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The Impact of Computers on Productivity in the Trade Sector: Explorations with Dutch Microdata

by

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Abstract

Trends in productivity, labour, and investment in the retail and wholesale trade sectors for the Netherlands in the 1988-94 period are examined. The analysis is based on a longitudinally linked panel of firms from the annual survey of Production Statistics collected by Statistics Netherlands (CBS). We find that computer investments have a positive impact on productivity and that the productivity impact of computers is greater in retail than in wholesale trade. There are a number of possible reasons for this finding, including greater penetration of computers in wholesale trade and differences in the way computers are deployed in the two sectors. Contrary to studies in the U.S., however, the impact of computer capital is about the same as other forms of capital. Differences in empirical specifications arising from the absence of data on capital suggest some caution with respect to this conclusion. We also find increased use of "flexible" employment practices, particularly among retail firms, and these appear related to computer use. As expected the measured impacts of computers on productivity are quite sensitive to the particular deflator used for computer equipment.

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1. Introduction

In many modern industrial economies nonmanufacturing sectors are growing both in terms of the proportion of the labour force employed and as a share of national output. In this paper we examine the performance of an important part of the nonmanufacturing sector: retail and wholesale trade. A primary goal of this effort is to ascertain the impact of computers on productivity growth and we rely on a new micro data base on individual firms derived from the Production Statistics of the Statistics Netherlands (CBS).[1]

This is a timely exercise for several reasons. The trade sector is a major component of nonmanufacturing output. As such it is a central focus of the recent literature suggesting that severe measurement problems plague research and policy formation. (See Baily and Gordon (1988) and Griliches (1994)) Moreover, most of the "hard to measure" sectors identified by Griliches feature computers as an important input (Triplett (1999)). Indeed measurement issues are at the heart of the widespread debate on the computer "productivity paradox" – derived from the famous comment by Robert Solow that "you see computers everywhere but in the productivity statistics." In fact, McGuckin and Stiroh (1999) find that increasing measurement problems may have significantly understated aggregate output growth in the 1990's in the U.S.[2] The trade sector is among the most important users of computers – accounting for about 25% of computer capital in the U.S. in 1996.

The trade sector is an important focus of structural reform in Europe. The expansion of the sector has been especially dramatic in the U.S., particularly when compared to most European nations. This difference in performance has taken on new importance as European countries – with an exception for The Netherlands - have been

[1] This research was carried out at the Center for Research of Economic Microdata (CEREM) of Statistics Netherlands. The views expressed in this paper are those of the authors and do not necessarily reflect the policies of Statistics Netherlands. Note that Statistics Netherlands ensures confidentiality of responses by requiring researchers to work on site at CEREM with output checked before leaving the premises.

[2] The role of computers - and more generally IT-investments - on productivity has gained a lot of momentum on the research agenda in the 1990's. See for example the special issue of *The Canadian Journal of Economics* 32(2), April 1999 and the references therein. Recent studies that stress the positive effect of computer (IT) investment on output and productivity are for example, e.g. Gera *et al*. (1999), Lehr and Lichtenberg (1999), Licht and Moch (1997,1999)), Stiroh (1998) , McGuckin and Stiroh (1998), McGuckin and Stiroh (1999). For a good review see Brynjolffson, Erik and Lorin Hitt (1996).

plagued with the relatively poor employment performance throughout the 1990s. (See McGuckin and van Ark (1998).)

Our point of departure is a longitudinally linked data base derived from the annual survey of Production Statistics (PS) conducted by Statistics Netherlands for the period 1988-1995. Much of the analysis is based on a balanced panel of 2,687 firms derived from the production surveys. Although selection is an issue for a sample composed of successful surviving firms, this panel is fairly representative of trade sector firms with more than 20 employees and includes some smaller firms. The panel accounts for about 34% of the employment and output in the Dutch trade sector.

Using these data and related published PS we describe the growth and structure of the trade sector over the study period. Since the data set we use is new we describe it in some detail before proceeding to analysis. We then turn to regression analysis of the impact of computers. Discussion follows and some concluding comments complete the paper.

2. The Trade Sector

The overall growth of the trade sector was fairly slow in the 1988-94 period that we study here. According to officially published PS the real net revenues of the trade sector grew 1.6% per year over that period, with retail trade growing 1.2% and wholesale at 3.2%[3]. Net revenue is defined as the sales revenue net of discounts, bonuses, deposit money and so on. The deflators we use are discussed below in section 3.3.4.

If, on the other hand, output of the sector is measured by real gross margin, growth was much higher, 3.7% per year, with retail contributing 2.9% and wholesale 4.1%. Gross margin is defined as the net revenue minus purchasing costs, consisting of

[3] The official statistics we use in this paper refer to the following CBS publications: CBS, Monthly Statistics of Retail Trade; CBS, Monthly Statistics of Domestic Trade; CBS, Retail Trade: Summary Statistics; CBS, Statline at http://argon2.cbs.nl/statweb/indexned.stm.

the costs of goods sold and related freight, insurance, and taxes.[4] Yet another output measure used in analysis of the trade sector is the value added. Value added is defined in the National Income Accounts as production (essentially gross margin as defined above) minus operating costs except for payroll. The average annual growth in real value added was 2.1% for the trade sector over the period 1998-94.

2.1 The Dutch Wholesale Industry

Wholesale firms sell goods, which they do not manufacture themselves, to retailers and other large-scale buyers. Dutch wholesale firms are generally small with almost 87% having less than 10 employees. (Table 1) Traditionally, the core business of wholesalers involves the storage and distribution of goods to firms that deal directly with the consumer. A significant fraction of Dutch wholesale firms are involved in international operations. Some 40% of all wholesale firms export their products. In 1995 about 32% of the wholesale revenue was obtained through sales, primarily food and capital goods, abroad. On the other hand, about 35% of all wholesale purchases are received from abroad, mainly capital goods, non-food products and raw materials and intermediate goods. In fact the share of wholesale trade in Dutch goods imports amounts to 40%. (See De Jong, Muizer and Van der Zwan (1999))

Recently there are indications of structural change in the industry with some firms specializing in physical storage and distribution of goods with others specializing in brokerage aspects of the business. In this latter role a key aspect of the business is connecting retail buyers with producers and providing market information to both groups.

