possible not only to look at the structure of firms in a given year but also to observe their development over time. In addition, the panel was matched with firm registers and administrative data in order to update the closing year and map firm mobility. We are now in the process of capturing data from a 1937 survey, and of the founding year and continuity of firms that operated between 1940 and 1948.

1.3 The Longitudinal Panel

The main problem in putting together a longitudinal panel covering 45 years is to identify firms in the various samples. When the CBS started industrial surveys in the mid-1950s, the sampling strategy was to change the sample every five years, keeping in the sample, with certainty, the larger firms. In fact, the bureau was not able to change samples every five years. The 1970 sample was continued until 1977 and the 1979 sample was continued until 1988, with a major updating in 1985. The most recent sample started in 1995 and it was still used in the 2002 survey, with annual corrections.

At the beginning, every sampled firm received a fixed ID number, with the intention that it be kept over the years. As we all know, the identity of a firm changes from to time to time and the ID number was designed to track those changes. The fixed ID and the original ID numbers were in use until 1977. The second milestone was the 1979 survey, which started a decade of industrial surveys. The 1979 sample was updated in 1985 by adding 200 firms. The third milestone was the 1990 industrial survey, which marked another decade of surveys, with a change of sample in 1995. As mentioned in the previous section, data from the 1955 to 1967 surveys was added to the panel only for firms that were identified in the 1979 surveys.

The 1955 –1999 longitudinal data panel includes all the firms that participated in at least one of the annual 1979-1999 industrial surveys. Data from the 1955-1977 survey was merged with the 1979 survey. From the other side, the panel was matched with the 2002 firm register in order to update closing year and M&A data. We are now computerizing data from a 1937 survey, as well as data concerning the founding year and continuity of firms which operated during the period of 1940-1948. Overall, the panel includes 20 full

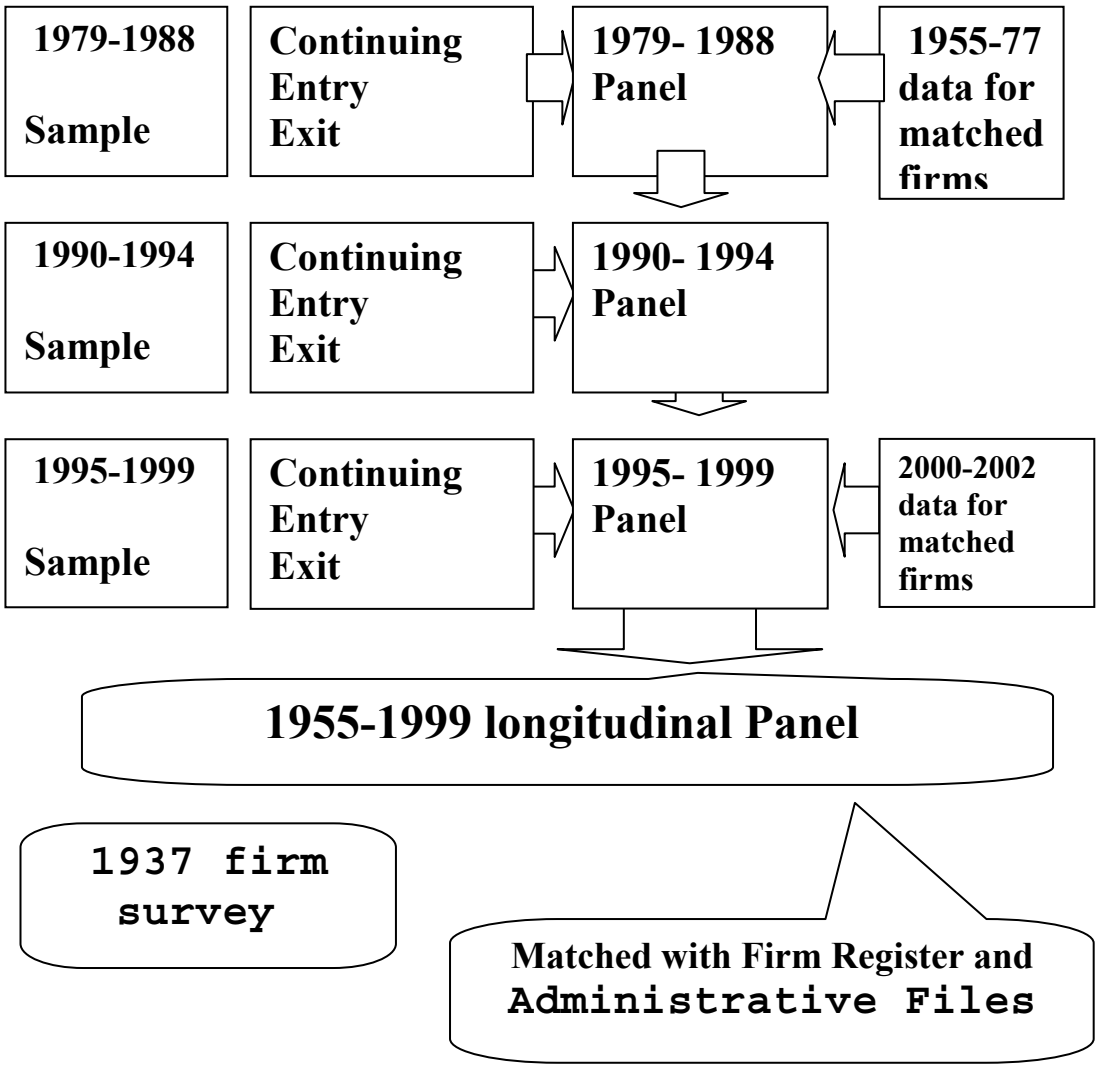
surveys for the period 1979 to 1999, and data from 18 surveys that were conducted from 1955 to 1977 and added for firms that were identified in the 1979 survey.

