



THE RESEARCH INSTITUTE OF INDUSTRIAL ECONOMICS

WORKING PAPER No. 509, 1998

**ARE FEMALE WORKERS LESS
PRODUCTIVE THAN MALE
WORKERS? PRODUCTIVITY
AND THE GENDER WAGE
GAP**

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Are Female Workers Less Productive Than Male Workers?
Productivity and the Gender Wage Gap*

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June 26, 1998 (First Version)

*This article is based on individual-level wage data made available from several sources: For Sweden, by the main employer's association, the Swedish Employer's Confederation (Svensk Arbetsgivarforening or SAF); for Norway, by Statistics Norway (SSB) and the main employer's association in Norway, the Confederation of Business and Industry (Næringslivets Hovedorganisasjon or NHO); for the U.S., by the Bureau of Labor Statistics in the U.S. Department of Labor and by Erica Groshen who provided data from several of the eight Industry Wage Surveys analyzed here. We are grateful to Coen Hendriks and Grethe Hoel at the SSB and Bjarne Thuv and Stein Omland in NHO for their cooperation in preparing these data for analysis. We are grateful to Ari Hietasalo and Marianne Lindahl at SAF for their cooperation in preparing these data for analysis. We are grateful for financial support from the Swedish Council for Research in the Humanities and Social Sciences (HSFR). Parts of the paper have been presented at seminars at Stanford University, Stockholm University, The Institute for Economic and Social Research in Stockholm, Uppsala University, University of Oslo, and the Annual Meetings of the American Sociological Association in Toronto (1997). We thank Erling Barth, Tore Ellingsen, Mark Granovetter, Assar Lindbekk, Donald Tomaskovic-Devey, and other seminar participants for useful comments.

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TITLE

Are Female Workers Less Productive Than Male Workers? Productivity and the Gender Wage Gap

ABSTRACT

It is extraordinarily difficult to determine the extent to which the gender wage gap reflects discriminatory behaviors by employers or differences in productive capacities between men and women. We note that where piece-rate work is performed, wages should in principle reflect productivity differences and that it is more difficult to discriminate on the basis of gender because one is paid for what one produces. With this as our point of departure, we compared men and women working in the same occupation in the same establishment, in three countries, the U.S., Norway, and Sweden. Our findings are easy to summarize. First, the gender wage gap is clearly smaller under piece- than under time-rate work. According to the argument put forth here, one third of the gap at the occupation-establishment level is due to discrimination, while two thirds of the gap is due to productivity differences. The main finding is that the productivity differences between sexes in typically male-dominated blue-collar industries are very small, of 1-3%. Second, in age groups where women on average have extensive family obligations, the wage gap is higher than in other age groups. Third, under time-rate work, the wage gap is more or less independent of supposed productivity differences between men and women, while under piece-rate work, the wage gap mirrors quite closely assumed productivity differences, with women receiving a wage premium in female-advantageous settings and a penalty in male-advantageous settings. Fourth, in two of three countries women sort more often into piece-rate work than men.

1 Introduction

There is no question there is a gender wage gap. There are however endless questions concerning its causes. One prominent explanation is that women are less productive than men, so that even when they do the same work for the same employer, they produce less. It is thus, at least from an economic point of view, legitimate that they also earn less. Another prominent explanation is that the gap reflects discrimination against women. Implicit then is the contention that men and women on average are equally productive. Under a legitimate system they should hence receive the same wages.

It is exceptionally difficult to adjudicate between these two opposing claims, none exists and none is in sight, simply because the central variable on which both explanations rest—productivity—is very hard to observe and measure. Where productivity in principle is unambiguous, it is rare that researchers have access to records thereof. More often, what constitutes productivity is ambiguous, as in many types of service and professional work, and how to measure it at the individual level is clear neither to employers nor to social scientists.