Computers in wholesaling are used for stock management, control, administration and communication with producers and consumers. They are also very important in "matching" retailers with producers. See Den Hertog *et al*. (1997). In 1989 81% of the firms had automation expenses – defined as firms with computers valued at least at 500 Dutch guilders (approx. 250 US $) or with automation personnel -- according to Statistics

[4] Purchasing costs include import duties, costs of customs clearance, import levies, excise duties, costs of freight, costs of transport insurance, (wage) costs of activities contracted out, depreciation of goods stock and transit trade.

Netherlands. (Table 2) This percentage had increased to 88% by 1997, well above the all industry average. Wholesale firms account for 10% of all automation spending in The Netherlands, while their share in GDP is about 6%.

2.2 The Dutch Retail Industry

Retail firms sell goods, manufactured elsewhere, to households and private persons. The market structure of retailing firms has changed dramatically in recent years. There has been a shift from small-scale local operations to larger scale establishments and integrated retailing, facilitated through commercial cooperation, through such things as franchising.[5] Despite this, the average Dutch retail firm is still very small with 95% of the firms having less than 10 employees. (Table 1)

Computers in retailing are used for inventory control and storage optimization, pricing and promotion of the products (scanning techniques) and administration. A major new use has been the introduction of electronic payment with debit bankcards in many retail stores, especially the larger ones. As shown in Table 3 the number of bank-store connections grew from only 90 in 1986 to 40,000 by 1994 and 70,000 just one year later. Despite the huge increase in electronic payment in retailing, retail firms account for less than 3% of total automation spending, according to Statistics Netherlands, while their share in GDP is about 4%. Moreover, 35% of the firms in retail have no automation expenses.

[5] The CBS (1999) reports that the number of private owners of retail firms has dropped dramatically in recent years. Nowadays one third of all retail firms is a subsidiary branch of a firm with five establishments or more or has some form of economic co-operation, like franchising. See also CBS, Press release May 10 1999.

3. Survey of Production Statistics

The data we use come primarily from an important survey of Statistics Netherlands (CBS): the Production Statistics. The Production Statistics (PS) is an annual survey that supports the official publications of Statistics Netherlands for all industries. Small firms -- firms with less than 20 employees -- are sampled for the PS and their results are weighted to give an adequate representation of the entire set of firms. The set of large firms -- firms with 20 employees or more – are covered completely. We have available the micro PS surveys for the Dutch retail and wholesale trade from 1988-1995.[6]

3.1 Data

The principal aim of the PS is to provide data on the revenue and cost structure of firms. For each firm, net revenue, defined as the total revenue from selling goods or providing services net of discounts, refunded packaging and related rebates is reported. Revenue of both wholesale firms and retail firms excludes value-added taxes (VAT)[7].

Information on costs of purchased goods and services are collected in the survey and these are used to create gross margins. When other revenues from sideline activities are added and operating costs, like payroll costs (wages, salaries, and social premiums), sales costs (advertisements, marketing), housing costs (rent, energy, maintenance) and so on are subtracted we obtain a 'profit' measure is obtained.

The PS also provides information on investments in a number of capital assets, among which are direct investments in computers (hardware). A major drawback to the

[6] We also had access to the General Business Register (GBR). This register is maintained by the Dutch Chambers of Commerce and contains a list of all firms in The Netherlands by size, SIC, and dates of entry and exit. Statistics Netherlands uses this register as a starting point to estimate the actual entry and exit of firms net of mergers, takeovers, buyouts and non-active firms. A sample of the entering and exiting firms according to the GBR is subjected to a separate survey focusing on active firms only, i.e. firms with at least one person working at least 15 hours a week. The results from this survey are the basis for the entry and exit of figures reported by CBS. We use the GBR for data checking and perspective on the balanced panel that we use to study productivity growth.

[7] The annual PS survey is based on the annual accounts of each firm and those are net of VAT. The monthly PS surveys, which contain less detailed information, are based on the cash box revenue for each firm and do include VAT.

data from the survey is the absence of any information on capital stocks. A list of the main items of data available in the survey is given in Table 4.

3.2 Comparability over Time

Over the period of our study the PS survey consists of roughly 16,000 firms per year or about 13% of the total number of firms in the Dutch trade sector. The sample covers about 18% of the firms in wholesale trade and 9% of retail firms. Coverage of employment in the PS is much larger, nearly 565,000 workers in the average year, or almost 60% of total employment in the Dutch trade sector.

Several major changes affected the comparability of data over time. First, there was a major definition change in the SIC classification in 1993 in The Netherlands.[8] We reconciled all the data to the latest classification system. This meant fewer categories than were available in earlier years.

Second, 1995 saw a number of changes, the most important of which was a complete revision of the PS questionnaire to make the data consistent with the National Income Accounts and the Labour Accounts of Statistics Netherlands. This revision had serious consequences for the reported numbers of part time and full time employees.[9]

Third, 'other labour' was treated differently after 1988.[10] While we were able to overcome the effects of the SIC classification change by reclassifying firms on the new classification, we were forced to drop 1995 from most of the analysis portions of the paper. Further is given below when we consider the composition of the balanced panel.

[8] For trade the two-digit SIC for wholesale and retail respectively changed from 61-62 before 1993 into SIC 51 and 52 from 1993 onwards.

[9] Furthermore, employees that worked very few hours a week and were not insured under the Sickness Act were counted as employee of the firm from 1995 onwards. Before 1995 they were not counted as employee. In addition the reference date of the PS surveys moved from September 31 to December 31. All this caused a major break in the employment and investment data of the PS surveys .

[10] The category 'other labour' consisted of owners, family member and employees lent to or borrowed from other firms. From 1989 managing directors of limited liability firms were also counted in this category, while previously they were (probably) counted as employees working 30 hours or more per week. This increased 'other labor' by some 10%.