In Figure 1 we present the outline of the longitudinal panel. On the left side, the three samples which were drawn during the 1979 to 1988 period are shown. The data that was collected from the sampled firms was organized in balanced panels which enabled us to distinguish between continuing firms and entry-exit firms and their yearly observations during the sampled period. Finally, all the yearly observations were pooled into the longitudinal panel. Data from 1955-1967 was added for the 1979 matched firms. The longitudinal panel was matched with the 1937 firm survey on the one hand, and with the 2002 firm register on the other**.**

1.4 Identification.

For research purposes, every firm is identified by an arbitrary ID number. A separate file, which serves the panel coordinator at the CBS, includes names, firm IDs in the various samples, the 3-digit classification, the administrative ID, the M&A details and data from other files such as the Chief Scientist's R&D support. This additional information enables the panel to be updated and linked with other data sets for research purposes.

Figure 1: Longitudinal Outline



2.1 Variables

A list of variables, their definition and a description of the data is listed below :

Variable	Description
1.Idn	**Identity Code** Firm Identity Code for the CBS
2. YR	**Year**
3. PRD	**Production at constant prices, per person year**
Includes:	Local sales + exports + income from work and repairs + income from manufacture of assets for own use + other income (securities, rentals of assets, etc.) + change in stock of products (finished and unfinished) during the year.
Price Deflator	The price deflator for output combines: Price deflators for the local (wholesale price) and for the export market weighted by the share of local sales and exports in the 3-digit Standard Industry Classif
Data Source	Industrial Surveys
4. MAT	**Intermediates at constant prices, per person year**
Includes:	Primary inputs (raw materials, fuel, water, electricity repair and maintenance.) + Other inputs (advertising, insurance, postal and telephone) + Other services (legal expenses, payment to employment agencies) + Change in stock of materials during the year
Price Deflator	The price deflator for inputs combines each local and imported component using weights from the Input Output Tables (at 3-digit industry level)
Data Source	Industrial Surveys
5. KS	**Fixed Capital Services per person year**
Includes:	Depreciation + interest on net capital stock (at 5 %)+ rental of capital goods
Data Source	Fixed Capital Surveys conducted in 1968, 1981, 1992 Industrial Surveys : Investment in fixed capital goods Industrial Surveys : Rental of capital goods

Price Deflator	National Accounts Division: Investment Price Indexes
Imputation.	For the majority of small firms the Capital services were imputed statistically using annual investment, firm characteristics and rental.
Durability	Buildings = 30 years, Equipment = 15 years , Cars = 8 years
6. ZK	**CS Imputation Dummy** =1 if Fixed Capital Services were imputed
7. Krd	**R&D Capital Services per person year**
Includes:	R&D depreciation + interest on net R&D capital stock (at 5 %)
Data Source	Annual R&D Surveys in Manufacturing Chief Scientist R&D Support Data Set
Price Deflator	Consumer Price Index
Durability	7 years
8. QL	**Labor Quality Index (Human Capital)**
Definition	1+[(number of engineers+0.75*number of technicians)/employees].
Data Source	Structure of Labor Force in Industry Surveys, 1970,1988, 1993, 1997
9. Ind	**Industry**

1. Food and Beverages
2. Textile, clothing, leather
3. Paper, printing, other industries
4. Wood, minerals
5. Chemical, pharmaceutical, plastic
6. Metal, machinery
7. Electric, electronic, transport equipment

10. Sct **Ownership Type and Sector**

1. Public Ltd. Companies
2. Histadrut (Union)
3. Kibbutz
4. Government
5. Private Co. and others

11. Size **Size Groups (in person years)**

1. up to 49
2. 50-99
3. 100-299
4. 300 and more

12. Eyr **Establishment Year**

13. Age **Age - observation** = (year-Establishment year +1)

14. Firm Age **Firm Age in 2002 or in closed year**

Identified in 2002	2002-establishment year+1
Disband	Disband year-establishment year+1
Other Firms	Last report year- establishment year+1year

14. Coh **Cohort**

1. Established 1911-1948
2. Established 1949-1961
3. Established 1962-1977
4. Established 1978-1988
5. Established 1989-1999

15. CNC **3 Firm Concentration Rate** at 3-digit level

Local sales of 3 leading firms / total local sale+ competitive import

16. PNT **Imported Penetration Rate** at 3-digit industries

Competitive import / total local sale+ competitive import

17. MF **Multi Firm**

18. M&A **Mergers and Acquisitions**

19. PRS_YRS **Person Years=** Total Annual Hours / 2000

21. CBS_ ID

22. CBS_ID

Data Sources.

The main data comes from the Annual Industrial Surveys that provide information on the usual variables at the firm level: sales, expenditures, labor, inventory change and investment. Additional information comes from the monthly reports made by the same firms to the CBS and from occasional surveys on capital, labor skill, and R&D.

3. The Industrial surveys – The master file

The master file of the panel is constructed from the industrial surveys, which provide the basic variables (production, intermediates and person-years), data on investments and payments for rented capital goods (which is used in the construction of the capital variable) and the firm characteristics such as industry, ownership type and sector. In addition, we used auxiliary data which was gathered in the process of collecting the data to create the mobility variables.