However, in some work settings one has better access to reasonable measures of productivity than in others. Where piece-rate work is performed, wages earned should on average match productivity, so that variation in wages, for the same work for the same employer, in principle should reflect variations in productivity. As Goldin (1990, p. 114) observed: “There is no clearer case of an individual who is paid her marginal product at every instant in time.”¹

It is moreover the case, and for the present purpose important, that it is harder to discriminate on the basis of gender in terms wages paid under piece- than under time-rate work, because under the former one gets paid for what is produced while under the latter one gets paid for being available for producing. This is forcefully expressed in the 1957 Equal Pay legislation in the European Union. Paragraph 3 of Article 119 provides (Ellis 1991, p. 43): “Equal pay without discrimination based on sex means: (a) that pay for the same work at piece rates shall be calculated on the same basis of the same unit of measurement...”²

¹This point was observed already by Max Weber in 1908 in his study of piece-rate work and productivity (Weber [1908]1924). He used wages earned under piece-rate work as indicators of effort and made many of the same kinds of comparisons of men and women as we do below (see esp. Weber [1908]1924, pp. 167, 177).

²There may obviously be discrimination with respect to who gets to do piece- versus time-rate work, and among those who do piece-rate work, who gets to do which piece-rate jobs.

These two considerations, that wages under piece-rate work reflect productivity and that it is more difficult to discriminate on the basis of gender under piece-rate work, lead to the following three observations, each of which may provide some progress toward solving the two opposing claims regarding the extent to which the wage gap reflects productivity differences or discrimination.

First, to the extent that the gender wage gap reflects productivity differences, not wage discrimination, one should expect to find the same gap under piece- as under time-rate work: In both cases the gap reflects productivity differences.

Second, to the extent there is wage discrimination between men and women, but no differences in productivity, one should expect a wage gap under time- but none under piece-rate work.³

Third, to the extent that there is both wage discrimination and differences in productivity, one should expect a smaller wage gap under piece- than under time-rate work. The gap under the former will reflect productivity differences, while the gap under the latter will reflect the same productivity differences plus a discrimination component. The difference in the gaps under piece- and time-rate work will give the discrimination component of the wage gap.⁴

Such, then, is the overall situation. But there are some important variations within it. In his extensive study of piece-rate work, effort, and wages, Max Weber remarked: "On the work suitability of the genders there are hardly any exact investigations." This is followed by the statement that on the one hand, "It is beyond doubt that within the linen textile factory men are at an advantage

³The lesser amount of discrimination between men and women under piece-rate work has been observed by historians of work. Scranton (1989, p. 401), writing on the Philadelphia textile industry around 1920, observes: "The generality of piece rates made gender shifts valueless unless dual male-female schedules for the same work were implanted. Of this there is no evidence in Philadelphia textiles, though sex segregation of jobs was widespread." This appears not to be a universal observation, at least not in other national contexts. For France, Downs (1995, p. 59) reports a female piece rate set at 55% of the male rate for the same work at Renault in 1916 with similar numbers for the rest of industry. She also reports a move in Britain during World War I to equalize piece-rate schedules between men and women, but with no similar move to equalize time-rate wages for the same work (Downs 1995, pp. 115, 300). Biernacki (1995, p. 426, n. 174) reports arguments for equal piece rates between men and women in Britain already in 1891: "British workers articulated the right of women workers to equal pay with men on the ground that the finished products were indistinguishable: 'When a manufacturer sells a piece he does not tell the merchant that it has been woven by a woman'." The same sentiment appeared in France during World War I, expressed as (Downs 1995, p. 114): "...; each piece produced should be paid according to what it is worth and not according to who made it." For similar U.S. practices in the 1930s see Milkman (1987, p. 21).