3.3 The Balanced Panel of Firms

The balanced panel -- firms that are observed continuously throughout the whole period 1988-1995 -- consists of 2,687 firms, 1,705 in wholesaling and 982 in retailing. It accounts for about 2% of the total number of firms in the trade sector, 4% of wholesale firms and 1% of retail firms. As expected, the balanced panel accounted for a much greater proportion of economic activity than its numbers would suggest because of the sampling design that concentrates on larger firms. In the period 1988-1995 the panel averaged 321 thousand workers, roughly 35% of total trade employment according to official sources. Employment coverage was 27% for wholesale trade and 38% for retail trade.

3.3.1 Size Distribution

Table 5 shows a comparison of the size distribution of firms in the balanced panel and the official statistics. It shows that on average about 13% of the firms in the balanced panel are small, 75% are intermediate, and 12% are large. A similar size distribution from the official statistics covering the period shows 94% of trade firms were small, 5.7% were intermediate and only 0.3% were large. The difference in the number of small firms is a result of the sampling method for the PS, from which the balanced panel was drawn, and attrition. Despite the sampling plan, the balanced panel also contains numerous smaller firms. Some 3% of the firms in the balanced panel have one employee or less. So small firms are still represented in this panel, although by no means near their numbers in the population.

Table 6 shows the effects of attrition and survivor growth in the balanced panel. Three classes of firm, small, less than 10 employees, intermediate,10-99 employees, and large, 100 or more employees are distinguished. The number of small firms declines steadily over the 1988-1995 period. The number of large firms increased considerably over the period, while the number of intermediate firms did not change much. This category consists of the firms that “pass through” when they grow or decline. Comparison with a similar development in time of the official PS, also shows a similar

increase in the number of large firms.[11] New firms starting to operate are usually small and are underreported in the first year of the panel and not included after that. This explains the difference between the balanced panel and the official statistics in the growth of firms in the smallest size class.

3.3.2 Industry (SIC) Composition

The distribution of the balanced panel by SIC is compared with official statistics in Figure 1 according to the 1993 SIC classification. For the retail sector (SIC 521-527), the number of firms in SIC 525-527 is clearly under represented in the balanced panel. This is not a surprise. SIC 525 contains firms trading second hand goods and antiques; SIC 526 is retail sales not in a shop, which largely consists of market sales, which are numerous but small (usually one employed person, the owner); and SIC 527 consists of repair shops for consumer goods. In these instances the firms are very small, frequently employing one person, the owner, and hence, hardly present in the balanced panel.

There is one category of firms in SIC 526 -- mail order firms – that are generally larger firms and do appear in the balanced panel. The distribution of the other retail firms in SIC 521-524 seem reasonable and the distribution of firms in the wholesale sector (SIC 512-517) is reasonably close to that of official statistics.

3.3.3 Labour Input

The PS provides each firm's total employment and employees by type. The following classification is used:

1. Employees working less than 15 hours a week

2. Employees working between 15-30 hours a week

3. Employees working 30 or more per week

[11] The official statistics covering 1988-1995 cannot distinguish between firms in the trade industry and firms in the hotel business. So the data of Table 5 pertain to both trade firms and hotels, restaurants, etc.

4. Temporary employees

5. Other labour: owners, participating family members, managing directors, *etc*.

We use this classification to obtain an estimate of the total annual number of hours worked by firms in our sample.[12] To estimate annual working hours we assigned weekly hours worked to each category of employees on the basis of some scattered evidence pertaining to 1995 on the number of employees in a comparable hours classification. Using these data and some additional assumptions, we used the following hours estimates. Employees in the class of less than 15 hours a week are assumed to work 8 hours a week, those in the 15-30 hours-class work 21 hours a week, and those with 30 hours or more work, 38 hours a week. Temporary employees were assigned 23 hours a week and "other labour" was assumed to work 40 hours a week. Using a 40 hours working week as the official full time hours allowed us to get an estimate of the annual working hours.[13] Note that the changes in 1995 cause a break in the distribution of employees between full time and part time, and hence in the number of hours worked and therefore we decided to limit most of the analysis to the period 1988-1994.

3.3.4 Price Deflators

Several price indexes were used to deflate the revenue and cost variables. Our choices, however, were limited. The major change in industrial classification in 1993 forced us to work with price indexes at fairly aggregated levels. Second, detailed price indexes for the retail trade industry are only available from 1996 onwards.

Since the retail industry is delivering to consumers, we used the overall CPI to deflate revenues in retail trade firms of the panel. In some cases, for example, for firms

[12] The above hours classification is not used in any of the official publications of Statistics Netherlands so we cannot compare the number of employees in each class with official statistics.

[13] When we assume that T_{year} is the number of contracted annual working hours for a full time worker, T_{week} is the official number of hours worked a week, t_i is the weekly number of hours assigned to each class i, i=15, 1530, 30, temp., for employees that work less than 15 hours, 15-30 hours, 30 or more hours a week and temporary employees and emp_i is the associated number of workers, we get the following estimate of the total annual working hours, H.
$H = (T_{year}/T_{week}) * (t_{15} * emp_{15} + t_{1530} * emp_{1530} + t_{30} * emp_{30} + t_{temp} * emp_{temp})$.

trading in food, clothes and shoes, it was possible to use a more detailed CPI. Output measures from the official PS were deflated with the overall CPI.

Firms in the wholesale industry deliver to other firms so we used the producer price index of domestic sales as our deflator. This price index is not available at a sufficiently disaggregated level for the period 1988-1995.

All investment items, except computers (investment in structures, transport equipment and so on) are deflated with the Dutch price index for investment in fixed assets. Investments in computers are deflated with the U.S. price index of computer equipment. Only recently the Netherlands Bureau of Economic Policy Analysis (CPB) has established a comparable computer price index for The Netherlands and in this version of the paper we have continued to use the U.S deflator. Clearly both computer price indexes reflect the notion that computer quality has increased. The index drops rapidly in the period under consideration. Table 7 gives an overview of these deflators.