3.1 History

The first Industrial Surveys in Israel were conducted during the second half of the 1950s. The first nine annual surveys – from 1955 to 1964 (1957 excluded) suffered considerably from under-coverage. In 1965, the CBS conducted an Industry and Crafts Census which also served as the framework for the forthcoming Industrial Surveys. Major changes were made in the 1970 and 1979 surveys, such as a new outline of the survey which included intensive use of administrative data in the construction of sampling frames, a new classification of economic activities, and new questionnaires, data capture and programming. Another major change was introduced in 1990 with the use of firm reports to the tax authorities (for the smaller firms), updating the economic activity classification.

3.2 The Investigation Unit

The investigation unit, which is also the reporting unit, is the ***establishment*** which is defined as an economic unit engaged in manufacturing activity, namely the creation of output through inputs. It includes mines, factories or workshops which were classified as manufacturing units according to the Standard Industrial Classification of Economic Activities [6,7]. As a rule, an establishment should be located on one site and engaged in a single economic activity. However, departments of an establishment which were located in other localities or belonged to different manufacturing branches if the department kept separate accounts, were considered as separate units. The above mentioned procedure enables the data to be tabulated by detailed industries and by localities. ***In our panel we aggregated the establishment data to the firm level, which is the basic economic unit.***

3.3 The Survey Population.

The survey population includes all the establishments that were active during the year under review (the entire year or part of it), that employed 5 or more persons on average year (in the months they operated). Their main activity is classified as Manufacturing, as defined in the *Standard Industrial Classification.*

The survey population does not include the following groups of establishments:

a. Non-profit establishments (such as workshops intended for rehabilitation).

b. Auxiliary manufacturing units in kibbutzim, most of whose products are used by the kibbutz itself (such as sewing and shoemakers workshops).

c. Establishments that were in the process of being set up or at the running-in stage the whole year under review, and did not contribute to the manufacturing output stage.

3.4 Sampling.

The industrial surveys are based on a sample of establishments. The sample is changed from time to time. The most recent sample in use is from the 1995 survey. Previous samples were drawn toward the 1990, 1979 and 1970 surveys. The samples are updated continuously for openings of new firms which replace establishments that were closed.

The sample procedure, based on size and industry, almost didn't change during the period surveyed by us. All the larger establishments, employing more than a minimum threshold of employees, are included in the sample. This group of establishments is named "certain". All the others are sampled proportional to their size, within the industry.

This sampling procedure requires creating and maintaining an establishment register or list (in the past it was called a framework) which includes a list of establishments with data on size, classified by a 3-digit industry classification. For sampling purposes, a size characteristic based on the number of employees was attributed to each establishment. The framework includes two components:

a. Files of employers (engaging employees) received from the National Insurance Institute;

b. Kibbutz manufacturing establishments that worked for profit but did not hire employees.

3.5 "Certain" and probable establishments

The "certain" establishments are:

- All establishments in a framework that hire 75 or more employed persons.
- In a number of groups, establishments engaging less than 75 employed persons are also included.
- Establishments which belong to large economic entities.
- Different establishments having a number of files at the National Insurance Institute.

The sampling probability for "probable" establishments was determined by the industry groups and by the size group - the number of employed persons in the establishment.
The sampling probability of an establishment increases in direct proportion to the number of employed persons, according to the framework. The expansion factor of an establishment is the inverse of its sampling probability, which expresses the number of establishments that it represents in the sample (the inflation factor of a "certain" establishment is 1). For aggregation purposes, the data (either original or imputed) on each establishment has to be multiplied by the inflation factor, and the sum obtained is the "inflated data" of the establishment.

3.6 The Survey Period

As of 1987, the establishments were asked to report on their activities during the calendar year January until December. Before 1987, the survey period covered the fiscal year (April until March). Establishments whose balance sheet year differed from the survey period were allowed to report according to their balance sheet year, provided that the latter included at least six months of the requested survey year. In recent years, only a few of the sample establishments reported for a non-calendar period. Prior to 1987, all of the kibbutz establishments reported according to the agricultural year (October to September) and about a quarter of the sample firms reported for the calendar year.

3.7 The core firms of the panel

As stated, the sampling procedure of the Industrial Surveys is that the larger firms in every 3-digit industry are included in the sample with certainty. The smaller firms are sampled proportional to their size. The ‘certain’ firms are the core firms of the sample because usually they are included in more than one sample, and the data reported by them is often

more precise. This is especially essential in the estimating the capital estimates which are based on a stream of investments.

3.8 Labor variables:

- Employed persons: Employees, proprietors, workers, and unpaid family members
- Employees: All workers appearing on employee payrolls, as well as cooperatives, including workers from Judea and Samaria and the Gaza Area. Members working in an establishment and appearing on its payrolls are defined as employees, even if their wages are transferred to the kibbutz.
- Hours of work: Actual hours of work of employees, including overtime and hours of paid absence (such as vacation and illness).
- Person Year: Hours of work + estimated hours of non paid workers divided by 2000.