⁴This point was observed by Goldin (1990, p. 105) who also made some computations along these lines based on U.S. wage data from 1890, as did Weber (1908[1924]). See also Gunderson (1975) for the U.S. and Chen and Edin (1994) for Sweden.

on the wide machine (for bed clothing and the like),” while on the other hand, “At the handkerchief machine it appears to me that females decidedly are best suited.” In other kinds of work he finds that men and women contribute equally: “On the machines for the narrow linen it seems that male and female work compete, to the extent that able female workers show at least the same output as the able men” (Weber [1908]1924, p. 163, our translation).⁵

With Weber’s remarks in hand, one should further expect that women are at an advantage in some kinds of work, work that could be termed “female advantageous”. In those lines one should observe that women earn more than men, at least under piece-rate work. In other kinds of work, for example, those involving heavy lifting, men should be at an advantage, and it could be termed “male advantageous”. Here one should expect that men earn more than women and that the wage gap is larger than elsewhere.

From Weber’s remarks also arise a question about sorting of men and women into payment schemes. If there is discrimination against women under time rates, then in order to escape it women may more often than men choose to work under piece rates. But this will have effects on the wage gap, as will be explained in Section 2. Specifically, a wage gap under piece rates need no longer reflect productivity differences but may be contaminated by the effects of differential sorting of men and women.⁶

Against this background, then, our investigation focuses on four processes. First, we investigate the gender wage gap under piece- and time-rate work respectively, comparing men and women working in the same occupation in the same establishment. This will throw light on the extent to which the gap reflects productivity differences versus discrimination. It is important here to note that productivity differences between employees most meaningfully can be assessed at the occupation-establishment or job level. The reason is simply that in most employment settings productivity gets jointly determined by the person and the job (e.g., Granovetter 1981). This makes comparison of productivity of employ-

⁵Here, as below, translations from German, Norwegian, and Swedish were done by the first author.

⁶A related concern is that if indeed women are more productive than men in some kinds of work and less productive in other kinds, one may speculate whether the sexes tend to concentrate their employment where they have their respective advantages (e.g., Filer 1989, p. 154). But this concern does not relate directly to our goal of assessing potential productivity differences. It will not be pursued, even though some relevant analyses to this effect were done, briefly to be reported in a footnote.

ees in different jobs difficult, but allows within-job comparison. To some extent employees may however be in different jobs because they have different levels of productivity. But that is not an easy phenomenon to research and is not pursued here.⁷ Second, we investigate whether the gaps vary according to life-cycle stage, for reasons elaborated in the next section. Third, we investigate further how these gaps vary according to whether men versus women are believed to be at an advantage in terms of productivity for the type of work in question. This will provide additional information on the extent to which the gap reflects productivity differences versus discrimination. Fourth, we investigate the extent to which women tend to sort into piece-rate work more often than men, which may contaminate any inference about productivity differences under piece rates.⁸

Our focus is on blue-collar work. This may help illuminate matters maximally. Not only is this the setting where piece-rate work is and has been most prevalent, it is also in blue-collar work that women stereotypically have been seen to suffer their greatest productivity disadvantages, rather than in for example clerical, caring, and teaching work.⁹ At the same time, there are sufficient variations within blue-collar work to identify settings where women at least stereotypically are at a productivity advantage. If a big overall productivity gap is found in work where women are negatively stereotyped, then the stereotypes were accurate. If not, however, it has implications for how one should view women's relative productivity not only in stereotyped but also in work that is not so. There is then all reason to expect that women in occupations where they are not negatively stereotyped are equally or even more productive than men. And it is this kind of work that has grown most in importance over the last 50 years: Much work in modern industries and occupations demand less in terms of classically masculine traits. Frederick W. Taylor saw it coming: "The Gorilla types, are no more needed." (cited from Milkman 1987, p. 17).

The research will use unique individual-level data, on wages, occupation,

⁷Across jobs one cannot easily disentangle the individual contribution from that of varying technologies, market conditions, etc. It is somewhat like sports competitions: One can easily determine who is the better runner, swimmer, or jumper, but comparisons across sports are less straightforward or meaningful.