3.3.5 Cost and Revenue Structure

Comparison of the firms in the balanced panel with the officially published statistics indicates similar patterns of costs and revenue. See Table 8. For example, the gross margins calculated from the balanced panel do not differ from the officially reported numbers. This is true for the trade sector, as well as retail and wholesale trade individually. This is somewhat of a surprise since we would have expected selection -- 'survival effects' -- to have led to better performance for firms in the balanced panel. However, firms in the balanced panel do not have higher margins than the industry-wide averages reported in the official statistics. Moreover, particularly for firms in the retail sector, the official statistics show lower labour costs and higher profits than in the balanced panel. For the wholesale sector the differences are very small.

The greater proportion of small retail firms in the official statistics suggests that the labour cost structure of small firms is more favorable than that of the larger firms. We are not sure how to explain this result. We do, however, note that it is a feature of the PS itself, and not simply an artifact of the balanced panel. One possibility for reconciling the difference is that small firms pay lower wages than large firms do. This is still a

largely unexplained phenomenon. Usually these differences are linked to difference in working conditions, worker quality, unionization and imperfect information effects (efficiency wages and monitoring). These items only explain a part of the wage difference; a large portion remains unexplained. Cf. Brown and Medoff (1989). Oosterbeek and van Praag (1995) find these firm-size wage differentials to be present in Dutch firms as well.

Another possibility for explaining these differences might be underreporting of wage costs due to the fact that very small retail firms, with only the owner working, have no wage costs since the owners 'wage ' is profit. Another is that the big and small firms do different things.

4. Descriptive Statistics: the Balanced Panel

Firms surviving over the period showed solid growth in the 1988-94 period, real revenue increased by 20.4% so that the average growth of real net revenue per year was about 3.1% for the balanced panel. According to the official PS real net revenue increased only 9.8% or on average with 1.6% per year over the same period. When we distinguish wholesale and retail trade, real net revenue also increased at a higher pace in the balanced panel. Table 9 shows the real output and associated productivity measures over the period 1988-1994.

Net revenue is not the measure of output that is used in the National Accounts. Output is measured by gross margins or value added. Value added is not directly reported in the PS.[14] Some argue that gross margins are a better measure of output in the trade sector. In essence gross margins are sales revenues minus purchasing costs. Using this measure also suggests that real output increased dramatically over the period. Between 1988 and 1994 the real gross margin increased 24.3%, or on average per year of 3.7%,

[14] Value added according to the NA is defined as the production (basically gross margin) minus intermediate costs. These intermediate costs include all operating costs except for payroll costs. Hence, value-added can be approximated by the sum of labour costs and firm "profits" for the PS or balanced panel.

which is faster than that obtained from net revenues. The published PS show the same growth rate of the real gross margin for the entire trade sector, with a slightly lower rate in gross margins for wholesale firms and slightly higher for retail firms.

Productivity levels in the balanced and official statistics are remarkably similar for the trade sector while the average real net revenue per worker for wholesale firms is much higher in the balanced panel than in the official PS. For retail trade the real net revenue per worker is approximately equal for balanced panel and official statistics. Something similar is true when we take the real gross margin as a measure of output.

The growth rate of real labour productivity is higher in the balanced panel than in the official PS, particularly when output is measured by real net revenue per worker. With this output measure, real productivity increased over the 1988-1994 period more than 5%, or an average annual increase of 0.8%. According to official statistics, productivity declined over the period. In wholesale trade the real net revenue per worker increased 1.4% per year, while in retail it remained virtually flat. See Table 9. Generally speaking the surviving firms of the balanced panel have higher productivity growth rates than the official statistics for all firms, particularly for firms in retail trade.

4.1 Labour Patterns

In the balanced panel, the proportion of part time workers is very high in retail trade, ranging from 29% in SIC 526, retail not in a shop (mainly mail order firms) to 62% in non specialized retail (SIC 521), among which supermarkets (SIC 5211) are an important group. Overall the percentage part time labour in retail trade is 55.9%. The share of part time labour in wholesale is only 7.5%, ranging from 4% in SIC 516, wholesale in machines, equipment and accessories to 10% in SIC 512, wholesale of agricultural products.

As noted above comparison of full time and part time labour in the balanced panel and official publications of Statistics Netherlands cannot adequately be made. In the Labour Accounts of Statistics Netherlands, the concept of full time versus part time employment is not based on the number of working hours per week, but instead on the

length of the official working week (in hours) of each firm.[15] For example, if a firm has a 40 hour working week, every employee working less than 40 hours is considered to be a part time worker. In the balanced panel we assume that part time workers are those employees working less than 30 hours a week. This clearly means that our estimate will be lower than that in the Labour Accounts (LA). Analogously, the number of full time workers is estimated higher in the balanced panel.

A similar problem occurs with temporary employees. The LA include only the total amount of workers employed via a temporary employment agency. Hence, we have no information with respect to temporary workers employed in the trade industry. The LA provide some information on flexible labour. This flexible labour is however a much broader concept than temporary labour. Flexible labour in the LA also includes persons employed 'on call' as 'stand in' workers, and workers with a temporary contract not via an employment agency. This latter group pertains primarily to new workers, who are usually offered a temporary contract of one year to start with. So this group of flexible workers is much bigger than the one in the balanced panel. In particular workers 'on call' and 'stand in' workers play a significant role in employment in retail shops, particularly supermarkets.

We can compare the overall level and growth of employment, both in persons and in hours, between the LA and the balanced panel. Second, we identify broad trends in the distribution of employees among full time and part time. Table 10 compares both the average levels of employment over 1988-1994 and the growth over the period. The levels depend on the number of firms included in the panel and thus cannot be compared to the total population as such. However, we can calculate the average number of working hours per worker in both balanced panel and the LA and these can be compared. As shown in the last lines of Table 10 the average number of hours an employed person works in both trade and retail is quite similar in the LA and the balanced panel.

Employment growth, in terms of employed persons, was similar for the trade sector. In both the PS and the balanced panel employment rose by 15% over the entire period, or 2.4% each year. Wholesale employment grew faster in the balanced panel than

[15] Since 1995 these Labour Accounts are consistently incorporated in the National Accounts. Since the micro PS surveys are source statistics of both NA and LA, this call for consistency is one of the reasons for

according to the Labour Accounts (LA). For retail trade this was the other way around. Growth in terms of the annual number of hours worked was lower in the balanced panel for both wholesale and retail trade. So in terms of persons there is hardly a difference between employment growth in the balanced panel and the LA, but in terms of the number of annual working hours, employment growth was lower in the balanced panel. This difference is explained by the fact that firms in the balanced panel are larger than in the population and large firms employ more part time employees than small firms.

