Micro-analysis of firm data

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1. Introduction

In the previous decade interest has been growing among economic researchers for micro-economic data of firms (enterprises and establishments). Statistics Netherlands (CBS) collects and processes large quantities of such data. For instance detailed information on output, inputs, costs and revenue for a large number of firms are collected in the annual Production Surveys, while the Investment Surveys cover gross investment expenditure of the same respondents.

Increasingly, statistical bureaus have recognised the importance of firm micro-data, both for their own statistical analyses and for research. For example, linking data from several surveys enables the creation of new statistical products, and by combining data from the same survey across several years one can analyse the dynamics of firm behaviour.

In recent years we have also seen a growing interest in firm micro-data of firms by academic researchers. In the USA a lot of research has been carried out, using mainly data from the US Bureau of the Census. In the Netherlands the CBS has been carrying out major research projects since 1985, exploring individual firm data (see Huigen et al., 1992, for an overview of the first seven years). In other countries, such as Norway, Israel, France, Canada, and Finland, similar research projects are being carried out by the national statistical bureaus. At the international level, Eurostat has initiated the Enterprise Panels Project (EPP), which provides international coordination and discussion forums (EPP-conf., 1994).

Lastly, policy makers, too, are becoming more and more interested in analyses of firm micro-data of firms. For example, the 1994 G7 conference decided to ask the OECD to carry out some research projects on productivity and employment, one of which was to analyse micro-data of firms. Work on these projects and similar ones has been the subject of official conferences in Washington DC and Rotterdam.

Within several statistical bureaus this growing interest in micro-data of firms has led to the institution of separate units to create and maintain statistical databases with micro-data, carry out research, and provide facilities. Examples are the Center for Economic Studies (CES) at the US Bureau of the Census and the Centre for Research of Economic Survey Data (CERES) at Statistics Netherlands.

This article reviews these developments, their background, and examples. In section 2 we discuss the importance of micro-data for statistics and in section 3 their importance for economic research. Section 4 gives some examples of recent research at Statistics Netherlands. Section 5 describes how micro-economic databases are created at Statistics Netherlands, and section 6 how external researches can analyse these data. Section 7 gives some conclusions and looks at future developments.

2. Micro-data and statistics

There are three main reasons why micro-economic data are important for statistics. First, when micro-economic data are gathered they allow the creation of new statistical products by linking data from several surveys and/or from several years. By combining data from several surveys we can make all kinds of tables that cannot be made from the aggregated data of the surveys themselves; for example, by linking data from the R&D Survey and the Production Survey we can tabulate the relation between R&D and profits, or R&D and employment. A case in point is the recently published R&D Survey (CBS, 1995), where such a linked database was used to show that enterprises with R&D expenditure have a much higher profit margin than enterprises without R&D expenditure; this holds in particular for firms innovating new products, whereas firms innovating new production processes have a lower profit margin than firms without R&D expenditure.

Dynamic relationships can be identified and change statistics drawn up by combining data on several years. An example are the gross-flows statistics of the labour market, which show how many jobs have been created and how many destroyed. These statistics are computed from a micro-database of firms with data on several years (Davis and Haltiwanger, 1994). The results show that flows in the labour market are much larger than the net changes. Another example are dynamic effects of R&D: the R&D Survey shows that labour productivity grows more in enterprises with R&D expenditure than in those without; particularly for firms innovating new production processes, whereas firms innovating new products are comparable with firms without R&D expenditure.

Micro-economic data can also be useful for industrial and commodity classifications. We can much more easily investigate the consequences of alternative classifications or extrapolate new classifications backwards in time. We can also use statistical techniques or econometric analyses to devise new classifications. For example, at Statistics Netherlands a project is underway to investigate the possibilities of cluster analysis for making an industrial classification.