⁸More broadly, beyond the specific questions addressed here, the operation of piece-rate systems has been extensively discussed in the sociology literature for more than fifty years. Recent discussions include Granovetter and Tilly (1988), Stinchcombe (1990, chap. 7), and Sørensen (1994), and in economics see Milgrom and Roberts (1992).

⁹In clerical work done on computers there is recent growth in use of piece-rate payment since output often is easy to measure.

payment system (piece- versus time-rate), and sex, from several thousand establishments and more than one million employees, from the U.S. in the period 1974–1978, from Sweden in the period 1970–1990, and from Norway in 1984 and 1990, thus assessing the issues across countries.

2 Productivity Differences

We now elaborate on what has been written and what is known about the four questions outlined in the introduction. Much of this is historical.

2.1 Overall Productivity Differences

The *first* question addresses the degree to which women overall are less productive than men. In some scholarly writing, and in parts of popular opinion, women are overall and especially in some work situations held to be less productive than men. If not always entirely explicit, the contention is there at least as an important undercurrent (e.g., Rhoads 1993, pp. 12–14, 141–42; Phelps Brown 1977, p. 158). It is however probably fair to say that to the extent there currently is a central explanation and also implicit justification for the gender wage gap, it is that men and women do different kinds of work, are employed in different firms, and so on but not that they differ greatly in innate productive capabilities.¹⁰

Historically, however, this was not the central justification. Rather, women were plainly viewed to be less productive than men in most situations. This might have been due to lack of physical strength, lack of initiative, family responsibilities, and more sick-days, and jobs were correspondingly divided into those suitable for each sex, such as light work for women and heavy for men. If such is the case, lower wages are on average legitimate. We shall first address whether there is evidence that women overall are less productive than men, without any distinction with respect to the kind of work done or to family responsibilities.

¹⁰See for example Goldin (1990, p. 69), Reskin and Roos (1990, pp. 36–37, 49–52), and Petersen and Morgan (1995). Some occupational sorting can obviously occur due to underlying productivity differences. This may explain why some women are in low-paying occupations.

2.2 Family Obligations and Productivity Differences

The *second* question relates to one particular alleged cause of women's lower productivity: the impact of family responsibilities. In periods where women have extensive family obligations, such as caring for small children, they may on average be less productive than men in the same age groups, even though women overall are not less productive than men (e.g., Becker 1985). In our second question we elaborate on the role of family responsibilities, whether they have the presumed impact on the gender wage gap. This relates to an older historical phenomenon and discussion. Before and at the turn of the century, and especially up through the 1920s and 1930s, many organizations practiced a so-called marriage bar, under which married women were not hired and women upon marriage or childbirth often were fired.¹¹

The arguments supporting the bar were many. One common line was that women's proper role was in the home, that women were morally superior and that work would morally corrupt them (see Davies 1982, chap. 5). Another justification was in terms of the family wage, where male breadwinners had to earn more in order to support a family. With high unemployment as was the case especially in the 1930s, married women had someone else to support them and should give up their work so that men out of work or unmarried women could take their place. This was the moral-economy of the working class, where work should be spread around to as many families as possible (Greenwald 1989). But for the present purpose it is the third argument that is of interest. Many employers argued that women upon marriage became less productive. This was a running concern in Weber's (1908[1924]) study, including a fascination with the relationship between preparation for wedding, marital status, sexual activity, and work effort and labor productivity. He writes (p. 168): "It seems...[that]... older, unmarried female workers,... are still useful on the bobbin winder, and then, since immune against erotica, are quite especially useful."¹² He also notes (p. 174) that male labor productivity depends strongly on marital status, higher among married than single men, opposite of the presumed relationship among women, as also reported in Burawoy (1979, chap. 10). In Norway, the marriage

¹¹For the U.S., see Goldin (1991), for Norway see Ellingsæter (1995, chap. 6), and for Sweden see Hobson (1993).

