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Are Small Firms Really Sub-Optimal?

Compensating Factor Differentials in Small Dutch Manufacturing Firms[1]

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Contents

Abstract

The advent of a growing share of small firms in modern economies raises some intriguing questions. The most intriguing question undoubtedly is why so many smaller firms, which have traditionally been classified as sub-optimal scale firms, can exist. We suggest that, through pursuing a strategy of compensating factor differentials, that is by remunerating and deploying factors of production differently than their larger counterparts, small firms are able to compensate for size-inherent cost disadvantages. Using a sample of over seven thousand Dutch manufacturing firms, we find considerable evidence that such a strategy of compensating factor differentials is pursued within a European context. When viewed through a static lens, the existence of such a strategy, while making small and sub-optimal scale firms viable, suggests that they impose a net welfare loss on the economy. However, when viewed through a dynamic lens, the findings of a positive relationship between firm age and employee compensation as well as firm age and firm productivity suggest that there may be at least a tendency for the inefficient firm of today to become the efficient firm of tomorrow.

1 Introduction

One of most striking findings emerging from studies focusing on new firms is that not only are most new firms small, but they are so small as to preclude operating at anything approaching an efficient scale of output, at least for most industries (Audretsch, 1995; Thurik, 1993; and Geroski, 1995).[1] This finding that the bulk of firms are small applies not just to new ones. Upon reviewing his 1964, 1976, and 1979 studies on the extent of sub-optimal scale plants and firms in industrial markets, Leonard Weiss in 1991 concluded that, 'In most industries the great majority of firms is sub-optimal. In a typical industry there are, let's say, one hundred firms. Typically only about five to ten of them will be operating at the MES (minimum efficient scale) level of output, or anything like it. So here is a subject that ought to be measured and critically analyzed and evaluated.'[2] Not only did Weiss (1976, p. 259) find that the MES level of output exceeds that of most firms (enterprises) and plants (establishments), but that, 'On the average, about half of total shipments in the industries covered are from sub-optimal plants. The majority of plants in most industries are sub-optimal in scale, and a very large percentage of output is from sub-optimal plants in some unconcentrated industries.'[3]

While the exact reason why the extent of sub-optimal plants and firms should vary so much across industries has remained something of a controversy during the decades subsequent to the path breaking studies by Weiss (1964 and 1976), Scherer (1973), and Pratten (1971), their actual existence has not.[4] The persistence of sub-optimal plants to dominate industrial markets over time and across developed western countries raises the question of not only *why* do sub-optimal scale plants exist but also *how* are they able to exist.[5] That is, Weiss (1991, p. 403) assumed that 'The term 'sub-optimal' capacity describes a condition in which some plants are too small to be efficient.'

1 Paul Geroski (1995) was able to comb through a diverse set of studies spanning a broad spectrum of countries, time periods, and methods of analysis, to uncover a set of 'Stylized Facts' that emerge with remarkable consistency to answer the question, 'What do we know about entry?' The only limitation of Geroski's survey is that it is confined to manufacturing. See Audretsch, Klomp and Thurik (1999) for exercises in services.

2 Quotation from p. xiv of the *Editor's Introduction* to Weiss (1991).

3 While Weiss (1964) concluded that suboptimal plants account for about 52.8 percent of industry value-of-shipments, Scherer (1973) found that 58.2 percent of value-of-shipments emanated from the suboptimal plants in twelve industries, and Pratten (1971) identified the suboptimal scale establishments accounting for 47.9 percent of industry shipments.

4 For example, Weiss (1991, p. 114) pointed out that, 'Mike Scherer had formulated a theory explaining the extent of suboptimal capacity. Firms make decisions about plant scale when they add to capacity, trading off increasing transport cost against falling production costs as additions to capacity are made. As a result, high concentration leads to larger scale plant and reduced suboptimal capacity.'

5 Weiss (1991, p. 404) observed that, 'The survival of smaller plants within any given industry may be due to their specialization in items with short production runs or to their service of small geographic markets within which their relatively small national market share is irrelevant. To the extent that such explanations hold, small plants are not necessarily suboptimal. However, such explanations seem unlikely to hold for a number of the industries where the percentage of suboptimal capacity is large.'

How are such sub-optimal scale establishments able to exist? One answer, provided by a growing body of literature linking survival rates to firm size and age[1], is that they cannot – at least not for an indefinite period of time. These studies have produced three consistent and compelling findings: (1) The likelihood of survival is lower for new and small firms; (2) The growth rates of small and new firms is greater than the growth rates of large and established ones; and (3) the likelihood of survival for small and new firms is lower but the growth rates of surviving firms are greater in industries where scale economies and capital intensity play an important role. A key conclusion from these studies is that such small and sub-optimal firms are, at least to some extent, in a state of static disequilibrium, in that they must grow and approach an efficient scale of output to remain viable in the long run. They do, however, exist in the short run because they are incurring the risk whether or not they possess the right endowments or qualities, both in terms of product offered as well as in terms of management, to facilitate growth and ultimately survival. In other words, they have only an option on growth and future prosperity.

The purpose of this paper is to offer an explanation as to how such sub-optimal scale plants are able to exist despite their inherent static efficiency disadvantages. We build upon a hypothesis introduced by Audretsch and Yamawaki (1992) and Audretsch (1995) suggesting that sub-optimal scale plants compensate for their size disadvantages by deviating from the manner that productive factors are deployed and remunerated by their larger counterparts. By engaging in a strategy of compensating factors of production differently than large established firms, smaller ones are able to offset, at least to some extent, their size-induced scale disadvantages.

Audretsch (1995) finds considerable evidence that smaller establishments in both the United States and Japan are able to compensate for their size related disadvantages through pursuing a strategy of compensating labor differentials differently than their larger counterparts. There are reasons to expect that a strategy of compensating factor differentials is more difficult to implement in Europe. Not only is protection under unions more widespread in Europe than in either Japan or the United States, but a broad spectrum of legal institutions

1 See for example Audretsch (1991 and 1995), Audretsch and Mahmood (1995), Audretsch and Mata (1995), Evans (1987), Hall (1987), Dunne, Roberts and Samuelson (1988 and 1989), Mata (1996), Mata, Portugal and Guimaraes (1995), Wagner (1992 and 1996) and Baldwin and Rafiquzzaman (1995).

restricts the ability of individual firms to deviate too far from industry norms.[1]

In the following section the manner used to calculate the minimum efficient scale (MES) is explained and the degree to which scale economies exist along with the prevalence of sub-optimal sized firms is examined. A model linking the existence of sub-optimal scale firms to compensating factor differentials is introduced in the third section. Using a system of simultaneous equations, our hypothesis on the existence of compensating factor differentials is tested for 7,716 Dutch manufacturing firms in the fourth section. Finally, in the fifth section a summary and conclusions are provided. We find considerable evidence that, even in a European context, a different remuneration to labor serves, at least to some extent, to compensate for the inherent size disadvantages confronting sub-optimal scale firms. The empirical results suggest that the degree to which such a strategy of compensatory factor differentials is implemented depends upon the extent to which the MES level of output exceeds that of the sub-optimal scale firm along with the extent to which efficiency declines with decreasing firm size.

The lower employee compensation associated with smaller firms has been attributed by Brown, Hamilton and Medoff (1990) to represent a net welfare loss. Similarly, Weiss (1979) argued that sub-optimal scale firms represent a net welfare loss in terms of lower efficiency. However, an important finding of this paper is that both the compensation differential and the productivity differential between large and small firms tends to disappear as sub-optimal firms age over time, even after controlling for the size of the firm. This may suggest that the strategy of compensating factor differentials is only viable in the early stages of a firm's existence. And more importantly, this new finding of the influence of firm age on wages and productivity suggests not only that the less productive firm of today becomes the productive firm of tomorrow, but, equally important in terms of welfare economics, that the low wage of today becomes the high wage of tomorrow.