Table 11 gives a flavor of the distribution of employment according to the official Labour Accounts between full time and part time workers. As mentioned before, this notion of full time and part time in the LA cannot be compared to the same notion in the balanced panel. The LA report employees that work less than 20 hours per week or 20 hours or more. This may serve as crude measure of part time and full time, but it still does not come close to our definition, where the boundary lies at 30 hours a week. Nevertheless we can state that the percentage full time and part time workers in the balanced panel must lie between these two measures from the LA. Table 11 shows that for wholesale trade this is indeed the case. However part time employment in retail firms of the balanced panel is much higher than that in the LA. We have noticed this phenomenon before. The main reason is the fact that the balanced panel has an over representation of large firms and large firms have a much higher number of part time workers than small firms.

Table 12 gives the development in time of the full time and part time employees according to the Labour Statistics and the balanced panel. This time we consider the period 1988-1993, since 1993 is the final year of the Labour Statistics that is still comparable to the balanced panel. Both data sources show that the impact of part time labour has increased significantly over the period.

4.2 Investment in Computers

Investments in computers as share of total investment in gross fixed assets averaged 12.3% over the period. The figure was much higher in wholesale, 15.7%, than

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the introduction of the new questionnaire in the PS surveys in 1995.

in retail, 6.3%. These figures are based on using the same deflator for all investment goods. However, based on the US experience, the quality-adjusted fall in computer hardware prices was much greater than that for other prices. If we apply the U.S. computer deflator as a more representative measure of computer price movements, then the average share of investment in theses sectors rises to 21.4% for wholesale and 8.9% for retail.

In terms of growth rates, firms in the balanced panel increased their computer investment as proportion of total investment steadily over 1988-1994 from 11% to about 14%. This is a growth rate of some 30% for the entire period using the investment goods deflator. If, however, we apply the U.S. computer deflator the respective figures are 9.0% to 28.2%, or a growth rate of more than 200% over the period. Similar differences are found in the retail and wholesale sectors individually.

Another way to look at the diffusion of computers is through movements in the percentage of firms with positive investments in computer hardware. For total trade this went from about 42% to 58% over the 1988-95 period. The increase was larger in retail trade – from 27% to 48% -- than in wholesale trade, which grew from a base of 51% of the firms investing in computers to 65%. On average the number of retail firms that invest in computers grew 8% per year in the period 1988-1995. For wholesale firms this percentage growth was a mere 3% a year. See Table 13.

Investment in computers varied greatly by size and detailed SIC. For example, nearly 60% of the firms with more than 50 employees invested in computers compared to less than a third for those with 10 or fewer employees. Table 14 shows that the increase in the number firms with positive investments in computers was much larger for the small firms than for the large ones. Investment in computers in SIC 514, wholesale in non-food consumer goods, was undertaken by 65% of all firms during 1988-1995. For the entire wholesale industry this percentage lies around 58% of all firms. The number of retail firms investing in computers is highest in SIC 526, mainly mail-order firms. About 55% of these firms invest in computers compared to an overall 35% in retail.

5. Regressions

This section presents some of the regression results for production, labour productivity and employment. The dependent variables in all specifications are in first (annual) differences. The specification of the percentage change in real production is "explained" by change in the number of hours worked and real investment. We included the log of real wages per hour to control for the average skill level of the work force. We let the share of other revenues represent the sideline activities of the firm (diversification). Real net revenue and real gross margin measure output.

The absence of investment data over a long period of time makes it impossible to use the perpetual inventory model to get standard measures of capital service flows. Therefore we can only approximate a standard production specification. A central issue is how to include investments in the equation. We have tried various specifications and settled on the log of real investment. The rationale for taking the log is to smooth the large differences in the distribution of real investment figures between different firms.

The sample period used for the regressions is 1988-1994.[16] We used a number of control dummies. First, seven time dummies for 1988 through 1994 were added, to account for time related factors not captured by the differenced variables. Second, nine size dummies were added to control for differences in production and productivity change due to firm size. To the extent that they are related to the firm's capital they will pickup differences in service flows from earlier vintages. Third, eight legal status dummies were added to control for differences in legal status of the firm. Fourth and finally, 227 5-digit industry dummies were added to control for differences in the structure of a firm's output. The size of the balanced panel implies that each 5-digit SIC on average consists of a dozen firms.

5.1 Output and productivity

Table 15 present the estimation results for the change in real production for both measures of output and Table 16 provides the productivity regressions. The results

suggest that investment in computer capital (hardware) has a positive impact on output and productivity, but non-computer capital (structures, transport, equipment and so on) appears to matter more. This is very different from the results in the US (see Stiroh, 1998), but given the specification, caution is necessary.

We find a strong effect of the change in labour input. This coefficient can be interpreted as an elasticity, so that an increase in the number of working hours of 1%-point raises output in the trade sector some 0.3 %-points, depending which variable is used to represent output. This effect of labour input is stronger in retail firms that in wholesale.

The coefficients of investment are small, but statistically significant. A 1 percentage-point increase in the log of real investment in non-computer capital is associated with an additional increase in the change in output of some 0.01%-point. Notice that the measured effect here is that due to the incremental affect of current investment only.[17] The skill level of the work force is highly significant in all specifications with higher skills, reflected by higher real wages per hour, implying increased production.

There is no great difference in results between the two output measures. The simple correlation between the output measures is 0.94. The results of the regressions are also broadly similar with the exception of the variable representing the effect of sideline activities on the production. This variable was very significant and negative in the estimations using gross margin as the output measure. But in those using net revenue to measure output the relationship was not as strong. Firms with more activities outside their core business tend to have slower output growth in trade.