A second area where micro-data of firms are important is in the statistical production process. Inconsistencies and structural breaks can often be solved only by investigating the micro-data. An example is given by Van Leeuwen (1992), who compared investment in buildings according to the Investment Survey and the construction of buildings according to the Construction Survey. The differences between the two series appeared to be caused by differences in observation between the two surveys and could only be traced by comparing the observations of the same entities from the two surveys.

A third reason why micro-data are important is that scientific research can indicate problems in surveys. Apart from statisticians, researchers are the most important users of micro-data and they often use the data for a research question that has not been anticipated by the statistician. Problems they encounter in their research can provide indications for improvements of a survey. For example, in an analysis of an econometric model of the demand for energy, it was found that the yearly changes in the energy unit values showed a spread that was too large in comparison with the rate changes of public utilities (Kleijweg et al., 1989), resulting in major improvements in the Statistics Netherlands Energy Survey.

All these examples clearly show that micro-data are important because firms are heterogeneous: they differ in all respects and these differences can only be investigated with a database with as many firms as possible and with as many characteristics as possible of these firms.

3. Micro-data and economic research

In recent years the discipline of economics has increasingly come to recognise that many problems, including macro-economic ones, can only be investigated by using micro-economic data of firms (McGuckin, 1995). For example, in a survey article on unemployment, Bean (1994, p. 615-6) argues that not much can be learned from macro-data and that only micro-econometric studies can bring new insights into the determinants of wages and employment; and Nobel laureate Richard Coase also emphasised the relevance of micro-data of firms in his Nobel speech (Coase, 1994, p. 14). One important reason why micro-data are needed for the analysis of macro-economic problems is that many recent macro-economic theories do not start from the 'representative producer', but from heterogeneous producers. Application and testing of these theories is not possible with aggregated data, but require micro-data.

Moreover, using micro-data has many practical advantages. In the first place, many explanatory variables in economic models, such as input prices, are exogenous at the micro level, whereas at the macro level there is often simultaneity between prices and quantities. For example, an increase in the demand for labour by an individual firm will have little effect on the wage rate, but an economy-wide increase will in general lead to a wage rise. A second advantage is that micro-data enable a disaggregation of the results, for example with respect to firm size or industry, whereas it is difficult to obtain sufficiently long time-series of meso-data. In this way the availability of time series data for individual firms can be used to test for differences in behaviour between groups of firms. Thirdly, estimation results based on aggregate time series may suffer from lack of precision because of the trendlike behaviour of most variables. Fourthly, panel data, constructed from the micro-databases, offer an opportunity to use the information on both the intertemporal dynamics (time-series dimension) and the unique features of individual firms (cross-section dimension of the data); this enables the researcher to test more complex models and to control for some sources of bias such as the effects of missing or unobservable time invariant variables.

However, micro-datasets also raise several problems related to data issues. For some variables there may be no appropriate observations at the micro level and for other variables measurement may deviate from theoretical constructs. Prices for inputs and outputs and data on the stock of physical capital are typical examples. For labour, materials, energy and output, some kind of implicit price measurement (unit values) is available from the Production Surveys. These measurements are fairly remote from the theoretically preferred price indices. Ignoring these errors in individual firm data will result in biased estimates and may lead to erroneous conclusions. As mentioned in section 2, measurement error is one area where economic research may have an impact on the production process of statistics. Another problem is that the data may not represent a random sample from the population due to attrition, resulting in selectivity bias. The various data problems can be solved by using information from other surveys, by using more restrictive models and by using standard econometric correction techniques.

4. Micro-data at Statistics Netherlands: organisational aspects

At Statistics Netherlands several divisions collect data on enterprises and establishments:

- the division of agriculture, industry and the environment collects data on output, value added, inputs, producer prices, energy, technology, the environment;
- the division of trade, transport and services collects data on output and value added, and financial data;
- the division of socio-economic statistics collects data on wages, employment, education.