¹²Later Weber continues (p. 174): "... the in no way irrelevant sexual life of the worker in relationship to the work effort has altogether not been researched," lamenting the lack of research on coital frequency by the medical profession!

bar for telegraphists was justified in part by the claim that the employer "had the right to the full work of the employee without the reduction stemming from the work a married women would have to do in the home" (Hagemann 1994, p. 256). As Strom (1992, p. 391) reports for the U.S., "Employers who were opposed to hiring women gave a variety of explanations, many of which focused on the transference of the married women's allegiance from job and employer to home and husband." The sociologist Mary Schauflier, in her 1927 study of three clerical occupations, remarked that "Employers say they are too independent in their attitude, they are apt frequently to be absent and late, ..." (cited from Strom 1992, p. 392).

Goldin (1991, pp. 525, 527) claims that the marriage bar was closely related to concerns about productivity, stating as evidence that (p. 527) "The bars, interestingly, were rarely found among factory operatives for whom piece-rate payment often was used (47 percent of all female operatives in the 1890s were on incentive pay) and for whom, therefore, the relationship between earnings and productivity was strictly maintained." She continues, "The marriage bar was most often found among firms and sectors having internal promotion and regular salary advances, and among local school boards having fixed salary scales. The sectoral distribution creates a prima facie case that the marriage bar emerged when the relationship between pay and productivity was severed."

These concerns about family responsibilities were important historically for many institutional barriers to women's employment. But they appear also in contemporary employment. Hanson and Pratt (1995, p. 157) report on employer attitudes in their study of Worcester in Massachusetts: "Many employers use familial ideology to frame women workers; their stereotypes about women are tied to assumptions about the way that family arrangements will affect their productivity as employees."

To assess indirectly the impact of family obligations we shall address whether relative productivity varies with life-cycle stage. Specifically, we will investigate whether the gap is larger in periods when family obligations peak.

2.3 Productivity Advantages by Sex

The *third* question we address deals with the claim that one should expect women to be at a productivity advantage in some lines of work, while men to be at an advantage in other lines. Stereotypes have been around for a long

time (Reskin and Hartmann 1986, pp. 41–42; Kessler–Harris 1982). Not all but some of these are probably accurate statistical generalizations. For example, in the U.S. automobile industry, one finds the early (1943) statement, “On certain kinds of operations—the very ones requiring high manipulative skill—women were found to be a whole lot quicker and more efficient than men.” Or from the electrical industry in 1942: “..., so the job requires feminine patience and deft fingers,” and further, “Westinghouse finds that women can handle these minute parts,..” (all citations from Milkman 1987, p. 59). The War Labor Board concluded, “If men were to be substituted for women on the so-called women’s jobs, there would probably be a very real loss in efficiency and productivity since it is recognized that men are not as well adapted as women for light, repetitive work requiring finger dexterity.” (cited from Milkman 1987, p. 81).

Similar sentiments are found both in Norway and Sweden.¹³ One forceful governmental report from Sweden, in which Alva Myrdal was a major contributor, states (Kock 1938, pp. 368, 383, 385, 388): “For some types of work women are clearly more suited than men,” stipulating that this holds where good color view, ability to judge appearances well, and finger dexterity are needed. In fact, “In a number of areas women’s superiority in the work done is so high, that one could not do without them.” In other kinds of work, such as in some parts of manufacturing where physical strength is needed and in meat cutting “where women cannot manage the cutting knife as well as men”, it is equally clear that men are more productive. The identical stereotype was found in meatpacking in the U.S., where “handling the knife” was not considered women’s work (Abbott and Breckinridge 1911).