We can make similar remarks about the productivity equations of Table 16. Notice that the labour productivity equation includes the lagged level of real labour productivity as explanatory variable to take account of regression to the mean – the

[16] We skipped 1995 from the regression due to a number of serious breaks. See earlier remarks.
[17] As focus point for additional research, we will use a crude proxy to create capital stock and capital service data for the individual firms of the balanced panel. As deflator, the recently developed Dutch computer price deflator will be used instead of the U.S. deflator. In this way we can specify and estimate more or less standard production functions in levels from which productivity equations can be derived. The preliminary results of this exercise, which will be presented in a later version of this paper, do not give rise to different conclusions as those of the current version of the paper.

tendency of firms with above average productivity to experience declines in the next period and vice-versa.

We find a strong negative effect of the change in labour input on the change in labour productivity. A fall of 1%-point in working hours leads to an increase in productivity of 0.5 to 0.7%-point, depending on which output measure is used. Productivity in wholesale is more sensitive to changes in working hours than productivity in retail. The effect of investments in both non-computer and computer capital, on productivity is again small but positive. The difference between the two productivity measures of Table 16 is small. A simple correlation between the two measures is 0.78.

5.2 Employment

Apart from output and labour productivity the impact of investment in computers on employment is also of interest. In the US there is strong evidence that computers substitute for labour (Stiroh, 1998). But, even if the substitution effects are strong, employment may be positively related to computer use due to output effects. Here we ask whether firms that invest in computers have lower employment growth? In order to address this question, we specify a model of the annual change in the total number of employed persons per firm. This model also includes all the control dummies discussed above and several other explanatory variables. Including the sideline activities of firms, represented by the share of other revenues.

We also introduced the change in the (log) share of labour costs in net revenue that captures labour costs in relation to the output, or the labour income share. A higher proportion of output being paid to labour implies that labour is getting more expensive in relation to total output. This may cause employment to fall

The log of investment in non-computer and computer capital was added to the regression, just as in Tables 15 and 16. Finally, we also added the lagged change in employment to account for regression to the mean. Table 17 presents the estimation results of this model.

A 1-percentage point increase in the labour income share of total trade leads to a fall in employment of 0.1 percentage point. Note that this effect differs substantially

between wholesale and retail sale. Employment in the wholesale industry is far less sensitive to changes in labour costs than in retailing. An increase in investment, both in non-computer capital and in computer hardware increases employment. These results suggest that investment in computers is associated with increases in employment growth, both in wholesale and in retail.

6. Concluding remarks

We have investigated the behavior of firms in the Dutch wholesale and retail industry, using annual Production Statistics for the trade sector of Statistics Netherlands. This unique data set contains information on costs and revenues of individual trade firms. We have constructed a longitudinally linked balanced panel of firms from 1988-1995. The analysis is based on the 2687 firms within this panel.

We find that computer investments have a positive impact on productivity. But, as expected, the measured impact of computers on output and productivity is extremely sensitive to the particular deflator used. The impact of computers is greater in retail than in wholesale trade. There are a number of possible reasons for this finding. An important one is the greater penetration of computers in wholesale trade and differences in the way computers are deployed in the two sectors probably also plays a role.

Contrary to studies in the U.S., however, the impact of computer capital is about the same as other forms of capital. There may be a number of reasons for this difference. First and foremost, differences in empirical specifications arising from the absence of data on capital suggest some caution with respect to this conclusion. Second, U.S. results do not necessarily have to apply to European countries in the same way, because of differences in organizational structure between Europe (or The Netherlands) and the U.S. The organization of trade firms in the sense of adjustment to the important role of computerization and automation may be further ahead in the U.S. than in Europe.

As a scope for future research we plan to augment the regressions used so far by including not only contemporaneous investments, but also investments in prior years. The idea is that investments over the past 3-5 years would account for most of the computer

capital service flows, because of rapid depreciation rates associated with computers. In fact the sum of these current and lagged investments may approximate the capital stock, which can next be used in regressions of output, productivity and employment for a particular year (e.g. 1994), in order to identify possible cross section effects. An alternative way to approximate the capital stock is to use the amount of depreciation and make assumptions about the life span of investment goods. The capital stock is then constructed by the depreciation times the inverse of the life span. Additionally, we will also experiment with the price deflator for computer capital using the new deflator for computer investment from the Netherlands Bureau of Economic Policy Analysis (CPB).

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Table 1. Size distribution of firms in percentages over 1993-1995, according to official statistics

number of employees	wholesale	retail	total trade
0-9	86.8	95.2	91.8
10-99	12.4	4.5	7.8
100 or more	0.8	0.3	0.5
Total	100.0	100.0	100.0

Source: Statistics Netherlands

Table 2. Degree of automation (percentage of firms in the industry that have positive automation expenses)

Industry	1989	1991	1993	1995	1997
Wholesale industry	81	85	90	89	88
Retail industry	53	71	63	63	65
Total trade	65	71	73	73	74
All industries	65	71	78	79	80

Source: Statistics Netherlands, Automation Statistics

Table 3. Number of connections for electronic payment with debit bankcards (mainly in retail)

	Number of connections for electronic payment (debit cards)
1986	90
1988	992
1990	2,000
1991	3,500
1992	10,500
1993	24,000
1994	40,000
1995	70,000

Source: Vogelesang (1996)

Table 4. Variables in Production Statistics

Variable	Amount
Financial variables	
Net revenue	A
Purchasing costs	B
Gross margin	C=A-B
Other revenues from sideline activities	D
Total revenue	E=C+D
Labor costs	F
Housing costs	G
Inventory and equipment costs	H
Car costs	I
Sales costs	J
Other costs	K
Total operating costs	L=F+G+...+K
Company result (net profit)	M=E-L
Employment	
Employees	N
< 15 hours a week	n1
15-30 hours a week	n2
>30 hours a week	n3
Flexible labor	O
Other	P
owners	p1
participating family members	p2
managing directors (limited liability firms)	p3
Total employment	Q=N+O+P
Investment	
Ground and structures	R
Accommodation	S
Transport equipment	T
Machines and other equipment	U
Computers	V
Other assets	W
Total investrment	X=R+...+W

Source: Statistics Netherlands

Table 5. Size distribution trade firms according to official statistics and balanced panel, average percentages over 1988-1995.