1 In the Netherlands collective wage-agreements do not only apply to the firms represented in the bargaining process, but due to mandatory extension-(collective bargaining agreements) also to all other firms in the industry. See Teulings and Hartog (1998).

2 Minimum Efficient Scale and Sub-Optimal Plant Share

2.1 Measuring the Extent of Scale Economies

As Caves, Kalilzadeh-Shirazi, and Porter (1975) and Scherer and Ross (1990, chapter eleven) both emphasize, estimating the extent of scale economies in an industry is a hazardous and imprecise undertaking. While a number of methodological approaches for estimating the industry MES have been introduced in the literature (Scherer and Ross, 1990, chapters eleven and four), here we follow the tradition in the industrial organization literature and adapt the method first introduced by Comanor and Wilson (1967), who approximated the MES by measuring the mean size of the plants accounting for the largest fifty percent of the industry value-of-shipments.[1] That is, the Comanor and Wilson measure yields the average size of the largest firms in the industry and is at least able to reflect whether the bulk of sales in an industry are made by larger or smaller firms.

It should be emphasized that this is not an exact measure of the actual MES. Rather, at best it is useful as an *index* in that it reveals relative differences in the extent of scale economies in a cross-industry context. That is, the MES index is useful in identifying that a certain industry, such as steel, has a greater extent of scale economies than, say, shoes. This proxy measure should never be interpreted as an exact measure of the actual MES in an industry. In any case, Scherer and Ross (1990, pp. 424-425) report that the various estimates of MES derived from industry census statistics correlated reasonably well with the presumably more precise engineering estimates for a limited sample of industries.

1 The Comaner and Wilson (1967) method for approximating the MES, while used by numerous researchers, is a slight variation on the original method introduced by Weiss (1963), who proxied the Mes as the plant size accounting for one-half of the industry value-of-shipments. It follows that the Comaner and Wilson measure is systematically larger than the Weiss measure

2.2 Computing the MES for the Netherlands

Using the 1991 Production Statistics, collected by the Department of Statistics of Manufacturing and Construction of Statistics Netherlands, the MES proxy was estimated.[1] The MES for Dutch manufacturing industries has been aggregated to two-digit manufacturing sectors for presentation purposes in Table 1. The computed MES is relatively large in chemicals, primary metals and transportation equipment. By contrast, the MES is relatively small in apparel, furniture and leather. This is also true in the United States and Japan.[2] In fact, the industry variations in the mean MES across sectors are quite the same among the three countries. In particular, the simple correlation of 0.86 between the computed MES in Japan and the United States suggests that, despite the conversion problem, the relative differences in the importance of scale economies are similar between the two countries. This similarity between the Netherlands and Japan is not so strong, as the simple correlation of 0.06 might suggest, and is even weaker between the United States and the Netherlands, as evidenced by the simple correlation coefficient of 0.30.

Next to the obviously crude method used to approximate the MES, there are also several other weaknesses which should be emphasized. The MES, when measured as total value of shipments, tends to be overstated in industries producing goods close to the final consumer and understated in industries producing goods that are predominantly used as intermediate inputs. That is, the level of the production process in the vertical chain is not controlled for in the value-of-shipments measure. In addition, comparing values of the MES across countries requires conversion into a common currency using

1 An additional complication in computing the MES for the Netherlands is that total industrial sales for each manufacturing industry is not easily computed, because of a lack of universal data on all small firms. To estimate total sales of small firms, a procedure based on the so-called ratio-estimator was implemented. The procedure is based on a stratum, or a sub-group within a three-digit industry containing companies within a specific firm size class. The mean sales was computed for each stratum. The mean sales (of each stratum) was then multiplied by the number of firms in the auxiliary data set, which contains the universe of firms (in terms of numbers). This then provided by the estimate for the total sales in each stratum. In addition, any potential sample bias was corrected for by using a correction factor, based on combining the auxiliary data set with the data files identifying the mean number of employees. For companies that can be located in both data files, the mean number of employees per stratum was also computed. Using the auxiliary data files the mean number of employees per stratum was also computed. Dividing the mean sales by the mean employees provided a correction factor which was then used. Total sales in each industry was then calculated by summing all sales over the strata for the smallest firms and adding in the sales of the largest firms.

2 The data for the United States are based on the 1982 *United States Census of Manufactures*. The data from Japan are based on the 1982 *Japanese Census of Manufactures*. They are both taken Audretsch (1995). To compare the computed MES for the Netherlands with that for the United States and Japan, the dollar estimates had to be obtained using a currency conversion exchange rate based on the 1993 *Yearbook of International Labor Statistics* from the International Labor Office, Geneva.

the exchange rates for any given year. But the exchange rates, particularly with respect to Japan, are volatile from year to year. To avoid these problems, Table 2 lists the number of employees associated with the MES firm. However, the employee measure is biased because it neglects the amount of capital input required to attain the MES. Thus, the MES tends to be understated in a highly capital-intensive industry and overstated in industries where the capital-labor ratio is relatively low. The limitations inherent in each of these measures explain why the rank order of industries according to the MES measured in terms of value-of-shipments does not exactly correspond to the rank order when the MES is measured in terms of employment.

There are at least four major reasons why the MES for any given industry should vary between nations. *First*, not all countries may be at the technological, management, and production frontier. *Second*, even if all three nations are at the technological frontier, variations in relative factor input prices will result in differences in the observed MES. *Third*, the aggregation of various productive activities under the umbrella of an encompassing industry classification will result in differences in the measured MES between the two countries, if the composition of various productive activities in the industry varies between nations. This is probably the explanation for the considerably greater MES measured in the American and Japanese transportation equipment sectors than in the Dutch transportation equipment sector. While considerable assembly production is included in the United States and Japan, the bulk of economic activity within this sector in the Netherlands involves the production of parts. *Fourth*, differences in domestic vertical and horizontal relationships as well as managerial techniques may result in variations in the computed MES across nations. For example, as Loveman and Sengenberger (1991) and Aoki (1988) point out, formal and informal subcontracting relationships are much more prevalent in Japanese manufacturing than in the United States or Western Europe. To the extent that Japanese plants tend to be less vertically integrated, the computed MES for a given Japanese industry will tend to be less than that for its American or Dutch counterpart. These four factors probably account for a considerable amount of the differentials in the aggregated mean MES for broad industrial sectors among the United States and Japan, which are shown in Table 1.

One common tendency exhibited in the Netherlands, as well as in the United States and Japan, is that the share of firms accounted for by sub-optimal scale firms is remarkably high. In all three countries the bulk of firms can be classified not only as being small, but as being so small that they can be classified as sub-optimal, at least according to the traditional definition found in the industrial organization literature.

3 Compensating Factor Differentials

The lower productivity associated with small firms displayed Tables 1 and 2 raises a question which has never been answered in the industrial organization literature: 'How are plants able to survive if they are operating at a scale that is sub-optimal, in that their level of production is less than the MES level of output?' While it is true that small and new firms often resort to a strategy of filling a small product niche[1], or else serve as a supplier of parts to a larger downstream producer within the same industry, the systematically lower propensity of such new and small firms to survive confirms that they are confronted with at least some type of size disadvantage. And this size disadvantage should increase as the extent of scale economies in the industry increases.