There are also interesting instances of attempts to gender-type certain kinds of work using arguments about presumed productivity advantages but where various parties disagreed on which sex constitutes the superior class of workers. For example, in the printing industry, with the introduction of the Linotype typesetting machine in 1885–1905, U.S. employers argued that “The machine is specially suitable for female use”, also claiming this was in part so because the work was intellectual (cited from Baron 1992, p. 78). Unions on the other hand sought to gender-type the work as masculine, stressing that it required strength

¹³Downs (1995, pp. 110, 213) reports identical considerations in various French and English industries during World War I, where women are praised for their extraordinary productivity at some tasks, stressing their biological advantages in form of “nimble little fingers”, ability to endure monotonous work, work requiring eye acuity, and so forth.

and endurance, was dirty, and that women lacked the mental abilities needed (Baron 1992, p. 80). A report by the U.S. Bureau of Labor Statistics from 1906 sides with the union in this matter: "The high average speed maintained by Linotype operators is the foremost factor in preventing the displacement of men by women in this line of work" (cited from Baron 1982, p. 82).

Again, these are not only historical antics, they show up in contemporary employment relationships as well. Hanson and Pratt (1995, p. 210) write: "...women are valued for their stability and loyalty but employers also mentioned women's capacity to doing boring, repetitive work and their superior manual dexterity." Here too employers refer to women's "nimble fingers" (p. 210), but many refer to their physical weakness as well, stating that "Women can't do heavy work".¹⁴

To sum up our third question, we investigate circumstances where women versus men are more productive, assessing whether the gaps match presumed productivity differences. Here, there has been much writing but as Weber remarked "hardly any exact investigations".

A summary of the central ideas outlined here with respect to questions 1-3 regarding the wage gap is given in Table 1, where the two dimensions or independent variables are discrimination regime and productivity differences, while the dependent are the wage gaps under time- and piece-rate work respectively.

(Table 1 about here)

2.4 *Sorting Into Payment Schemes*

The *fourth* question we address is whether men and women tend to sort into one payment scheme rather than another.

A sizeable economics literature has addressed not only how piece-rate systems may induce workers to expend more effort but also how they may serve to

¹⁴Productivity differences have been extensively discussed in contemporary fire fighting. Few women have held firefighter jobs and still few do. In fire-fighter tests the 20 percent fittest women perform about as well as the 20 percent least fit men, so that in New York, the top female applicant came in at number 4,652 of 21,000 and the next came in at about 2,500 (Olson 1997, pp. 181-82). Physical strength is exceptionally important in this setting and there is no question that men on average are better fit for the occupation, not to deny that sexism has and probably still exists in such work. But this is an unusual type of work and it would be an error to invest much intellectual energy in discussing relative productivities in that setting.

sort low and high-productivity workers into time- and piece-rate jobs (Lazear 1986). The idea is that only for workers above a certain productivity level will it pay to work on piece rates because only those workers will tend to produce above the minimum output required in order to make any piece-rate earnings. Output below the minimum receive a low guaranteed wage, which is all that low-productivity workers typically will be able to get.

In the present context this argument may take peculiar twists. One scenario occurs when men and women on average are equally productive, so that if all men and women worked under the same payment system (e.g., piece rates), then their observed average productivity would be identical and if there is no discrimination so would wages be. But if there is some discrimination under time and none under piece rates, then various perverse effects may emerge. What could happen is that a higher proportion among females than males would choose to work on piece rates, due to its lack of penalty for being female. If so, under piece rates women would on average be less productive than men because one goes further down into the productivity distribution among women. Suppose that the 30% most productive females choose piece rates while only the 20% most productive males would do so. On piece rates, then, one excludes in terms of productivity the lower 70th percentile among females and the lower 80th percentile among males, thus getting a female group that on average is less productive. Conversely, among time-rate workers we find the 70% lower productive females and the 80% lower productive males. So females would also on time rates on average be less productive because they don't include the workers found between the 70–80th percentile in terms of productivity.