Size class number of employees	official statistics*	balanced panel
0-9	94.0	13.3
10-99	5.7	74.9
100 or more	0.3	11.8

* firms in the hotel business are included

Source: Statistics Netherlands

Table 6 Change in size distribution of trade firms in balanced panel and official statistics 1988-1995 (index, 1988=100)

Size class	official statistics*		balanced panel	
number of employees	1991	1995	1991	1995
0-9	106.1	115.7	83.0	74.8
10-99	112.9	133.0	100.0	99.3
100 or more	130.1	147.0	129.3	150.0

* firms in the hotel business are included

Source: Statistics Netherlands

Table 7. Price deflators applied at financial variables (1990=100)

	CPI total	CPI food	CPI clothes	CPI shoes	PPI sales	Price index investments	Price index computers	U.S price index computers
1988	96	97	104	103	96	96.3	115.1	119.6
1989	97	98	101	101	98	98.0	113.7	111.3
1990	100	100	100	100	100	100.0	100.0	100.0
1991	103	103	97	97	102	102.1	93.2	89.6
1992	106	106	98	97	102	104.1	80.8	77.1
1993	109	107	99	99	101	105.4	74.0	66.3
1994	112	109	98	99	102	106.4	69.9	59.9
1995	114	110	96	98	104	107.4	63.0	48.1

Source: Statistics Netherlands, various sources.
Netherlands Bureaus of Economic Policy Analysis (CPB), unpublished series
U.S. computer deflator: J. Triplett, Brookings.

Table 8. Measures of revenue and costs of firms, averages over 1988-1995, balanced panel and official statistics

		% of net revenue			
	Net revenue (billion guilders)	Gross margin	Labor costs	Other costs	Profits
Balanced panel					
Wholesale	105.6	17.2	6.9	6.5	4.3
Retail	41.0	29.9	14.6	10.4	5.4
Trade	146.6	20.8	9.1	7.6	4.6
Official statistics					
Wholesale	315.5	18.6	7.2	7.3	4.5
Retail	109.5	29.7	11.7	10.9	7.5
Trade	425.0	21.4	8.4	8.2	5.3

Source: Statistics Netherlands

Table 9. Comparison of real output and labour productivity according to Production Statistics and balanced panel, 1988-1994.

	Production Statistics		Balanced Panel	
	average 1988-94	1994	average 1988-94	1994
	bln. Guilders	1988=100	bln. Guilders	1988=100
Real net revenue				
wholesale	313.1	120.7	98.8	124.7
retail	100.4	107.5	37.3	113.9
total trade	398.3	109.8	135.7	120.4
Real gross margin				
wholesale	55.4	127.4	17.0	125.0
retail	29.6	118.6	11.1	122.8
total trade	85.0	124.3	28.2	124.3
Real net revenue per worker				
wholesale	813.8	107.4	939.0	108.4
retail	177.1	92.3	175.0	99.6
total trade	418.7	95.6	426.1	105.1
Real gross margin per worker				
wholesale	143.9	113.4	161.9	108.7
retail	52.2	101.8	52.2	107.4
total trade	89.2	108.2	88.5	108.5

Source: Statistics Netherlands

Table 10. Comparison of employment in persons and hours according to Labour Accounts and Balanced Panel, 1988-1994.

	Labor Accounts		Balanced Panel	
	average 1988-94	1994 1988=100	average 1988-94	1994 1988=100
Employment (ths. persons)				
wholesale	384.5	112.4	105.1	115.0
retail	567.6	116.5	213.1	114.3
total trade	952.1	114.9	318.3	114.6
Employment (mln. annual hours)				
wholesale	582.4	116.0	163.9	112.7
retail	577.9	115.7	220.2	111.4
total trade	1160.3	115.8	384.2	111.9
Hours per employed person				
wholesale	1515		1559	
retail	1018		1033	
total trade	1219		1207	

Source: Statistics Netherlands

Table 11. Comparison percentage employees by working time according to Labour Accounts and Balanced Panel, 1988-1994*

	Labor Accounts				Balanced Panel	
	full time	part time	> 20 hours	< 20 hours	full time > 30 hours	part time < 30 hours
Employees (%)						
wholesale	88.2	11.8	94.3	5.7	88.4	7.5
retail	55.2	44.8	66.4	33.6	42.4	55.9
total trade	70.4	29.6	78.2	21.8	57.6	39.9

* Labor Accounts: 1988-1996

Source: Statistics Netherlands

Table 12. Comparison of growth of employees by working time according to Labour Accounts and Balanced Panel, 1988-1993 (1988=100)

	Labor Accounts				Balanced Panel	
	full time	part time	> 20 hours	< 20 hours	full time > 30 hours	part time < 30 hours
Index in 1993						
wholesale	114.5	134.4	117.6	133.3	110.5	118.0
retail	114.6	133.3	111.9	174.1	110.2	117.2
total trade	114.6	133.5	113.1	154.3	110.4	117.3

Source: Statistics Netherlands

Table 13. Percentage of firms with positive investment in computers, according to the balanced panel

	Wholesale	Retail	Total trade
1988	51.0	26.9	42.2
1989	53.3	29.9	44.6
1990	56.4	32.0	47.5
1991	56.8	36.4	50.3
1992	60.3	36.8	52.1
1993	61.7	37.8	53.0
1994	64.3	39.1	55.3
1995	64.6	47.5	58.4
avg 88-95	58.5	35.8	50.4

Source: Statistics Netherlands

Table 14. Development of the number of firms in trade with positive investment in computers by size class 1988=100 (balanced panel).

number of employees	1995
0-9	193.1
10-99	135.3
>=100	121.8

Source: Statistics Netherlands

Table 15. Estimation results of model for change in real production, 1988-1994*

1. Dependent variable: change in log of real gross margin

Explanatory variables	Wholesale		Retail		Total trade	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
Change in log hours worked	0.318	(20.42)	0.466	(26.29)	0.357	(28.78)
Log of real investment in non computer capital	0.009	(3.975)	0.011	(3.959)	0.009	(5.009)
Log of real investment in computers	0.002	(1.118)	0.006	(1.909)	0.002	(1.118)
Skill (=log of wages per hour)	0.065	(5.871)	0.073	(4.868)	0.065	(7.120)
Other activities (=other revenue as % of total revenue)	-0.003	(-7.747)	-0.003	(-2.315)	-0.003	(-8.442)
R squared	0.152		0.391		0.189	
Number of observations	4637		1667		6305	