That is, one reaction to the question of how sub-optimal firms manage to survive is that they do not, at least not with the same likelihood as larger firms. As previously mentioned, a growing and impressive literature has confirmed across a wide spectrum of countries, time periods and industries the existence of a positive relationship between the likelihood of survival and firm size. Similarly, those smaller firms surviving in the long run have been found to experience higher growth rates than their larger counterparts, so that presumably more than a few of them attain or at least approach the MES level of output. That is, small firms tend also to be young firms. The results of this literature clearly show that, while the probability of a young and small firm surviving is lower than that of a larger and more experienced firm, the growth rate of those young small firms that do survive tends to be greater than that of older and larger firms.

Still, until smaller scale firms grow sufficiently to attain or at least approach the MES level of output, the question of how they manage to stay viable remains. The observation made by Brown and Medoff (1989) and Brown, Hamilton, and Medoff (1990) that employee compensation tends to be systematically lower in small firms than in large ones provides at least on explanation.[2] Through providing a lower level of employee compensation than that provided by their

1 Bradburd and Ross (1989).
2 Similar results have been found by Oosterbeek and van Praag (1995) for the Netherlands. Hartog and Tuelings (1994) conclude that the firm size effect is smaller in the Netherlands than in the US. For the Netherlands they obtain firm size elasticities of wages between 0.006 and 0.02, whereas Brown and Medoff (1989) obtain an elasticity of 0.03 for the US.

larger counterparts, smaller scale plants can effectively offset their inherent cost disadvantages.[1] To the degree that sub-optimal scale firms are able to reduce the level of employee compensation below that paid by optimal-sized plants, the average cost will be correspondingly lower. Should the sub-optimal firm succeed in reducing employee compensation to a sufficient degree, it can actually lower its average cost to that faced by the larger firms, at which point it will be viable and able to survive in the long run.

Table 3 shows that sub-optimal firms do experience a considerable productivity disadvantage. Productivity is measured here as value added divided by employment. The productivity differential tends to be the greatest in those industrial sectors exhibiting the largest MES in Tables 1 and 2. Not only is the productivity the greatest in the Dutch industry exhibiting the largest computed MES – chemicals – but the gap between the optimal and sub-optimal firms is also the largest, where the large firms are nearly twice as productive as their smaller counterparts. By contrast, in industries with a very low computed MES, such as apparel, lumber, and furniture, the productivity gap between the optimal and sub-optimal plants is virtually non-existent. As might be expected, given the relatively high wage rate and other institutional rigidities in the Netherlands, the productivity gap between the optimal and sub-optimal firms is lower in the Netherlands than in either the United States or in Japan.

Table 4 confirms that employee compensation is lower in sub-optimal plants than in optimal plants in the Netherlands, as well as in the United States and in Japan. The differential in employee compensation generally reflects the differentials in productivity shown in Table 3. Thus, the Dutch sector exhibiting the greatest differential in productivity, chemicals, also exhibits the largest differential in labor compensation between optimal and sub-optimal scale firms. By contrast, in the sectors where there are virtually no differences in productivity between sub-optimal and optimal, such as apparel and furniture, there is also no difference in employee compensation.

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1 An example of the strategy of compensating factor differentials is provided by the Wall Street Journal (1991, p. 1), which reports that 'Wall Street has been in love with Nucor Corp.', which has become the seventh largest steel company in the United States through its fifteen *mini-mill* plants. Nucor has pursued a strategy not only of '. . . declaring war on corporate hierarchy', but also by being '. . .terribly efficient, aggressively non-union and quite profitable. Most of its 15 mini-mills and steel fabrication operations are situated in small towns, where they have trained all sorts of people who never thought they'd make so much money. And Nucor has developed a revolutionary new plant that spins gleaming sheet steel out of scrapped cars and refrigerators.' In the case of Nucor, compensating factor differentials also apparently include the health and safety of the employees: 'Its worker death rate since 1980 is the highest in the steel industry . . . Nucor is a highly decentralized company with little corporate structure. It doesn't have a corporate safety director or uniform training programs, leaving safety up to plant managers.' One employee reports, ' If something's not right, and you can fix it in a half hour the wrong way and two hours the right way, you take the shorter way.'

Table 5 shows that the productivity gap between optimal and sub-optimal scale firms is the largest in Japan, second largest in the United States and the smallest in the Netherlands. At the same time, the gap in employment compensation between the optimal and sub-optimal scale firms is the greatest in Japan and virtually identical in the United States and the Netherlands.

As Tables 4 and 5 indicate, there is considerable evidence suggesting that a sub-optimal scale firm can exist by compensating for its inherent size disadvantages through deviating from the manner in which factor inputs are paid. As Brown, Hamilton and Medoff (1990) point out, smaller firms may be able to avoid labor rigidities imposed by unions and therefore subject employees to longer working hours. Similarly, a strategy of compensating factor differentials may be reflected in differing managerial organizations and methods of production. For example, as a result of their small size, sub-optimal plants may require less of a vertical hierarchy than their larger optimal counterparts, thereby reducing the amount of white-collar overhead cost. Carlsson and Taymaz (1994) and Dosi (1989) have argued that small establishments are more adept at implementing flexible methods of production than larger plants, which are more likely to be burdened with rigid work rules. And Caves and Pugel (1980), Audretsch (1995) and Audretsch and Yamawaki (1992) found evidence that small firms can offset their inherent size disadvantage through pursuing a strategy of product innovation and deploying factor inputs differently than their larger counterparts.

An important insight of Caves, Khalilzadeh-Shirazi, and Porter (1976) was that the extent to which sub-optimal sized establishments are encumbered with an inherent cost disadvantage is determined not only by the extent to which the MES level of output is in excess of a sub-optimal plant output level, but also by the slope of the long-run average cost curve over the sub-optimal scale range. In fact, they introduced the cost disadvantage ratio, which they defined as average value-added per employee in establishments providing the lowest fifty percent of industry value-added, divided by the mean value-added per employee in establishments supplying the top half. The greater their computed *cost disadvantage ratio,* the greater will be the slope of the long-run average cost function in an industry. This suggests that in order for a sub-optimal firm to be viable, for any given size, the compensating differentials in terms of employee compensation, must be sufficiently greater to offset the greater cost disadvantage associated with a steeper long-run average cost curve.

Thus, the extent to which a sub-optimal scale firm shipping an output with a value of $VSHIP_{SO}$ falls short of the equivalent value-of-shipments corresponding to the MES level of output, or, $VSHIP_{O}$, will determine the degree to which the firm must compensate for its productivity disadvantage, by reducing its labor costs and deploying its resources differently from that practiced in optimal-sized firms, so that

$$VSHIP_{so} - VSHIP_{o} = \alpha_{o} + \alpha_{l}(W_{so} - W_{o}) + \sum_{i=1,I} \alpha_{2\,i}\,(F_{so} - F_{o}) + \alpha_{3}(VA_{so} - VA_{o}) + \sum_{j=1,J} \alpha_{4\,j}\,K_{j} + \mu_{l} \qquad (1)$$

where W_{SO} and W_{O} represent the employee compensation in sub-optimal and optimal firms, F_{SO} and F_{O} represent the use of factor and managerial practices i in sub-optimal and optimal firms[1], and VA_{SO} and VA_{O} refer to the value-added per employee in sub-optimal and optimal firms. Finally, K refers to the j industry-specific characteristics influencing the extent to which sub-optimal firms must compensate for their cost disadvantages in order to be viable.