3.9 Classification by Industry (branch*)*.

The establishments in the 1970 to 1994 surveys were classified by industry (3-digit level) according to the 1970 "Standard Industrial Classification of All Economic Activities [6]. As of 1995, a new economic classification was adopted [7] and the firms that were included in the 1995 sample were classified by it. In addition, the 1990 sample firms were also classified by the new classification, and not only the certain firms which were, of course, classified by the old and new classifications. As part of the panel activity, we classified all the other firms by the new classification or by the old classification (respectively) by transition tables. ***As a result, all the 48,000 panel observations are classified by both the 1970 and 1993 classification systems.***

3.10 Classification by type of ownership and sector

In the various surveys, establishments were classified by sectors according to their main proprietor. In private and public limited companies, classification by sector was generally set in accordance with the voting shares held by the proprietors.. For the purpose of the Manufacturing Survey, establishments were classified into three main sectors:

a. **The public sector** - includes establishments owned mainly by the government.

b. **Histadrut (Union), Kibbutzim and cooperatives** - comprises units which were owned by the Histadrut (union), and establishments owned by kibbutzim and cooperatives.

c. The private sector - Establishments that were not related to the public sector or to the Histadrut, kibbutzim and cooperatives sectors were recorded in the private sector. This includes establishments owned by private individuals, and limited companies that are mainly owned by private individuals. The private sector is divided into two categories - limited establishments that are recorded as public share companies, and other private establishments.

4. Fixed Capital Variables.

The production function requires estimating fixed capital variables. Without a doubt, capital variables are among the more complex to measure. The usual estimating methods are based on long term series of investments, which only a panel is able to deliver.

4.1 Conceptual issues.

This section is based on reference [1], The Measurement of Capital, which was published in 1976 by the NBER. In the introduction, the editor, Dan Usher, identifies five purposes of measuring Fixed Capital, among them the investment function, the consumption function and the production function. We adopted the production function aspect, where capital is essential in estimating the elasticity of substitution between the means of production (material, labor, capital, R&D) in estimating economic growth and productivity, with an emphasis on technology.

4.1.1 Fixed gross capital stock.

The concept of capital that is most widely used by agencies that measure capital is that of fixed gross capital, measured by revalued cost. The fixed capital survey was also used in the Israeli capital surveys and defined as the **gross revalued values** of **fixed, tangible and reproducible assets**, which were employed by establishments on the end of the survey year**.**

- **'Fixed"** implies that the asset is generally employed for at least one year (i.e., not including current stocks).
- **"Tangible"** implies that only physical assets are included (but not financial goodwill, patents, etc.).
- **"Reproducible"** implies produced by man and not merely a gift of nature (such as land).

Capital defined and measured on this basis was often used in the measurement of productivity [4]

4.1.3 Fixed Net Capital Stock

Net stock of capital is defined as the sum of unused , un-depreciated, capital measured by its costs. It is calculated by deducting accumulated depreciation from gross capital stock. Depreciation is defined as the allocation of the asset over its service life. The simplest and most frequently used method is the straight line allocation method over estimated economic life. Many economists criticize this method and prefer a concept of economic depreciation which expresses the loss in value as an asset ages or the change in the price of the asset due to aging. Besides the aging, one has to take into account additional factors such as early retirement of capital and obsolescence.

It seems that the available data is too crude for estimating the more sophisticated measures of depreciation, so we remain with the straight line method, assuming that it is a close approximation of the "real" measure of depreciation.

4.1.4 Owned versus Rented Assets.

Another important issue is owned versus rented capital equipment and buildings. In recent decades, a significant portion of fixed capital has been rented by the capital user or leased from leasing companies. Young and Musgrave [4] argue that there is a need to develop capital stock by using industries (in our work, firms) rather than owning industries (or firms). Imputing the value of vast amounts of rented and leased equipment and buildings to the relevant industries can be a frustrating an impossible task. The value of owned assets is converted to implicit rental costs, and rental costs of rented or leased assets are added to derive the total capital costs. For this procedure, data are needed on rental payments and receipts.

4.1.5 Capital Services.

The late Prof. Griliches decided to adopt in our work the Capital Service measure as the proper measure for our production function oriented data panels. This is a flow, rather than a stock, concept. **It is measured by converting the owned fixed capital stock to an estimate of implicit rental costs and the addition of the rental costs for rented or leased assets.**

Fortunately the data on yearly capital rental payments are reported in the industrial surveys.

In our work, Capital Services were defined as the sum of estimated depreciation and interest on net stock of capital (at five percent) plus the cost of equipment and building rentals.

4.2 The Perpetual Inventory.

The so-called **Perpetual Inventory** method is widely used by institutions that are involved in estimating capital. The perpetual inventory method derives gross capital stock for a given year by cumulating past investment and deducting the cumulated value of investment that has been discarded.

Our capital estimates were estimated using the perpetual inventory procedure, at a firm level. The success of the perpetual inventory method in measuring the stock of fixed capital depends, to a large extent, on the service life assigned to different types of assets [4].

4.3 Data Sources

The fixed capital estimates are based on data from the following sources:

- **Capital Surveys**. Three Capital Surveys were conducted in Israel, in 1968, 1982, and 1992, covering only a 25 percent sub-sample of firms. For those firms, the distribution of the owned capital by year of investment and the annual investments that were collected regularly in the Industrial Surveys were used in the constructing of capital stock, net capital and capital services measures using the perpetual inventory method.
- **“Certain" Firms**. The annual investment data which was reported by the large firms which were included in the panel for many years (designated as "certain" firms), supplied a large part of the data needed for the estimation of their capital measure. Missing data was imputed by interpolation and extrapolation.
- **Other Firms**. For other, smaller firms, we did not have an appropriate benchmark, and **capital services** levels were imputed statistically, using information on

investment in the sample and its relation to the estimated capital services and other variables in the sub-samples with available benchmark data.

See Appendix A for a more detailed description of the Fixed Capital Surveys.

5. 1 Capital R&D.