Together the division of agriculture, industry and the environment and the R&D division have set up two units for micro-data of firms. The first – the Microlab – assembles databases from the separate surveys, links the firms from these databases and creates statistical products. The databases cover the years 1978–1993, until now only for the manufacturing industry. Recently, the Microlab has started to link these data to the data from the wages and employment surveys, so that a database with firms and employees within these firms can be created.

The other unit, the Centre for Research on Economic Survey Data (CERES), conducts research and provides facilities for external researchers. Previously the research focused on production structures; now it focuses on technology and productivity (see section 5). For the second task of CERES, providing facilities for external researchers, a separate computer network has been installed. External researchers wishing to analyse micro-data can hire the facilities; they also have to pay a fee for using the data. Strict security procedures ensure the protection of confidential data: only academic researchers have access to the data, external researchers have to sign a confidentiality form and are not allowed to take results outside the building, the report is thoroughly checked before it is to be published, and access to the CBS computer network is impossible from the separate network.

5. Research at Statistics Netherlands

In cooperation with Rotterdam University and the Economic Institute for Medium-sized and Small Businesses, Statistics Netherlands set up a research project on firm behaviour in 1985 (see Huigen et al., 1992). The project focused on the structure of production, in particular the aspects of energy and employment, and lasted until 1992. Several studies were carried out, concerning:
- energy demand
- the relation between firm size and firm growth
- the dynamics of employment
- the substitution between production factors
- the effect of sampling errors on estimation
- the appropriateness of firm-specific unit values.

For each study databases were constructed from several surveys and data problems had to be solved before the actual analysis could start.

In 1994 a new research project was started, in cooperation with the Free University of Amsterdam, focusing on technology and productivity. This project consisted of the following studies:
- productivity and downsizing
- productivity and new technology
- the return to R&D.

Again databases had to be constructed, in addition to the earlier ones.

The remainder of this section will discuss some of the data problems and the results of some of the studies. More information on the first research project can be found in Huigen et al., 1992 and in the papers mentioned in the references list at the end of this paper.

Data problems

Extensive data sets are needed for the estimation of models of firm behaviour. In order to make inferences about economies of scale and substitution between factors of production such models require data on prices and quantities for all factors of production and for gross output. The list of production factors includes material inputs, labour (preferably for different skill levels), capital and energy. Data on prices are required to decompose changes in values into changes in prices and changes in quantities, and are also important explanatory variables in models of firm behaviour. The yearly Production Surveys consist of data on costs of inputs and the value of sales and gross output together with corresponding quantities for material inputs. For several reasons the implicit price data of the Production Surveys could not be used straightforwardly.

Using data of the Production Surveys, unit values for intermediate inputs and gross output could have been calculated. To evaluate the implicit price data of the Production Surveys the available data on gross output for a small sector, i.e. the rubber processing industry, were investigated more closely (Huigen, 1989). The results clearly showed that unit values, not corrected for quality changes, are far inferior to the Laspeyres price indices compiled by the Department of Price Statistics for the sector as a whole. Therefore it was decided to use the sector price indices for material inputs and gross output instead of unit values at the firm level. These indices are available for approximately 70 branches of the manufacturing industry.

Data on total employment and total labour costs are available from the Production Surveys. Dividing the reported total wage bill (including social contributions paid by employers) by the number of employees, yields data on the implicit price (unit value) of labour. Total employment is used as a measure of labour input. These measures for labour input do not take into account the reduction in the weekly working hours in 1983 and 1984 and the steady increase in part-time work. Furthermore, there is a wide dispersion across firms in the average labour costs, probably reflecting differences in the composition of employment rather than true wage differences. In order to obtain more appropriate measures for labour input and labour costs, taking into account shortening of working hours and inter-firm differences in the composition of employment, Production Survey data were matched with Wage Survey data. The latter contain information on the composition of employment, working hours and wages. These data have been collected in yearly sample surveys from 1984 onwards. Constructing longitudinal data on labour costs and inputs for different types of labour proved to be very time consuming. Many difficulties had to be solved in order to be able to use the data from the Wage Surveys (Huigen et al., 1990a and 1990b). Lastly, it only appeared to be feasible to construct measures for labour inputs and labour costs for two broad categories (blue and white collar workers) and for a relatively short period comprising the years 1984–1987.