Equation 1 can be most easily interpreted as identifying the extent to which wages must be lowered and factors deployed differently, such as investment strategy, in order for a sub-optimal firm of a given size to compensate for its size-induced productivity disadvantage. Three different phenomena determine the extent to which the payment of factors and their deployment must compensate for the inherent size disadvantage. The *first* is the degree to which the MES level of output exceeds that of the sub-optimal firm. The greater this difference becomes, the more wages must be reduced, and the greater is the extent to which other non-wage compensatory strategies must be deployed. That is, as the degree to which a firm is sub-optimal increases, the more a firm must compensate for its size-induced cost disadvantages. *Second*, for a given extent to which the MES level of output exceeds that of a sub-optimal firm, a greater slope of the long-run average cost function (negatively) causes an increases in the extent to which a strategy of compensating differentials must be deployed. *Finally*, certain industry-specific characteristics will presumably reduce or increase the extent to which a sub-optimal scale firm must compensate for a disadvantage of any given magnitude. For example, to the extent that the market price is elevated above long-run average costs, the need for a sub-optimal scale firm to com-

1 These practices include the investment rate, advertising intensity, human resource management, etc.

pensate will be that much less.[1] More specifically, Bradburd and Caves (1982) have shown that high industry growth is associated with higher industry profitability and therefore presumably higher prices.

Audretsch (1995) and Caves and Pugel (1980) provide evidence that pursuing a strategy of product innovation is one mechanism that small and presumably sub-optimal businesses can deploy to compensate for size-induced disadvantages. However, an important conclusion of Audretsch (1995) is that the relative innovative advantage of small firms vis-à-vis their larger and more established counterparts is anything but constant across industries. Thus, the extent to which small firms need to compensate for their size disadvantages may be reduced somewhat in industries where small-firm innovative activity is particularly high.

A particular econometric challenge posed in estimating equation 1 is that, as Brown and Medoff's (1989) work makes clear, the gap in employee compensation between sub-optimal scale and optimal scale firms is largely determined by the size difference between the sub-optimal scale firm size and the MES level of output. Similarly, differentials in value-added-per employee between firms within an industry are determined, to a considerable extent, by differences in firm size. This suggests that, equation 1 must be estimated within the context of a simultaneous-three-equations-model, where the differences in value-added-per employee and employee compensation between sub-optimal and optimal scale firms, as well as the size differential, are endogenous variables.

Assuming linearity we obtain the following equation:

$$W_{so} - W_o = \beta_0 + \beta_1(VSHIP_{so} - VSHIP_o) + \beta_2(VA_{so} - VA_o) + \beta_3 AGE + \beta_4 ULAB + \mu_2 \qquad (2)$$

where the additional variable AGE is the age of the firm and ULAB is an industry level measure for the amount of unskilled labor. The gap between optimal firm and sub-optimal firm employee compensation is estimated as being determined by the differentials in firm size and value-added per employee, along with the age of the firm and the share of the labor force accounted for by unskilled labor in

1 As Weiss (1976, p. 127) argues, to the degree that a certain market structure, '. . . results in prices above minimum long-run average cost, sub-optimal plants would be protected in the long run, especially if their cost disadvantages were mild.'

the industry in which the firm is operating. Since it is more difficult to implement a strategy of compensating wage differentials for skilled than for unskilled labor it would be expected that the share of the labor force accounted for by unskilled labor should have a negative impact on the gap in employment compensation between sub-optimal and optimal scale firms.

Assuming linearity we obtain the third equation:

$$VA_{so} - VA_{o} = \delta_0 + \delta_1(VSHIP_{so} - VSHIP_{o}) + \delta_2(INV_{so} - INV_{o}) + \delta_3 AGE + \mu_3 \qquad (3)$$

where the additional variable INV is a firm-level variable measuring the level of investment. The differential in value-added per employee, or productivity, between optimal and sub-optimal scale firms is estimated as being determined not only by the differential in firm size, but also by the differential investment activity, as well as the age of the firm. That is, a difference in plant size of a given amount will presumably result in a greater difference in value-added per employee when the differential in investment activity is also large.

4 Empirical Results

4.1 The Difference between the Firm Size and the MES Level of Output

To estimate equation 1 and test the hypothesis that sub-optimal scale firms offset, at least to some extent, their size inherent disadvantages by deviating from the manner that larger firms deploy and compensate labor, the dependent variable, $VSHIP_{so}$ - $VSHIP_{o}$, is formed by subtracting the value-of-shipment for 7,716 firms from the computed value of VS_{MES} for the relevant three-digit industry. Employee compensation is measured as total employee wages plus non-wage compensation, including social security taxes paid by the firm, divided by the number of employees in that firm, for 1991. The difference in employee compensation between sub-optimal and optimal scale firms is then formed by subtracting the *employee compensation* of the MES sized firms from that of each sub-optimal firm. Thus, the gap in employee compensation is measured in terms of a negative number, so that a positive coefficient is expected indicating that a sub-optimal scale firm can compensate, at least partially, for its size-induced disadvantages by reducing workers wages and salaries below that paid by optimal sized firms.

The *productivity differential* between sub-optimal scale firms and firms having attained the MES level of output is analogously measured as the difference in the value-added-per employee, defined as manufacturing value added (in thousands of Dutch guilders) divided by the number of employees. A negative coefficient is expected and would reflect the need for differential strategies to be deployed by sub-optimal scale firms to compensate for a productivity disadvantage. That is, as the productivity disadvantage increases for a given sub-optimal firm size, a negative coefficient of this variable will contribute to determining the extent to which employee compensation must be reduced.

In addition, differences in *investment activity* are also included. Investment activity is proxied in terms of the depreciation costs associated with the cumulative stock of capital (in terms of thousands of Dutch guilders), divided by the number of employees in 1991. A negative coefficient of the differential between depreciated cumulative capital expenditures would suggest that sub-optimal firms resort to a strategy of higher capital investment to offset their size disadvantages.

As explained in the previous section, in addition to the above variables, which are specific to a particular firm, several industry-specific characteristics are also hypothesized to influence the extent to which sub-optimal scale firms engage in compensatory strategies to offset their size-induced disadvantages. *Market growth* is measured as the mean percentage growth of sales in each three-digit industry between 1985-1990. It is expected that a strategy of compensatory differentials is less important in industries experiencing high growth than in those industries growing more slowly. Finally, the degree to which small firms tend to have the *innovative advantage* over their larger counterparts is represented by a measure of the small-firm innovative advantage. The small-firm innovative advantage is measured as the mean R&D intensity of firms with fewer than 100 employees divided by the mean R&D intensity of all firms. The R&D intensity is measured as the total number of employees in the relevant three-digit industry occupied with R&D for the company, including formal, informal and external R&D, divided by total employment. A negative coefficient of the small-firm innovative advantage would indicate that in industries where the small firms tend to have the relative innovative advantage, less of a compensatory strategy is needed by sub-optimal firms to offset any given size disadvantages. A brief description and summary of all variables estimated in the three-equation model can be found in Table 6.

Based on the 7,718 firms for which full records and compatible industry-specific variables are available, equation 1 is estimated first using the method of ordinary least squares (OLS), and the results are shown in the first column of Table 7. In fact, the coefficients of the compensation differential, productivity differential, market growth, and small-firm innovative advantage are all counter-intuitive. Of course, the OLS estimation treats the compensation and productivity differentials as if they were exogenous from the firm size differential (that is the differential between each firm and the computed MES in the relevant industry), which, as stressed in the previous section, is not a realistic assumption. Thus, in the two-stage least squares estimation (2SLS), both the compensation differential and the productivity differential are included as endogenous variables in a system of simultaneous equations. The actual estimates for the compensation differential and productivity differential will be examined in sections 4.2 and 4.3. Under the 2SLS estimation the coefficient of the compensation differential becomes positive and statistically significant, suggesting that the ability to reduce employee compensation facilitates the viability of smaller scale firms. Computing the elasticity at the mean shows that as the compensation gap shrinks by 1 percent, the firm will have to increase its size by 0.56 percent in order to maintain viability.