The basic approach in our panel is that, for the study of productivity, it is proper to include not only tangible capital but also knowledge and human capital.

The traditional accounting system deals only with physical capital; R&D expenditures are treated as current expenditures and not as investments, and are included as such in the profit and loss accounting report. The alternative approach is to refer to R&D expenditure as investments and to construct R&D capital by aggregating past R&D expenditures. Prof. Griliches. (2000) adopted this approach, and in *Education and Productivity, A Retrospective* [3] he discusses some conceptual and practical concerns associated with this definition, such as linearity, obsolescence and depreciation (the conventional R&D service life of 7 years). We estimated R&D capital services as of the early seventies for all the firms that reported R&D expenditure in the R&D surveys and in other sources such as the Supported R&D data base.

5.2 R&D Definition.

Research and Development (R&D) is defined as a systematic and original activity, intended to create new scientific or technological know-how or alternatively to develop new applications for existing scientific or technological know-how.

R&D does not include planning and running-in of a production system of a product whose production process is already established technologically; purchase of know-how (including

patents); quality control; market research; promotion of sales and providing services related to sales; surveys and calculations related to planning or to the production process.

5.3 Sources of data. The R&D Surveys

As of 1969, the CBS has conducted regular surveys on R&D expenditures and grants. The first ten R&D surveys (in the years 1969 to 1979) were conducted on a census basis. Afterwards, through 1984/5, the surveys were sample surveys drawn from a frame list which is assumed to cover the entire population engaged in R&D. From 1985 to 1989, the sample covered only the larger firms with R&D (50 employees and more). In 1990, the sources of information on firms which conduct R&D were broadened and the survey was conducted as a census of all manufacturing establishments engaged in R&D with 5 or more employees. Since 1991, the R&D surveys have been based again on a sample basis which was drawn from the 1990 sample with adjustments for firms that began conducting R&D. In 1997, the sample frame was updated and a new sample was drawn, which is still in use.

A panel of all the firms which reported R&D in at least one of the 1969 to 1999 R&D surveys was constructed. Missing data was imputed using interpolation techniques. These data were deflated by the Consumer Price Index and used to calculate, for each firm*year, R&D capital stock and services using the same procedure as for fixed capital services, assuming a service life of 7 year (A depreciation rate of 1/7).

The R&D panel was matched with the detailed data set that was received by the CBS from the Chief Scientist on supported R&D for the years 1987-1999 and used to estimate R&D expenditures for firms that were not included in the R&D sample but conducted supported R&D.

The R&D survey population: The survey includes all manufacturing establishments employing 5 persons or more, which were engaged in R&D. The population does not include non-profit institutions or the diamond industry. Nor does it include defense R&D conducted by the large defense establishments.

The sample frame. The CBS maintains a list of firms that are likely to conduct R&D. Most regular information on R&D firms is received annually from the Chief Scientist of the Ministry of Industry and Commerce. The information refers not only to firms that conducted R&D but also to firms that applied for R&D support, but whose applications were denied. In addition, the bureau collects information on R&D activity from the firms that report to the annual industrial surveys which were described in the previous section. The list is updated on an ongoing basis, especially in years that the sample is changed. For example, during the nineties the list was updated in 1990 from an R&D census which was conducted in that year. In 1997 the list was updated from an innovation survey that also included firms that were engaged in the development of products and processes beside the establishments that received government funding in 1995-1997 from the Chief Scientist of the Ministry of Industry and Trade or funding from bi-national foundations. Establishments receiving funds from consortia were included as well. As stated, the main data which was used in the estimation of the R&D Capital variable was the annual expenditure on R&D, which includes the following items:

- **Wages and additional labor expenses on R&D**: The establishments' total expenditures which are related to persons employed in R&D, including practical engineers, technicians and not professionals. This item includes payments for wages, overtime, premiums, "13th month salary," clothing fees, vacation, recreation and illness fees, directly paid to the employees by the establishments, as well as payments by the establishment to various funds (such as National Insurance, pension schemes, etc.).

- **Expenditures on materials and energy for R&D**: This item includes raw materials, auxiliary materials, tools and instruments which are used for less than one year, fuel, water, electricity, etc.
- **Other expenses, including overhead**: The establishment's expenditure related to R&D which are not included in the previous items, such as overhead maintenance, travel abroad related to R&D, etc.
- **Payments to external factors for R&D work** (excluding payments for patents): This item relates to R&D conducted by external factors.
- **Capital formation** in construction and equipment for R&D is capital formation in buildings, machinery and equipment, whose usage exceeds one year, for research and development.

  The firms were also asked to report on employed persons in R&D during the year, not only academics or technicians but also production and maintenance workers, as well as managers and clerks.

Reliability and Limitations of the Data. The results of this survey, like those of any other statistical survey, are subject to a number of limitations. The main limitations of the R&D survey are the lack of the establishments' accurate recording of expenditure related to R&D (especially in the case of expenditure on wages, when a considerate portion of those engaged in R&D are also engaged in other activities, and there is no distinction in the records between the labor inputs in the various activities); and incomplete understanding of the definition of "Research and Development" as a result of which, in some of the establishments, R&D activities were excluded, whereas activities erroneously related to R&D were included.

It should be noted that most of the establishments to which we applied responded willingly and filled in the questionnaires.