Attempts have been made to construct alternative measures for the stock of capital by using data on financial capital and data on investment in fixed assets. These attempts were not very successful either (Hommes and Van Leeuwen, 1987). It appeared to be impossible to integrate the information about the financial structure of enterprises and the firm data of the Production Surveys, mainly because of differences in definitions of the statistical units. A measure for capital costs was constructed using the Jorgenson formula for the implicit rental value of capital. Components of this measure are price indices for investment goods, the long term interest rate and tax parameters such as the corporate tax rate and investment subsidies. Price indices for investment goods were derived from capital stock deflators for 50 sectors of industry. These implicit deflators were computed with the aid of aggregated data on the composition of the capital stock in 1986.

Compared with the other production factors there were only minor data problems for energy. Data on quantities consumed and costs paid for natural gas and electricity were readily available from the Production Surveys. These have been used to compute unit values. Because of the homogeneous nature of both commodities unit values may serve as adequate price measures. In addition Divisia price indices were calculated for total energy. Data problems for energy were restricted to the elimination of outliers with the help of extraneous information on the structure of tariffs of natural gas and electricity supply. Furthermore many firms, especially small ones, did not report either the value or the volume of natural gas and electricity consumption, so that these firms had to be omitted in the analyses of energy demand at the firm level.

Energy demand

In the energy study the reaction of firms to the increases of energy prices was analysed by estimating a cost share equation for energy. We followed the standard neoclassical theory of the firm to derive the cost share equation, in which the cost share of energy is related to the level of gross output, the price of energy and the prices of other inputs. The equation contains firm-specific constants as well as time-specific industry constants. The first constants represent the effects on the cost share of energy of time-invariant missing or unobservable variables. The other group of constants represent the effects on the energy cost share of labour and capital prices. The equation was extended with three lagged energy prices in order to make inferences about the speed of adjustment.

The cost share equation was estimated for different partitions of the energy panel in order to investigate differences between groups of firms. Estimation results for different sectors of industry are presented in Kleijweg et al. (1989). In Table 1 the estimation results for the scale and long-run price elasticities for energy demand are presented for firms classified by energy intensity, investment/output ratio and number of employees. The scale and price elasticities measure the percentage change of energy consumption due to a one percent increase of output and energy prices respectively.

For total manufacturing the estimate for the scale elasticity of energy demand is 0.61 and for the price elasticity of energy demand –0.56. The corresponding standard deviations are 0.02 and 0.10. Thus, both the effects of output and energy prices are estimated with substantial precision. The result for the price elasticity clearly implies that energy consumption is considerably reduced when prices increase. It should be noted that the estimate of the price elasticity obtained with panel data is strikingly similar to the price elasticity –0.54 found by the Dutch Central Planning Bureau (CPB, 1984) in a study based on aggregate time series data. This indicates that most of the energy reduction takes place within existing firms, and should not be attributed to the changing composition of industries e.g. due to the birth and death of firms.

Table 1. Scale and energy-price elasticities

	Number	Scale	Own-price
Energy intensity			
< average	1,321	0.47	–0.80
		(0.01)	(0.04)
> average	322	0.67	–0.60
		(0.04)	(0.14)
Investment ratio			
< average	1,024	0.50	–0.45
		(0.03)	(0.13)
> average	619	0.71	–0.69
		(0.04)	(0.14)
Firm size			
Small firms	733	0.54	–0.48
(10–50 employees)		(0.04)	(0.16)
Medium-sized firms	364	0.70	–0.61
(51–100 employees)		(0.04)	(0.18)
Large firms	425	0.61	–0.68
(101–500 employees)		(0.04)	(0.15)
Very large firms	121	0.62	–0.95
(500 employees)		(0.11)	(0.43)