Similarly, under the 2SLS estimation the coefficient of the productivity differential becomes negative, implying that an increase in the productivity gap will force sub-optimal firms of any size to resort to a more intensive strategy of compensating factor differentials in order to compensate for the greater cost disadvantage. Or alternatively, it suggests that given a certain degree of compensating factor differentials, the size of any sub-optimal firm will have to increase as the productivity gap increases to maintain viability. Computing the elasticity at the mean suggests that as the productivity gap decreases by 1 percent, the size gap can correspondingly increase by a maximum of 1.09 percent for the firm to maintain its viability.

The positive and statistically significant coefficient of the investment differential suggests that smaller firms cannot compensate for size-inherent disadvantages by raising their investment intensities, relative to that of their larger counterparts. Perhaps production requires some minimum investment in capital goods. This suggests that capital goods requirements are a disadvantage to small firms. On the other hand, the positive and statistically significant coefficient of market growth suggests that the extent of a compensatory differential strategy for any firm needs to actually be greater in high growing markets than in more slowly or declining markets. Stated alternatively, given any degree of compensating factor differentials, as market growth increases, the size of a (sub-optimal) firm also needs to increase in order to maintain viability. Finally, the coefficient of the small-firm innovative advantage can not be considered to be statistically significant.

An alternative specification of equation 1 is to scale the difference between the size of a firm and the size associated with the MES level of output by MES. The advantage of scaling is that the dependent variables become measured free of dimensions in the same manner as all exogenous variables. In this case, the dependent variable to be estimated becomes $(VSHIP_{so} - VSHIP_o)/VSHIP_o$. However, this measure of the *relative* size gap is likely to suffer from heteroskedasticity, since the error term tends to be systematically larger as the relative size gap increases and thus the estimates need to be corrected for heteroskedasticity.[1] Estimation results of the scaled version of equation 1 can be found in the last two columns of Table 7.

1 Presence of heteroskedasticity was tested using the Breusch Pagan test statistic. The statistic took on a value of 175, far above 15.09, which is the 99th Percentile of the Chi-Square distribution with 5 degrees of freedom. Hence, the null hypothesis of constant variance is rejected at a one percent significance level.

In fact, as the final column of Table 7 indicates, the 2SLS estimation of the relative size gap, corrected for heteroskedasticity, produces coefficients for the *firm level* variables that are consistent with the unscaled 2SLS estimation. Both *industry level* variables show a change of sign and now show signs in accordance with the hypotheses. The coefficient of market growth is negative and statistically significant. This suggests that less of a strategy of compensating factor differentials is required in industries growing rapidly. The coefficient of the small-firm innovative advantage also becomes negative and statistically significant implying that less of a strategy of compensating factor differentials is required to maintain firm viability in industries where small firms have the innovative advantage. The observation that only the effect of industry level variables changes indicates that some industries have dominated the estimation results in the first three columns, because of a systematically greater residual variance.

4.2 Employee Compensation Differential

The estimated model for the differences in the employment compensation between optimal and sub-optimal firms is shown in Table 8. The differential in employment compensation between optimal and sub-optimal firms is estimated by the size differential (the dependent variable of equation 1), the productivity differential, the age of the firm and the share of the labor force accounted for by unskilled labor, measured in 1987.[1] Based on the 2SLS estimation the results are qualitatively identical for both the unscaled compensation differential as well as the scaled differential. The positive and statistically significant coefficient of the size differential suggests that as the gap in firm size increases so does the gap in employee compensation.

Similarly, the positive and statistically significant coefficient for the productivity differential suggests that as the differential in productivity increases, holding the difference in firm size constant, the gap in the employment compensation between the optimal and sub-optimal firms also increases correspondingly. The negative and statistically significant coefficient of unskilled labor suggests that as the share of unskilled labor in the industry labor force increases, the compensation gap tends to increase. This suggests that a strategy of compensatory factor differentials is easier to implement in an industry where unskilled labor plays a more important role than in an industry where skilled labor plays a more important role.

1 The share of the labor force accounted for by unskilled labor is measured at the level of two-digit industries and repeated across common three-digit industries.

The positive and statistically significant coefficient of the age of the firm suggests that the compensation gap between the sub-optimal and optimal sized firms tends to fall as a firm matures, holding constant the size of that firm. This may reflect the propensity for firms to substitute a higher level of human capital and skilled labor as it matures over time and its prospects for longer-term survival improve. Alternatively, it may indicate that the ability for firms to suppress employee compensation below that of their larger and more established counterparts tends to deteriorate over time. A third potential explanation is that the impact of firm age on the compensation gap may be due to the fact that on average younger firms have younger employees. As the firm matures, also the age (and experience) of the average worker increases. In any case an increase in firm age by one year will increase employee compensation by $143. Alternatively, computing the elasticity at the mean suggests that an increase in firm age of 1 percent will lead to a decrease in compensation gap by 0.38 percent.

4.3 Productivity Differential

The productivity differential between sub-optimal and optimal firms is estimated by the size differential, the degree of capital investment, and firm age. The results are presented in Table 9. The positive and statistically significant coefficient of the size difference in the OLS estimation suggests that as the gap between the size of a particular firm and that associated with a firm operating at the MES level of output increases, the productivity gap also increases. Surprisingly, this coefficient becomes reversed under the 2SLS estimation, both scaled and unscaled. The positive and statistically significant coefficient of the investment differential suggests that by reducing the gap in investment per worker, a small firm can also reduce the productivity gap.

The positive and statistically significant coefficient of firm age suggests that, holding the firm size and investment intensity constant, as firms mature the productivity gap tends to decrease. This result is consistent with the finding from Table 8 suggesting that the compensation differential also tends to decrease as firms mature over time. An increase of one year in the life of a firm leads to an increase of productivity of $205 per worker. Alternatively, computing the elasticity at the mean yields a decrease in the productivity gap of 0.50 percent associated with a one percent increase in the age of the firm.

As previously mentioned, the positive influence of firm age on productivity may reflect the propensity for new firms to substitute skilled for unskilled labor as they mature, or alternatively, for firms to take advantage of *learning by doing* and *experience to achieve* greater productivity. In either case, the result is a clear association between the age of a firm and its levels of productivity and employee compensation, even after controlling firm size and investment.

4.4 Decomposing Surviving and Exiting Firms

One of the concerns about comparing the wage and productivity performance to firm size is that at any one point in time, each size cohort consists of unsuccessful firms, in that they will ultimately fail, as well as successful ones, in that they will survive over an extended period. A result found repeatedly across a wide spectrum of nations (Evans, 1987; Hall, 1987; Audretsch, 1991; Audretsch and Mahmood, 1991; Wagner, 1996 and Mata, 1996) is that the likelihood of survival tends to increase systematically with firm size and firm age. These results suggest that cohorts of smaller firms, which also tend to be younger firms, will systematically include a greater share of firms that will ultimately fail than do the larger firm size classes. Presumably it is those firms which are the least productive and forced to compensate employees at lower levels that ultimately exit out of the industry.

Therefore, the inclusion of such firms which ultimately exit results in the estimation of a smaller mean productivity and employee compensation associated with the smaller firm size classes than would have been calculated had only surviving firms been included. It is conceivable that the observed relationships between firm size, employee compensation and productivity are simply attributable to the greater presence of inefficient firms within the smaller firm-size classes. This would suggest that the observed relationships are less the result of a strategy of compensating factor differentials being deployed by sub-optimal firms and more the result of including a higher proportion of unsuccessful firms in the cohorts containing the smaller firms.