6. Human Capital

Human capital was also one of the topics that was given priority in Prof.Griliches research agenda. He claimed that the main, and possibly only, approach to testing the productivity of schooling directly is to include it as a separate variable in an estimated production function. In his attempt to find a measure of the quality of labor, he adopted the suggested method of creating a "weighted measure of labor input, weighting different types of labor (by occupation) by their relative wages or cost of labor" (see [3]). He also mentioned that its inclusion in a Cobb Douglas production function has the additional implication that the coefficient of such an index should equal, approximately, the coefficient of labor quantity.

Our labor quality index is based on the occupational distribution of a firm's labor force. It is an index of technical-scientific labor per worker, with different groups weighted by approximate relative wage weights. The data is based on periodic surveys of labor structure in manufacturing conducted by the CBS. For each firm we created the index of technical-scientific labor 'quality' (per worker) with different groups weighted by appropriate relative wage (engineers=2, technicians=1.75, other workers =1). The 1970 and 1978 values of the index were used in the 1970-1977 period, the 1978, 1982 and the 1988 values were interpolated in the 1979-88 period and the 1988 and 1997 index values were interpolated for the 1990-1999 period. Missing data was imputed by tabulation by industry and size groups.

6.1 Professional Labor Force Surveys

Data on the occupational mix of the labor force was collected in periodic Surveys of Professional Labor Force in Industry which were conducted by the CBS in 1970, 1988, 1993 and 1997. For the years 1978 and 1982 we used data from the Ministry of Industry and Trade The surveys distinguish between engineers and scientists, other academics, practical engineers, and technicians and other workers.

Population and Sample All the surveys are based on the industrial surveys. All of the

establishments that were included in the sample were included in the structure of labor force in industry.

The Topics of Investigation. The main topics are education, sex and age distribution. In the first three surveys, firms were asked to report the distribution of their workers by their education. In the 1993 survey, it became clear that workers' education was irrelevant for the new immigrants from the former USSR because many of them didn't work in their profession. In addition, the establishments were unable to report education skills for those immigrants and other workers and instead reported for them education levels required to fulfill the post that they held. In the 1997 survey, the CBS explicitly asked the firms to report the education distribution by the education required to fulfill the positions actually held. This change made it easier for the establishments to answer the questionnaire. The survey questionnaire also included questions on age, sex and shift distribution. The rate of response was around 75 to 80 percent. Imputations were made using the questionnaire in a previous survey or by the firms' industry distribution. The results of these surveys, like those of any other statistical survey, are susceptible to several limitations in addition to sampling errors. The limitations in the surveys at issue here are the absence of accurate records on the distribution of employed persons by function and age group, and incomplete understanding of the definition of function versus schooling.

Definitions of Education Groups.

- **Engineers and scientists** include persons with academic schooling in engineering, computer sciences, natural sciences, medicine, or pharmacy, and other employed persons with a similar level of education who were given appropriate functions.
- **Practical engineers and technicians** include practical engineers, technicians, and computer personnel who graduated from a recognized post-secondary school, and other employed persons with a similar level of education who were given appropriate functions.

- **Other professionals** include persons with other academic schooling, such as economists, accountants, and attorneys, and other employed persons with a similar level of education who were given appropriate functions.

- **Other employed persons** include those who belong to none of the previous categories.

7**. Life cycle variables**.

7.1 Age and cohort. One benefit of such a panel is that it enables us to improve what we call life-cycle variables, namely age and cohort variables. An organization's age is calculated, by definition, by subtracting the year the firm was founded from the current year. While the age of a human being is clearly defined, an organizational age is not a clear-cut event. Several events, such as the year of change in ownership, or a change in the legal status or in the business activity domain, are frequently referred to as the firm's foundation year. In addition, the firm's officials do not always know their firm's founding year, perhaps because age is not a figure that firms are usually requested to report to the authorities or to the public. During the 45 years which are covered by our data, the firms were requested several times to report their establishment year. During this time, many firms reported quite different founding years. In the process of putting together the longitudinal panel, we were able to track more precisely the year that a firm entered the manufacturing industry for the first time. The information we recorded during the longitudinal data construction was very valuable in mapping cohorts and firm age.

7.2 Entry and Exit Events

Regarding firms' entry, Caroll and Hannan [2] distinguish between founding, new entries without prior organizational experience, and other entries such as mergers, spin-offs and

entries from other industries. In a similar way, the exit events are disband (probably the main exit path of the small and medium firms), mergers (for the large firms), and acquisitions (common now in high tech industries). With multiple types of entries and ways to exit, it is much more difficult to define and understand the turnover or replacement process.

7.3 Multi Firms and Mergers and Acquisitions.

We define a multi firm as a group of manufacturing firms which are controlled by or belong to a holding company. Often the holding company is a leading manufacturing firm which owns or controls other firms. In that case the leading company is counted as a multi firm. In other cases, the holding company is an investment company which doesn't belong to the manufacturing industry and it is not included in the panel. The original industrial firms are those that were founded during the British Mandate of Palestine, from 1918 to 1948. At that time, only a few firms could be considered as multi firms. Firms that were established afterward started as a single firm identity. That is why we can assume that a great portion of the current multi firms are outcomes of mergers or acquisitions. The acquired firms continued to exist for a while as legal entities, and at some stage they where fully included in the leading firm. Only in the last case, the acquired firm is recorded in the official statistics as an exit. The information on the creation of multi firms by mergers or acquisitions, disbands or other relevant events was gathered from information received during the collection of data from the firms, from the Dun and Bradstreet directories and from administrative data, i.e. the VAT ID. A multi firm unit is eligible to pay VAT for all of the firms that belong to it, or are controlled by it, and allocate to the firms the same VAT ID number. The multi firm also records the year that each firm started to report under the multi firm's ID. This information enabled us to identify mergers and acquisitions and to track the pre-merger and post-merger periods. As the VAT was established in Israel in 1976, and Dun and Bradstreet published its first Israeli directory in 1979, we are able to

record the merger year only for mergers that occurred from the late seventies of the 20 century.