These effects are truly perverse but the logical outcomes of entirely understandable processes. Employers may assume women to be less productive than men and hence offer lower wages to women under time rates, while under piece rates both sexes receive wages commensurate with their productivity. After men and women have self-selected themselves into the two schemes the women on average become less productive than the men under both systems. This confirms the employer's assumptions and prejudices, making them a self-fulfilling prophecy. It becomes so not due to any underlying productivity differences between men and women, but rather is forced upon women by the discriminatory behavior of employers under time rates making relatively more women self-select into piece-rate systems. This in turn justifies the employer's initial behavior, to pay

women less than men under time rates. If so, the pay gaps observed under the two systems are hence not representative of underlying productivities as these would be observed in the absence of discrimination. Without discrimination and thus self-selection, men and women would on average be equally productive under each of the two payment systems.

If this scenario is correct one should observe two things. First, the wage gap under time rates should be larger than that under piece rates, because in the latter one does not have the discriminatory component. Second, proportionally more women than men should be on piece rates.

Against this scenario one may object that workers rarely have as much choice between payment systems as here presumed. In most cases, workers must accept a given type of job and the payment system that goes with it.

In summary of our *fourth* question, we assess the extent of sorting by sex into payment schemes.

3 Data

We use extensive and unique data sets from three countries: The U.S., Norway, and Sweden, covering the periods 1974–1978 (U.S.), 1984 and 1990 (Norway), and 1970–1990 (Sweden), for Norway and Sweden emphasizing the most recent year 1990. We describe the U.S. data in most detail. The corresponding Swedish and Norwegian data are similar, but contain more information.

The first data set comes from eight Industry Wage Surveys (IWS) conducted by the U.S. Bureau of Labor Statistics in the period 1974–1978 (see, e.g., U.S. Department of Labor 1976), corresponding to industry codes at three and more digits as defined in the *Standard Industrial Classification Manual* (see U.S. Executive Office of the President 1987). All are in the manufacturing industries. The populations for the surveys and the sampling from the populations are described in various U.S. Department of Labor publications (e.g., 1976, p. 48).¹⁵ The selection of industries was to a large extent determined by availability from the Bureau of Labor Statistics.

In each industry, the Bureau of Labor Statistics drew a sample of several hundred establishments, often covering a large proportion of the establishments in the industry. For each establishment, information was obtained, from establish-

¹⁵For a full listing of the publications see the note to Table 1 in Petersen and Morgan (1995).

ment records, both on establishment characteristics and on a large number of the production workers in the establishment. Within each industry, only a selection of occupations were surveyed, providing a wide representation of production occupations in an industry. The individual-level data, on tapes purchased from the Bureau of Labor Statistics, provide information on each individual in the relevant occupation and establishment, as well as on characteristics of the establishment in which the individual worked.

For each employee surveyed, information was obtained on sex, occupation (an industry-specific code), method of wage payment (incentive- or time-rate), and hourly earnings. No information was collected on race, age, experience, or education. The occupational classification is unusually detailed, corresponding in many cases to nine digits in the *Dictionary of Occupational Titles* (see U.S. Department of Labor 1977). In other cases, the titles are specific to the Bureau Labor Statistics data, based on industry-specific codes, but are usually as detailed as nine-digit DOT titles.¹⁶ Within such detailed occupations, there is probably little variation in educational credentials.

Wage data are straight-time hourly wages, excluding premium pay for overtime and work on weekends, holidays, and late shifts. Thus, we do not conflate pay earned on regular hours with pay earned on overtime and irregular hours, making the wage data less prone to bias than virtually any other study used for assessing wage differences. Men work more overtime hours than women (see, e.g., U.S. Department of Labor 1982, Table C-33), either due to preference for more overtime or due to better access to overtime hours, and overtime hours are usually paid at a higher rate. Nonproduction bonuses, such as year-end bonuses, are also excluded, whereas incentive pay is included (e.g., U.S. Department of Labor 1976, p. 48).