To shed at least some light on distinguishing between the compositional effect from the strategy of factor compensation differentials, firms in existence in 1980 are divided into two major cohorts – those firms surviving through 1991 and those no longer in existence as of 1991. In forming and interpreting these two cohorts, two important qualifications must be emphasized. *First*, due to constraints within the Statistics Netherlands, it is not possible to include firms with fewer then ten employees, which is a crucial size class in a study focusing on the link between firm size and a strategy of compensating factor differentials. *Second*, a firm disappears from the files for a number of reasons on addition to simply going out of business. For example, firms acquired or involved in consolidations are recorded as exiting.

Table 10 shows that the likelihood of survival tends to increase along with firm size over the eleven-year period. The 1980 productivity of surviving firms is systematically greater than that for their competitors which exited prior to 1991 for all size classes. At the same time, the gap in mean productivity between smaller and larger firms still remains, even for the exiting firms, although it is considerably greater for the surviving ones. That is, on average the surviving firms are 14.7 percent more productive than their counterparts that exited. At the same time, the largest surviving firms are 17.4 percent more productive than the smallest firms. Thus, some of the propensity for smaller firm size classes to exhibit lower productivity levels can be attributed to the inclusion of a higher proportion of firms that will ultimately exit. But at the same time, even after including only surviving firms, the positive relationship between firm size and productivity still remains. And, the productivity gap is greater between the smallest and largest firms than between the surviving and exiting ones within any size class. In fact, it is within the largest firm size class that the productivity gap between surviving and exiting firms is the greatest, both in relative as well as in absolute terms.

The gap in employee compensation is also considerably greater across firm-size classes than within any particular size class. That is, employee compensation by surviving firms is 18.2 percent greater in the largest firm-size class than in the smallest. However, on average, there is only a 2.91 percent higher level of employee compensation in surviving firms than in exiting firms. Thus, differentials in employee compensation are far more attributable to firm size than to whether the firm ultimately survives or fails. The tendency for smaller firms to engage in a strategy of compensating factor differentials remains and does not vary greatly within a firm size class. Rather, it is the relatively large variations in employee compensation across firm size classes, for both surviving and exiting firms, that is consistent with the theory of compensating factor differentials.

5 Conclusions

The growing importance of small firms (Audretsch and Thurik, 1997 and 1998) and their contribution to economic growth (Audretsch and Thurik, 1998; Carree and Thurik, 1998 and 1999) gives rise to some intriguing questions. Probably, the most intriguing question is how small firms are able to survive. And even more strikingly, how is it that small firms in industries where scale economies play an important role or firms that have been termed in the industrial organization literature as sub-optimal scale firms, are able to exist? One answer provided by a now rather large literature linking firm size and age to survival rates is that they are not – at least, not with the same likelihood as their larger and more mature counterparts. It is exactly this literature identifying the positive relationship between firm size (and age) and the likelihood of survival that confirms the suspicion that, at least some small firms are confronted by a size-related disadvantage.

In this paper, we extend the arguments of Audretsch (1995) and Audretsch and Yamawaki (1992) and suggest a different answer: small firms are able to compensate for any size related disadvantage by pursuing a strategy of compensating factor differentials, where factors of production are deployed differently and compensated differently. Given the institutional rigidities in European labor markets, it might have been suspected that perhaps such a strategy of compensating factor differentials is possible in the United States and even Japan, but not in Europe. Yet we find considerable evidence suggesting that, even within the European context, small firms can compensate for their size inherent disadvantages by reducing the compensation to labor and by increasing investment. And the evidence for the Netherlands suggests that, as the cost differential increases (measured by the productivity differential) for any given firm size, the reliance upon such a strategy of compensating factor differentials also increases.

In using the firm as a unit of observation we are unable to control for the *type* or *quality* of labor input used by each individual firm. And as a virtual stylized fact in the labor economics literature suggests[1], the level of skilled labor tends to increase systematically with firm size. Thus, the strategy of compensating factor differentials employed by firms confronted by a cost disadvantage (as captured by the pro-

1 See for example, Freeman and Medoff, 1979 and Brown, Hamilton and Medoff 1990.

ductivity differential), certainly may involve the deployment of factors of production and the type and quality of factors.

Probably, smaller scale firms pursue a strategy of seeking product niches and therefore do not compete directly against the larger firms included in a rather broadly defined *industry* classified by a national statistical office.[1] This is certainly consistent with the findings in this paper that firms operating in an industry where the small firms have the innovative advantage rely less on reducing employee compensation. That is, innovative activity and pursuing niches is clearly a type of compensating strategy deployed by smaller competitors to offset *what would otherwise be* an inherent size disadvantage.

What are the economic welfare implications? Leonard Weiss (1991) argued that the existence of small firms which are sub-optimal within the organization of an industry represented a loss in economic efficiency. Weiss (1979, p. 1137) advocated any public policy '. . .creates social gains in the form of less sub-optimal capacity.' Translating this lower efficiency into the impact on the labor market, Brown, Hamilton and Medoff (1990, pp. 88 and 89) conclude that, 'Workers in large firms earn higher wages, and this fact cannot be explained completely by differences in labor quality, industry, working conditions, or union status. Workers in large firms also enjoy better benefits and greater job security than their counterparts in small firms. When these factors are added together, it appears that workers in large firms do have a superior employment package.'

The conclusions by Weiss (1991) and Brown, Hamilton and Medoff (1990) are based on a static analysis. However, when viewed through a dynamic lens, a different conclusion emerges. One of the most striking results of this study is the positive impact of firm age on productivity and employee compensation, even after controlling for the size of the firm. And given the strongly confirmed stylized fact linking both firm size and age to a negative rate of growth (that is the smaller and younger a firm is the faster it will grow), this new finding linking firm age to employee compensation and productivity suggests that not only will some of the small and sub-optimal firms of today become the large and optimal firms of tomorrow, but that there is at least a tendency for the low productivity and wage of today to become the high productivity and wage of tomorrow.

1 See Audretsch, Prince and Thurik (1999).

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Table 1 MES[a] measured in terms of sales, in Dutch, U.S. and Japanese Manufacturing Sectors, 1991

	Netherlands[b]		U.S.[c]		Japan[c]	
Industry	MES (1991 $)	Sub-Optimal Share	MES (1991 $)	Sub-Optimal Share	MES (1991 $)	Sub-Optimal Share
Food	165.960	94.9	77.247	83.3	35.347	91.5
Textiles	58.077	95.3	53.793	86.4	11.024	90.1
Apparel	8.007	92.1	15.301	83.2	4.135	87.5
Lumber	11.486	96.3	5.832	79.6	6.940	86.9
Furniture	7.499	95.4	24.380	90.9	10.513	92.7
Paper	102.704	95.0	226.277	94.3	89.468	96.7
Printing	40.829	96.8	42.623	96.6	67.381	98.1
Chemicals	968.179	96.6	220.556	92.2	340.519	95.0
Rubber	50.987	97.1	32.837	86.6	163.664	98.6
Leather	6.748	97.0	30.779	84.2	5.519	86.0
Stone Clay and Glass	37.028	95.0	35.326	89.7	25.582	92.6
Primary Metals	856.523	94.9	291.527	95.1	1,038.575	98.3
Fabricated Metal Products	24.807	95.7	35.196	74.3	24.249	95.6
Machinery (non-electric)	38.103	94.8	109.454	96.3	154.450	98.4
Electrical Equipment	106.285	97.6	170.889	93.2	347.558	98.6
Transportation Equipment	261.648	97.2	1,321.239	98.1	1,284.744	99.1
Instruments	9.874	97.2	147.589	97.4	132.178	98.3
Miscellaneous	6.658	95.5	26.628	90.5	13.720	90.6
Entire Manufacturing[d]	153.410	95.8	159.304	89.6	208.642	94.1

a The MES is determined at the two digit level. This mean is computed as a weighted mean of the MES values from the three digit industries.
b Source - *Production Statistics*, collected by the Department of Manufacturing and Construction of Statistics Netherlands.
c Source - Audretsch and Yamawaki (1991).
d Not weighted.