In conclusion, our mobility measures include a dummy for disband firms, which represents the period they operated before their closures; a dummy for firms that went through a process of M&A for the period that they operated as autonomous firms; and a dummy for multi firms which includes the post-merger years.

8. Firm Characteristics

8.1 Industries.

This characteristic variable is based on the 3-digit classification of industries which is described in Chapter 3.6. It includes 7 aggregate industries:

1) **Food** manufacturing includes: food products, beverages, and tobacco products (Divisions l4, 15, 16).

2) **Textiles**, Apparel, and Leather manufacturing includes: textiles, apparel and footwear products, and leather and leather products (Divisions 17, 18, 19).

3) **Paper, Printing**, and Manufacturing n.e.c. includes: paper and paper products publishing and printing, jewelry, goldsmith and silversmith articles, and other manufacturing n.e.c. (Divisions 21, 22, 38, 39).

4) **Building manufacturing** includes: mining of minerals, quarrying of stone and sand, wood and wood products, and furniture and non-metallic mineral products (Divisions 13, 20, 26, 36).

5) **Chemicals** and Plastic manufacturing includes: chemicals and their products, refinery of petroleum, and plastic and rubber products (Divisions 23, 24, 25).

6) **Metals and Machinery** manufacturing includes: basic metal, metal products, machinery and equipment, and office machinery (Divisions 27, 28, 29, 30).

7) **Electricity and Electronics** manufacturing includes: electric motors and electric distribution apparatus, electronic components, and transport equipment (Divisions 32, 33, 34, 35).

8.2 Ownership and Sector.

This classification is based on the classification which is described in Chapter 3.7

In the panel we classified the firms into five groups:

- Public Ltd. firms
- Histadrut (union)
- Kibbutz
- Public (government)
- Private (All the other firms)

8.3 The industry technological intensity classification was developed by the OECD. They classified industries into 4 groups: high tech industries, medium-high, medium-low and low-tech industries. The technology intensity classification was adjusted to Israel's industry structure and it is now widely used in the industrial statistics.

List of Industries by Technological Intensity

Industry	Code
1. High technology industries	

Office & computing equipment	30
Electronic components	32
Aircraft	355
Electronic communication equipment	33
Equipment for control & supervision	34
Pharmaceutical products	245
2. Medium-high technology industries	
Chemicals & refining petroleum (excl. pharmaceutical products)	24+23-(245)
Machinery & equipment	29
Electrical equipment & electrical motors	31
Transport equipment	35-(353+355+358)
Transport equipment n.e.c	358
3. Medium-Low technology industries	
Mining & quarrying	10,11,12,13
Rubber & plastic products	25
Non-metallic mineral products	26
Non-ferrous & precious metals	271, 273
Iron & steel foundries	270, 272, 274
Metal products	28
Ships & boats	353
Jewelry & silversmiths	38
Articles n.e.c	39
4. Low technology industries	
Food products, beverages & tobacco	14, 15,16
Textiles, wearing apparel & leather	17,18,19
Paper, printing & paper products	21,22
Wood & furniture	20,36

9. Market Variables

9.1 Concentration. Concentration is defined as the market share of the three leading firms in the local market at the 3-digit level of industries. The local market includes sales of

domestic and “penetrated imports”. Penetrated import is defined as the import of products in which the domestic production exceeds 20 percent of total sales at the 3-digit level.

9.2 **Import penetration**. Import penetration is defined as the share of the products that were defined as competitive import, from the total sales in the industries market.

Appendix A.

The 1992, 1982 and 1968 Surveys of Gross Capital Stock in Manufacturing.

The surveys supply detailed data on the composition and the vintage of the fixed gross capital stock in manufacturing. This data enables the gross and net capital at constant prices to be estimated. Gross capital refers to assets that were in use at the surveyed year and complied with the following: they are fixed, intended to be used for more than a year; tangible, physical assets, as opposed to financial assets, reputation, patents, and so on; manufactured assets which are man-made, and not gifts of nature, such as land.

The value of the assets that were in use by the establishments in the beginning of the surveyed years 1992, 1982 and 1968, at replacement costs namely the estimated cost required at that time to purchase these assets in current prices, if they were new, were of the same type, model, capacity, and had the same unique features.this sentence is too long and confusing… Fixed gross capital stock does not include merchandise - finished products, products in process, or stock of raw materials. By definition, the value of the annual depreciation rates of the assets is not deducted from the fixed gross capital stock.

The survey estimated data on fixed gross capital stock (according to the above definition) by revaluation of historical data.

There are other ways of estimating gross capital as well, such as estimation by an assessor or assessment of assets by type and list price. These methods are complicated and impractical when dealing with manufacturing establishments in all industries. The capital assets were divided into three main categories:

• **Structures** stock, which includes buildings and parts thereof (offices and stores), plumbing for the buildings, fences, facilities, and environmental development, but not the value of the land. The value of buildings older than 30 years was included in the survey at one annual depreciation portion of the acquisition value, assuming the "straight-line" depreciation method and an asset lifetime of 30 years. This is done to reflect deteriorating use and scrap of old capital stock.

• **Machinery and equipment** stock, which includes machines, instruments, dies, cranes, pitchforks, tractors, furnaces, furniture, office equipment, computers, and service equipment, including installation charges. Start-up costs are part of the capital formation in equipment and are therefore included in the survey.