Table 1 shows that the scale elasticity is significantly higher for the energy-intensive firms than for the energy-extensive ones. The opposite applies to the price elasticity. This result may be explained by the fact that relatively energy-intensive firms use more of their energy consumption in the production process than energy-extensive ones. It is less easy to reduce this type of energy use than the energy consumption associated with heating and lighting buildings. Lastly the pattern observed for the partition according to the investment/output ratio supports the view that to some extent energy savings can only be realised by investing in more energy-extensive equipment.

The division by size shows that medium-sized firms have the highest and small firms the lowest scale elasticity. Furthermore the price elasticity increases monotonously (in absolute value) with firm size. Although the difference between the estimated price elasticities of small and very large firms is not significant this may indicate that large firms can reduce energy costs more than small firms. Large firms may have more know-how and experience so that they have more possibilities to save energy. In Kleijweg et al. (1990) it is shown that these differences in long-term price elasticities between size classes are related to differences in adjustment patterns. The immediate impact of a change in energy prices is almost the same for all size classes. For small firms this impact vanishes after two years. For other firms, however, it vanishes after three years (medium-sized firms) or even longer (large and very large firms).

The relationship between firm size and firm growth

The statement ’small firms grow faster than large ones, so growth of employment is due to small firms’ was investigated using employment data of 3,147 firms for the period 1972–1986. Following the approach of several earlier studies, such as Hall (1987), a simple regression model was specified for the relationship between firm growth and firm size. In this model the growth of employment in the years 1972–1986 was regressed on the natural logarithm of employment in 1972 using ordinary regression techniques. The results clearly point out that the estimated effect of size on growth was significantly negative, so that this result seems to corroborate the finding of other studies that small firms grow faster than large ones.

Several extensions of the simple model have been specified in order to investigate whether the result could be reproduced when allowing for measurement errors in the employment variable or selectivity (Hommes and Van Leeuwen, 1988, and Huigen et al., 1991). The results of this sensitivity analysis show that measurement errors in the employment variable are positively correlated, but the influence of measurement errors on the relation between firm growth and firm size appears to be negligible. Furthermore it is shown that the effects of attrition are likely to be quite small as well.

We also investigated whether the negative relationship between firm growth and firm size may be attributed to the phenomenon of 'regression to the mean', which may refer to a spurious negative correlation between firm growth and firm size in case of a time invariant size distributions of employment. To eliminate possible 'regression to the mean effects' the orthogonal regression technique was applied (Huigen et al., 1991). The orthogonal regression estimates show that the influence of size on growth remains slightly negative, but the estimated coefficient of firm size is reduced by a factor 7 compared with earlier estimates and is hardly significant. This result indicates that when taking into account the possibility of regression to the mean the claim that 'small firms grow faster than large firms' loses a lot of validity.

Technology and economic performance

A topic which has attracted much attention recently is the relationship between technology and the performance of economies. Part of the research effort in this field is initiated and coordinated by the OECD within the framework of its Technology-Economy Program. From the outset the research effort was macro oriented and it followed the generally accepted view that technology can be looked upon as a public commodity which may have substantial spillover effects to all parts of the economy. For instance, the R&D endeavours of private firms in specific sectors may also have substantial benefits for other economic agents, even on a worldwide scale. The mechanisms at work in transferring the benefits of technology and its impact on economic performance have been the subject of many studies.