Table 2 MES[a], measured in terms of employees, in Dutch, U.S. and Japanese Manufacturing Sectors, 1991

	Netherlands[b]		U.S.[c]		Japan[c]	
Industry	MES	Sub-Optimal Share	MES	Sub-Optimal Share	MES	Sub-Optimal Share
Food	557	94.9	295	83.3	130	91.5
Textiles	364	95.3	579	86.4	85	90.1
Apparel	196	92.1	251	83.2	70	87.5
Lumber	108	96.3	51	79.6	43	86.9
Furniture	61	95.4	309	90.9	74	92.7
Paper	457	95.0	1025	94.3	253	96.7
Printing	218	96.8	392	96.6	280	98.1
Chemicals	2567	96.6	798	92.2	741	95.0
Rubber	268	97.1	271	86.6	786	98.6
Leather	76	97.0	449	84.2	45	86.0
Stone Clay and Glass	315	95.0	284	89.7	136	92.6
Primary Metals	5704	94.9	1555	95.2	2320	98.3
Fabricated Metal Products	164	95.7	280	74.3	126	95.6
Machinery (non-electric)	228	94.8	764	96.3	634	98.4
Electrical Equipment	936	97.6	1432	93.2	1317	98.6
Transportation Equipment	1459	97.2	6547	98.1	3057	99.1
Instruments	114	97.2	1454	97.4	728	98.3
Miscellaneous	55	95.5	249	90.5	756	90.6
Entire Manufacturing[d]	770	95.8	943	89.6	643	94.1

a The MES is determined at the two digit level. This mean is computed as a weighted mean of the MES values from the three digit industries.
b Source - Production Statistics, collected by the Department of Manufacturing and Construction of Statistics Netherlands.
c Source - Audretsch and Yamawaki (1991).
d Not weighted.

Table 3 Productivity ($) in Optimal and Sub-Optimal Plants for Dutch, U.S. and Japanese Manufacturing Sectors, 1991

	Netherlands[a] ($)		U.S.[b] ($)		Japan[b] ($)	
Industry	Optimal	Sub-Optimal	Optimal	Sub-Optimal	Optimal	Sub-Optimal
Food	58.520	43.401	88.062	72.246	77.434	40.794
Textiles	63.470	45.232	36.237	36.847	43.599	36.392
Apparel	63.470	44.122	30.539	32.301	25.708	25.137
Lumber	43.835	47.175	39.207	33.005	47.150	35.374
Furniture	47.410	44.566	42.443	39.815	54.827	36.347
Paper	73.975	56.943	95.593	60.120	88.248	51.276
Printing	58.190	51.781	69.493	47.546	130.052	51.827
Chemicals	115.170	63.159	132.931	111.146	164.983	126.730
Rubber	61.820	50.283	61.068	48.055	79.470	44.093
Leather	51.205	47.341	34.315	31.438	41.682	36.897
Stone Clay and Glass	62.150	57.331	66.876	52.925	82.809	53.948
Primary Metals	50.105	57.553	57.791	51.649	115.003	72.168
Fabricated Metal Products	57.750	49.228	62.651	48.873	72.674	46.977
Machinery (non-electric)	55.385	48.618	76.028	53.948	96.561	57.101
Electrical Equipment	60.115	48.510	69.446	52.655	102.205	41.338
Transportation Equipment	46.695	46.509	82.884	64.810	103.497	53.160
Instruments	40.755	58.330	91.200	61.194	64.289	42.408
Miscelleneous	49.885	51.060	57.092	40.840	61.549	41.749
Entire Manufacturing[c]	58.882	50.618	66.325	52.189	80.652	49.650

a Source - Production Statistics, collected by the Department of Manufacturing and Construction of Statistics Netherlands.
b Source - Audretsch and Yamawaki (1991).
c Not weighted.

Table 4 Employee Compensation ($) in Optimal and Sub-Optimal Plants for Dutch, U.S. and Japanese Manufacturing Sectors, 1991

	Netherlands[a] ($)		U.S.[b] ($)		Japan[b] ($)	
Industry	Optimal	Sub-Optimal	Optimal	Sub-Optimal	Optimal	Sub-Optimal
Food	36.241	22.755	25.852	21.666	23.406	17.754
Textiles	38.905	29.304	17.791	20.234	21.067	15.475
Apparel	23.143	28.305	14.290	14.741	14.192	12.522
Lumber	34.798	29.970	22.410	16.050	22.379	17.399
Furniture	32.301	26.917	20.109	18.913	23.271	18.821
Paper	41.458	33.133	34.306	26.046	33.940	22.253
Printing	40.404	32.689	27.253	21.884	46.262	25.631
Chemicals	48.285	36.852	36.437	28.896	39.221	32.176
Rubber	36.019	30.525	25.849	20.766	33.976	21.397
Leather	35.409	29.914	15.720	15.407	20.174	16.621
Stone Clay and Glass	37.795	31.690	29.129	23.359	30.029	21.253
Primary Metals	39.904	34.077	39.448	27.659	40.176	30.308
Fabricated Metal Products	35.464	30.802	29.512	24.239	29.643	22.914
Machinery (non-electric)	37.018	32.745	32.931	27.032	37.363	27.227
Electrical Equipment	38.940	30.635	31.823	23.511	32.654	19.968
Transportation Equipment	35.131	29.692	40.385	30.416	38.046	27.018
Instruments	30.691	32.190	32.798	25.453	30.834	21.754
Miscellaneous	30.414	29.026	21.612	19.140	24.775	18.709
Entire Manufacturing[c]	36.239	30.622	27.647	22.522	30.078	21.622

a Source - Production Statistics, collected by the Department of Manufacturing and Construction of Statistics Netherlands.
b Source - Audretsch and Yamawaki (1991).
c Not weighted.

Table 5 Productivity Disadvantage and Employee Compensation Advantage confronting Optimal and Sub-Optimal Plants for Dutch, U.S. and Japanese Manufacturing Sectors, 1991

	Netherlands[a]		U.S.[b]		Japan[b]	
Industry	Productivity: Sub-Optimal/ Optimal	Compensation: Sub-Optimal/ Optimal	Productivity: Sub-Optimal/ Optimal	Compensation: Sub-Optimal/ Optimal	Productivity: Sub-Optimal/ Optimal	Compensation: Sub-Optimal/ Optimal
Food	0.73	0.63	0.82	0.84	0.53	0.69
Textiles	0.71	0.75	1.02	1.00	0.84	0.74
Apparel	0.69	1.22	1.06	1.03	0.98	0.88
Lumber	1.07	0.86	0.84	0.72	0.75	0.78
Furniture	0.93	0.83	0.94	0.94	0.66	0.81
Paper	0.76	0.80	0.63	0.76	0.58	0.66
Printing	0.88	0.81	0.68	0.80	0.40	0.55
Chemicals	0.54	0.76	0.84	0.79	0.77	0.82
Rubber	0.81	0.85	0.79	0.80	0.56	0.63
Leather	0.92	0.84	0.92	0.98	0.89	0.82
Stone Clay and Glass	0.91	0.84	0.79	0.80	0.65	0.71
Primary Metals	1.14	0.85	0.89	0.70	0.64	0.75
Fabricated Metal Products	0.84	0.87	0.78	0.82	0.65	0.77
Machinery (non-electric)	0.87	0.88	0.71	0.82	0.59	0.73
Electrical Equipment	0.87	0.78	0.76	0.74	0.41	0.61
Transportation Equipment	0.99	0.85	0.78	0.75	0.51	0.71
Instruments	1.09	0.79	0.67	0.78	0.66	0.71
Miscelleneous	1.01	0.95	0.72	0.89	0.68	0.76
Entire Manufacturing[c]	0.88	0.84	0.81	0.83	0.65	0.73

a Source - Production Statistics, collected by the Department of Manufacturing and Construction of Statistics Netherlands.
b Source - Audretsch and Yamawaki (1991).
c Not weighted.