2. Dependent variable: change in log of real net revenue

Explanatory variables	Wholesale		Retail		Total trade	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
Change in log hours worked	0.208	(16.37)	0.305	(20.81)	0.233	(23.08)
Log of real investment in non computer capital	0.008	(4.031)	0.008	(3.415)	0.007	(4.914)
Log of real investment in computers	0.003	(1.548)	0.005	(2.123)	0.004	(2.319)
Skill (=log of wages per hour)	0.040	(4.388)	0.039	(3.034)	0.038	(5.072)
Other activities (=other revenue as % of total revenue)	0.0006	(1.790)	-0.002	(-2.713)	0.0004	(1.395)
R squared	0.127		0.347		0.160	
Number of observations	4639		1667		6307	

* The parameter values of the control dummies are omitted for convenience.

Table 16. Estimation results of model for change in real labour productivity, 1988-1994*

1. Dependent variable: change in log real gross margin per hour

Explanatory variables	Wholesale		Retail		Total trade	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
Lagged dependent variable	-0.240	(-29.15)	-0.283	(-19.81)	-0.239	(-33.98)
Change in log hours worked	-0.524	(-34.26)	-0.416	(-24.59)	-0.503	(-41.56)
Log of real investment in non computer capital	0.015	(7.007)	0.015	(5.841)	0.015	(8.479)
Log of real investment in computers	0.008	(3.369)	0.009	(3.262)	0.008	(4.303)
Skill (=log of wages per hour)	0.273	(21.94)	0.241	(15.13)	0.255	(25.36)
Other activities (=other revenue as % of total revenue)	-0.006	(-13.70)	-0.004	(-3.786)	-0.005	(-14.87)
R squared	0.465		0.553		0.470	
Number of observations	4637		1667		6305	

2. Dependent variable: change in log real net revenue per hour

Explanatory variables	Wholesale		Retail		Total trade	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
Lagged dependent variable	-0.058	(-13.59)	-0.098	(-9.101)	-0.059	(-15.54)
Change in log hours worked	-0.752	(-58.68)	-0.652	(-43.24)	-0.730	(-71.59)
Log of real investment in non computer capital	0.009	(5.039)	0.008	(3.500)	0.009	(5.942)
Log of real investment in computers	0.007	(3.396)	0.006	(2.373)	0.007	(4.101)
Skill (=log of wages per hour)	0.104	(10.24)	0.097	(6.918)	0.096	(11.56)
Other activities (=other revenue as % of total revenue)	0.0007	(1.935)	-0.002	(-2.702)	0.0005	(1.544)
R squared	0.536		0.570		0.556	
Number of observations	4638		1667		6306	

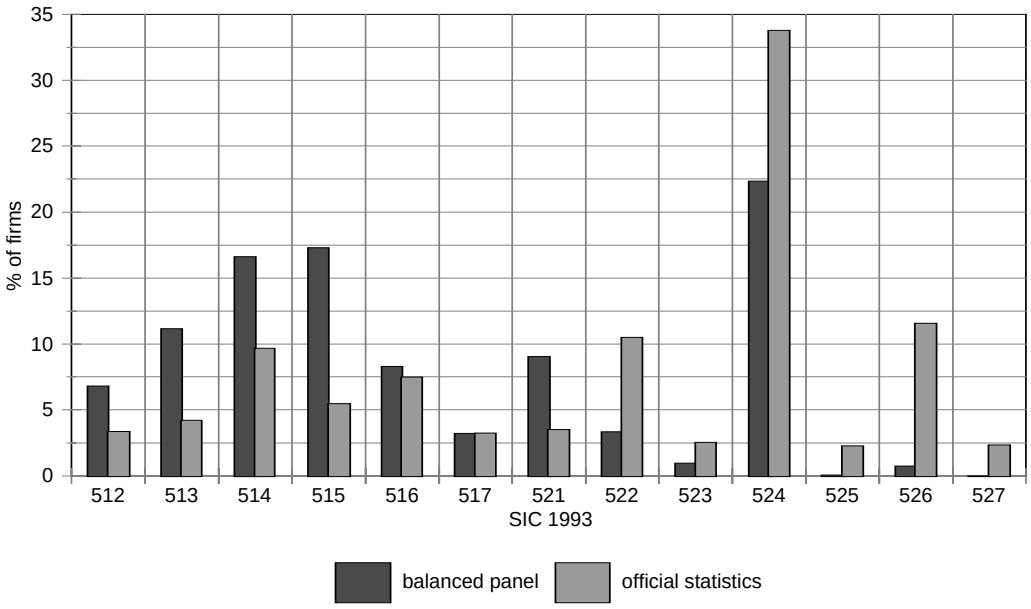
* The parameter values of the control dummies are omitted for convenience.

Table 17. Estimation results of model for change in total log of employment (number of employed persons), 1988-1994*

Explanatory variables	Wholesale coefficient	t-value	Retail coefficient	t-value	Total trade coefficient	t-value
Lagged log of employment	-0.087	(-11.02)	-0.102	(-9.127)	-0.090	(-14.21)
Change in log of labor costs as % of net revenue	-0.072	(-14.25)	-0.220	(-16.31)	-0.094	(-19.50)
Log of real investment in non-computer capital	0.018	(9.671)	0.024	(6.542)	0.020	(12.11)
Log of real investment in computers	0.016	(7.532)	0.019	(5.026)	0.017	(9.247)
Other activities (=other revenue as % of total revenue)	-0.0004	(-1.180)	-0.0004	(-0.288)	-0.0003	(-0.975)
R squared	0.165		0.300		0.187	
Number of observations	4639		1667		6307	

* The parameter values of the control dummies are omitted for convenience.

Figure 1. Distribution of firms according to SIC of 1993.



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