Recently these studies have been supplemented with micro related analysis of the relationship between technology and economic performance. It is increasingly acknowledged that looking at the macro or meso level does not reveal all of the intricacies at work. For instance, in several micro studies it has been shown that the process of employment, output and productivity growth in manufacturing is far more complex than the picture which emerges from macro or meso level data, see e.g. Davis and Haltiwanger (1992), and Baily et al. (1995). These studies indicate that more attention should be paid to how productivity distributions of firms change over time and to the factors that determine the position of firms in the productivity distribution. Indeed, examining micro-level data may lead to an exposure of generally accepted views which originate in inferences drawn from the analysis of aggregated data. For instance, following the Davis and Haltiwanger line of research on firm-level data for the USA, it has also been established for the Netherlands that successful upsizing firms contributed relatively more to manufacturing productivity growth in the previous decade than downsizing firms (see Bartelsman e.a. 1995). This results contradicts the general belief that downsizing and productivity growth are inextricably linked.

The adoption of advanced manufacturing technology

We analysed the characteristics of firms which employ advanced manufacturing technology (AMT), explored the pattern of adoption of such technology and traced the effects of adoption on the evolution of employment and productivity. This study used linked firm-level data on production, factor inputs and on advanced manufacturing technology from three sources. Data on production and factor inputs were sourced from the yearly Production Surveys for 1985 and 1991. Data on the inputs of capital were derived from the Capital Stock Surveys. This is a rather unique dataset which contains data on stocks of capital by type of commodity and vintage for the same enterprise unit as observed in the Production Surveys. Both datasets were linked to the 1992 Survey of Advanced Manufacturing Technology (AMT), which contains data on the use of computer aided manufacturing, design and planning. We focused on the information pertaining to computer aided manufacturing equipment, because it is this technology which is most expected to lead to productivity improvements through streamlining of production processes and associated job losses.

It is found that the percentage of firms which employ advanced technology increases with higher labour productivity, higher export sales ratios and especially firm size. Corrected for interactions, however, only initial size and capital-labour ratios can predict adoption of AMT. Conditional on adoption of AMT it is found that the intensity of advanced technology inputs decreases with firm size and with labour productivity. Also, firms which employed AMT in 1992 show higher average growth rates of employment and of capital intensity. A most striking result of this study is that employment growth of AMT firms between 1985 an 1991 increased with the intensity of AMT application. Again this is contrary to the general belief that adoption of advanced technologies decreases employment opportunities.

R&D and productivity

In a second project we investigated whether firm performance and R&D are related. A considerable body of foreign literature suggests that the R&D productivity puzzle still remains unsolved. Contrary to the foreign situation there is very limited empirical evidence on the relationship between R&D and productivity for the Netherlands. The evidence which is available is almost exclusively based on macro data research. This situation is in sharp contrast with foreign research practice, where the mainstream of research pertaining to the relationship between R&D and productivity uses firm level data (see e.g. Mairesse and Sassenou, 1991, for a recent review of econometric studies of the R&D and productivity relation at the firm level).

For the Netherlands the investigation of the contribution of R&D to productivity growth raises considerable problems because of the very skew size distribution of R&D. It is well known that R&D expenditure of Dutch manufacturing is highly concentrated in five multinational companies. These companies spend a disproportional – albeit decreasing – part of their worldwide R&D in the Netherlands, whereas their production is largely located outside the Netherlands. The recent dramatic decrease of domestic R&D expenditure of these companies accounts for the negative performance of Dutch manufacturing R&D since 1989. Because of the dominance of these companies Dutch macro studies of the relationship between R&D and productivity growth are not very conclusive or even contradictory.

Apart from the distribution related problem these contradictory results may also be due to the more familiar aggregation problem inherent in the use of macro data. The latter problem can only be circumvented if firm level data are available. By linking files of the R&D surveys and data from the yearly Production Surveys, firm level data have recently become available. These data were used to estimate the relationship between R&D and productivity growth in a production function framework. Our primary objective was the estimation of private returns to R&D expenditure. We used data from the four-yearly extended R&D surveys for 1985, 1989 and 1993 to construct measures of the stock of R&D capital, which were included as a separate input in the production function.