Table 6 Description of all variables

Firm Levels	
Age	Number of months that a company is registered with the Central Statistics Office Netherlands. Registration began in 1967. A company changing core business will be registered as a new company in the new industry, 1991.
Investment	Depreciation costs (in Fl. 1000) of cumulative lagged investments (capital stock), divided by the number of employees, 1991.
Compensation	Total amount the employer has to compensate employees divided by total number of employees. This includes social security taxes and benefits paid to the government, 1991.
Employees	Number of employees, 1991.
Productivity	Value added (in Fl. 1000) divided by the number of employees, 1991.
Sales	Value of the total amounts of goods sold (in Fl. 1000), 1991.
Size Difference	Sales of the sub-optimal firm minus the MES (sales), 1991.
Size Difference Scaled by MES	Sales of the sub-optimal firm minus the MES (sales) divided by the MES (%), 1991.
Industry levels	
MES	Mean sales (in Fl. 1000) of the largest companies in the industry, which have aggregate sales accounting for half of the total sales in the 3-digit industry. Three-digit industry variable, 1991.
Market Growth	Mean market growth, measured as mean percentage growth of sales, 1985-1990. Three-digit industry variable.
Small Firm Innovative Advantage	Mean R&D intensity of small firms (<= 100 employees) divided by mean R&D intensity of all firms. R&D intensity is measured as total number of employees involved in R&D for the company (formal, informal and external R&D) divided by total employment. Three-digit industry variable, 1988.
Unskilled Labor	Total amount of blue-collar workers in a two-digit industry divided by the number of white-collar employees, 1987. Two-digit industry variable, 1987.

Table 7 Regression Results for Differences between Sub-Optimal and Optimal Firm Size, equation (1) (t-statistics in parentheses)[a]

	Unscaled[b]		Scaled by MES		Hypotheses
	OLS	2SLS	Not corrected for hetero-skedasticity 2SLS	Corrected for hetero-skedasticity 2SLS	Expected signs
Compensation	-0.458*	4.89*	0.539**	2.84**	+
Difference	(-1.96)	(2.13)	(3.96)	(13.3)	
Productivity	1.38**	-8.70**	0.165*	-0.560**	-
Difference	(13.3)	(-7.12)	(2.28)	(-9.49)	
Investment	-1.42**	16.5**	-0.307**	0.727**	-
Difference	(-3.89)	(7.26)	(-2.70)	(8.40)	
Market	27.6**	12.9**	0.631**	-2.419**	-
Growth	(16.4)	(4.15)	(4.00)	(-12.0)	-
Small Firm Innovation	23.6**	0.67	0.055	-4.39**	
Advantage	(6.99)	(0.11)	(0.20)	(-9.70)	
Sample Size	7716	7716	7716	7716	
R^2	0.27	0.14	0.04	0.24	
F-value	125.94	54.14	15.12	102.83	

a Dummies for each 2-digit sector were used to compensate for differences between industries. These replace the intercept and are not reported for presentation purposes. The first two columns are divided by 1000 for presentation purposes.

b The regressions are weighted by the sample proportion.

* Statistically significant for 95 percent level of confidence, two-tailed test.

** Statistically significant for 99 percent level of confidence, two-tailed test.

Table 8 Regression Results for Differences in Employment Compensation between Sub-Optimal and Optimal Firms, equation (2) (t-statistics in parentheses)[a]

	Size Difference Unscaled[b]		Size Difference Scaled by MES
	OLS	2SLS	2SLS
Size Difference	-0.00070	0.0073*	0.36**
	(-1.28)	(2.23)	(4.08)
Productivity Difference	156**	97.2**	0.10**
	(38.8)	(12.35)	(12.4)
Age	23.1**	21.6**	0.011**
	(12.9)	(11.5)	(4.91)
Unskilled	-7660**	-8520**	-6.49**
Labor	(-6.02)	(-6.09)	(-5.70)
Sample Size	7716	7716	7716
R^2	0.28	0.17	0.13
F-value	133.84	69.23	51.65

a Dummies for each 2-digit sector were used to compensate for differences between industries. These replace the intercept and are not reported for presentation purposes. The first two columns are multiplied by 1000 for presentation purposes.

b The regressions are weighted by the sample proportion.

* Statistically significant for 95 percent level of confidence, two-tailed test.

** Statistically significant for 99 percent level of confidence, two-tailed test.

Table 9 Regression Results for Differences in Productivity between Sub-Optimal and Optimal Firms, equation (3) (t-statistics in parentheses[a]

	Size Difference Unscaled[b]		Size Difference Scaled by MES
	OLS	2SLS	2SLS
Size Difference	0.023**	-0.014	-3.17**
	(16.8)	(-1.70)	(-5.90)
Investment	2120**	3100**	4.13**
Difference	(43.6)	(44.4)	(22.6)
Age	14.4**	31**	0.092**
	(3.15)	(6.11)	(6.89)
Sample Size	7716	7716	7716
R^2	0.30	0.28	0.11
F-value	156	144.21	46.53

a Dummies for each 2-digit sector were used to compensate for differences between industries. These replace the intercept and are not reported for presentation purposes. The first two columns are multiplied by 1000 for presentation purposes.

b The regressions are weighted by the sample proportion.

* Statistically significant for 95 percent level of confidence, two-tailed test.

** Statistically significant for 99 percent level of confidence, two-tailed test.

Table 10 Productivity and Employee Compensation for 1991 Survivors and Exiting Firms (standard deviation in parentheses)

	Number of observations		Productivity ($), 1980			Employee Compensation ($), 1980		
Size class (Employees)	Firms surviving until 1991	Firms exiting the industry	Firms surviving until 1991	Firms exiting the industry	T-value of difference	Firms surviving until 1991	Firms exiting the industry	T-value of difference
10-20	1276	1848	28.809 (12.251)	25.000 (11.442)	8.8	20.773 (5.040)	19.969 (5.759)	4.1
20-50	1608	1419	28.763 (36.286)	24.763 (12.140)	4.2	20.814 (4.332)	20.331 (4.975)	2.8
50-100	780	591	28.753 (11.683)	25.492 (12.357)	5.0	21.080 (3.859)	20.713 (5.256)	1.4
100-200	423	290	29.874 (14.407)	27.934 (24.241)	1.2	21.869 (3.789)	21.698 (4.181)	0.6
200-500	247	202	29.281 (9.929)	27.381 (15.171)	1.5	22.341 (3.628)	23.778 (13.367)	-1.5
500+	134	88	33.834 (16.603)	27.562 (11.920)	3.3	24.557 (3.895)	23.788 (3.457)	1.5
10+*	4468	4438	29.060 (23.959)	25.341 (13.201)	7.1	21.145 (4.442)	20.547 (5.980)	5.4

* Averaged over all firms in the dataset.

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