• **Vehicle stock**, which includes cars, motorcycles, and all other motor vehicles. The survey includes the vehicle stock older than 8 years. .

Sampling . The Capital survey included a sub-sample of the firms which were investigated in the current Industrial Survey. In the 1992 survey, the probability that an establishment would be included in the sample was determined as follows:

• All establishments with 400 or more employed persons were included ("certain" establishments). There were several cases that the reporting unit of a "certain" establishment included several establishments. In these cases, all activity of the reporting unit was included in the sample with certainty.

• The relative share of each establishment was computed on the basis of total expanded estimate (using the expansion factor of the sample from Manufacturing and Crafts Survey) for four variables: wage-earners, wages, revenue, imputed capital stock. The average of the four variables was then calculated for each establishment. The probability for the establishment was relative to this value; however, if this calculation produced a probability greater than 0.75, the establishment was deemed "certain." An effort was made to maximize overlap between the new sample and sample used in the 1982 Survey of' Fixed Capital Stock, without impairing computed probabilities.

The sampling order was as follows: a division according to the 1993 Standard Industrial Classification of all Economic Activities, two size groups (except industries 13, I G, 23, and 39), a group according to the above classification industries, and revenue per employed person.

Stages of work on the survey

Collection of data: The survey is based on data from the so called “Form 1324/K”, which is submitted by the establishments to the income tax authorities. This form includes the information needed to calculate depreciation, mainly investments by capital good (type) and investment year. For most of the firms, the data was available in the firms’ file at the tax authorities and photocopied. For the remaining establishments, the data was collected by phone or by visits to the firms’ offices or to their accountants. Only a small number of forms were received on magnetic media.

Preparation and typing of the data – The main problem was to capture the data on magnetic media. The 1324/K Forms ranged in size from a few lines, up to tens of thousands of lines per firm. Overall, in the 1992 survey, close to one billion digits were

received. The preparation of these forms included marking the acquisition values of assets, marking acquisition dates, classifying assets by main type of capital stock, assigning a check digit for each year, and marking the currency used on the form.

The reliability of the data and the accuracy of typing are of extreme importance, because an error of a few shekels in an acquisition cost or an error in the year an asset was purchased, may cause an error of millions of shekels in the sum (because of the difference between cost price and revaluation price due to high inflation). Therefore, maximum effort was invested in checking the material entered. Furthermore, the reliability and feasibility of the data obtained from the 1324/K Forms were evaluated by comparing the data with capital formations recorded in the Manufacturing and Crafts Surveys and with data obtained in the 1982 Survey of Fixed Capital Stock. In a few cases, division workers had to contact establishments to verify data on the purchase of assets that seemed completely unreasonable.

Checking of data input: The preliminary typing check was done by comparing sums of data entered with the sums that appeared on the 1324/K Forms themselves . Years that seemed unreasonable were also checked.

Additional logical checks - In order to achieve the desired high quality of material entered, relatively simple typing checks were not sufficient, and a series of meticulous logical checks was also done.

The value of assets was converted in constant prices. For this purpose, the historical price of the assets (or the market price at time of purchase, in the case of gifts and grants) were revalued using investment price indexes derived by the National Account

Imputations - In the 1992 survey, data could not be obtained for 12.7% of the establishments in the survey sample. For those firms, fixed gross capital stock was imputed. Imputation for total capital components per employed person and grants per employed person, with the year unspecified, was done by linear regression, where the explanatory variables were wage per wage-earner, materials per employee.

Fixed Values. The Production Function model requires data on quantities of production and inputs. In fact, only labor is measured quantitatively – in hours or person years. The production and all the other inputs: intermediates, fixed capital, R&D capital, are estimated by converting data in current prices to data in constant prices.

In Israel we do not have an index of industrial output and input. We do have a local sales price index and we have, from the foreign trade statistics, export and import prices. This price data enabled us to construct a production price index by weighting them with local and export sales, at the 3-digit industry level. The construction of the intermediate price index was much more complicated. It is based on information regarding imports and purchases from local production as calculated in the Input-Output Tables. Here the data are classified into 186 sub-branches of commodities and services. The overall index for an industry for the intermediate output price is a weighted index of import and local production prices, weighted by the values from the 1982 or 1995 basic input-output tables. This method was suggested by Professor Melvyn Fuss of the University of Toronto.

Innovation Index

Mobility

Multi Firms

We define a multi firm as a group of manufacturing firms which are controlled by or belong to a holding company. Often the holding company is a leading manufacturing firm which owns or controls other firms. In that case, the holding company is counted as a multi firm. In other cases, the holding company is an investment company which does not belong to the manufacturing industry, and it is not included in the panel.

The roots of the industrial firms can be found in the firms that were founded during the British Mandate of Palestine, from 1918 to 1948. At that time, only a small number of firms could be classified as multi firms. Firms that were established afterward started as a single firm identity. That is why we can assume that a great portion of the current multi firms are outcomes of mergers or acquisitions. The acquired firms continued to exist for some time as legal entities before eventually becoming fully incorporated into the leading firm. Only in this latter stage were the acquired firms recorded in the official statistics as an exit.

In conclusion, our mobility measures include a dummy for disband firms which represents the period they operated before their closures; a dummy for firms that went through a process of M&A during the period that they operated as an autonomous firm; and a dummy for multi firms, which includes the post-M&A years. At a later stage, we will try to incorporate the time of the M&A of the multi firms.

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