Our data enable us to prevent biases by correcting for double counting of inputs, but on the other hand have the disadvantage of being selective. It is shown that the probability of exiting the sample is negatively related to the level of R&D intensity. This problem appeared to be exacerbated in the period 1989–1993, the years of declining R&D expenditure. In our estimation procedure we accounted for this selectivity problem by using a Tobit model. Furthermore we investigated the robustness of our results to different measures for the growth of the stock of R&D capital, by imposing non-negativity constraints on the growth of R&D capital and using different depreciation schedules.

After correcting for selectivity and heteroskedasticity we simultaneously obtain estimates for the elasticities of physical capital and R&D capital that are plausible and robust to our measures for the growth of R&D capital. In the R&D intensity approach we found an estimate for the gross marginal rate of return to R&D varying between 0.20 and 0.30. In the R&D knowledge stock approach – assuming that R&D expenditures are subject to deterioration – we found, for plausible values of the depreciation rate, an output elasticity for the R&D stock of approximately 0.10 and an estimate for ordinary capital close to 0.30. These results are very similar to the estimates of similar previous studies on firm-level data (e.g. Hall and Mairesse, 1995). This is surprising as the Hall and Mairesse estimates, for example, were derived from a panel with considerably more observations in the time dimension.

Conclusion

Many problems had to be solved before the micro-data of the Production Surveys could be used for analytical research purposes. Data on gross and net output, employment, total labour costs, energy costs and costs of material inputs were readily available to construct time series of sufficient length and for a sizeable number of firms. Constructing price data on the firm level, however, appeared to be very difficult. Data problems pertaining to prices were tackled by using micro-data from other statistics or, in the absence of sound alternatives, sector data. In general these problems could only be solved at the cost of substantial attrition, both in the firm and time dimension of the data, or (aggrevated) measurement errors.

Despite the data difficulties encountered it has been shown that satisfactory results could be obtained when applying estimation methods that take into account heterogeneity and measurement errors. The estimation results of the energy and employment studies clearly provide evidence for adjustment patterns that differ according to firm size.

6. Conclusion

Micro-data of establishments and enterprises are important for both statisticians and researchers. For the statistician they are important because they allow him to create new statistical products, to deal with inconsistencies and structural breaks, and to construct retrospective time series when new classifications are introduced. For researchers they are important because many economic questions can only be investigated with micro-data, because macro-economics is increasingly taking into account the heterogeneity of the underlying micro-data, because micro-data allow more disaggregation, and because micro-data better match the models of micro-economic theory. This article has elaborated these points and clearly shown that firms differ in many respects, i.e. they are heterogeneous. Therefore it is of the utmost importance to create databases with firms joined across surveys and across years. The article has also shown that several national and international statistical bureaus are responding to this growing need for micro-data; for example Statistics Netherlands has carried out several research projects concerning the structure of production and the effects of technology and has created separate units for the construction of micro-databases and research.

Future developments will take several directions. First, more data on the composition of the workforce within firms are needed. This will require linking data from several surveys, such as the Labour Force Survey, Wages Survey and the Production Survey (see Troske, 1995, for such a database for the USA). A database with a panel of firms and within each firm a panel of employees would be ideal for research purposes (Entorf and Kramarz, 1995). In the near future Statistics Netherlands will create a database with a panel of firms and within each firm a sample of its employees, with data on wages, education and other characteristics of the individual employees; the creation of a panel of employees within each firm will be the subject of a pilot project. Second, there will be a need for international comparisons (Doms et al., 1995.) and for the creation of a database of multinational firms, in which data from several countries are linked. Eurostat is already playing a role in these international developments. Third, there is a need for more financial data. The present databases are usually constructed from establishment data and focus on the structure of production. Because financial data are mostly on the enterprise level, the creation of a linked database requires the linking of establishments to enterprises. At Statistics Netherlands a project is being carried out in which this linking is done for the 100 largest enterprises.

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