For Sweden we have access to the database on wages collected by the Central Confederation of Employers (SAF). These data contain information for all blue-collar workers in every industry in the private sector within the SAF domain. For 1990 the data cover 612,252 employees in 27,493 establishments, which is about 36% of employees in the Swedish private sector and a much higher

¹⁶The occupational codes are reported on "job lists" and are intended to reflect jobs in the establishments surveyed. We are therefore able to report within-job wage differences. A job is commonly defined (e.g., Treiman and Hartmann 1981, p. 24) as a specific position, with particular duties and responsibilities, in a specific setting, such as grinder in a given establishment. To get a sense of the level of detail, see Petersen (1991) for a listing of the occupations in the nonferrous foundries industry.

percentage in the manufacturing industries. Member firms have been providing information to the database since 1970 up to 1990, so that we have access to a panel of individuals and establishments for a 20-year period. The data come from establishment records and have been used as inputs in the annual wage negotiations and are monitored not only by SAF but also by the labor unions. The data are of very high quality. For each employee surveyed, information was obtained on sex, method of wage payment (incentive- or time-rate), age, hours worked, part-time or full-time employed, union status and if unionized the name of the union, and a detailed description of job content. The occupational codes are industry specific. The data cover practically the entire occupational spectrum for blue-collar workers.

The wage data are reported in an unusually detailed manner. For each individual, the wages (as well as hours worked), are reported separately for those earned during regular hours and those earned during overtime hours. The computations of the wage gap are done for wages earned on regular hours. Furthermore, for employees who alternate between time- and incentive-rate jobs, the wages are specified separately for the two wage forms. The wages are given in hourly units.

The Norwegian data are exactly parallel to the Swedish, collected by the Norwegian Confederation of Employers (NHO). For the blue-collar workers analyzed here, we have information on 165,249 individuals working in 317 occupations, 6,200 establishments, and 24,502 occupation-establishment units (for documentation see Petersen et al. 1997), covering a substantial proportion of workers in the manufacturing sector.

Before proceeding one issue requires consideration. Crucial to our analysis is the assumption that variation in wages reflects variation in productivity. It is fairly obvious that this is so at the occupation-establishment or job level at which our analysis is conducted. There can be some but not likely systematic deviations here, as when an employee operates defective machinery or gets inferior input materials. The variation in wages will however usually not perfectly reflect variation in productivity. The reason is simply that most piece-rate systems are not perfectly colinear with productivity, mostly because they contain a guaranteed wage in addition to a piece-rate component (e.g., Sørensen 1994). So someone who earns 25% more than someone else does not necessarily produce 25% more. How much more is produced depends on the relationship between

the guaranteed wage and the piece-rate schedule. So in many situations our wage data at the occupation-establishment level only give an ordinal ranking of employee productivity, not the exact relative difference in productivity. In the discussion of our results we shall abstract from this complication, proceeding as if we had wage data that perfectly matched variations in productivity.

4 Methods

We report the relative wages between men and women at the occupation-establishment level, with technical details given in the Appendix. For the first question, we compute the average female wage as percentage of the average male wage, separately for time- and piece-rate workers. This is done for men and women working in the same occupation and establishment, the level at which productivity most meaningfully can be assessed (e.g., Granovetter 1981).

For our second question, we compute the same wage gaps, but now separately by life-cycle stage, for each of five age groups defined by ten-year intervals. We also present graphs for five-year moving averages.

For our third question, we turn to a separate analysis of the wage gap for a selection of occupations that we judge to be female versus male advantageous in terms of the productivity of the genders.

Finally, we study whether women sort more often into piece-rate work than men. We present measures of sex segregation on payment schemes.

5 Overall Productivity Differences

Table 2 gives an initial view of our central message, reporting in columns 1 and 2 the gender wage gap for piece- and for time-rate workers respectively. The third column gives the wage penalty for being female under piece rates, computed as the wage gap in column 1 minus 100, giving the estimate of the productivity differential. The fourth column gives the difference in the pay gaps between time- and piece-rate workers, computed as column 2 minus column 1. Note that all computations are based on occupation-establishment units that are sex-integrated for each of the payment forms. In the first column, included are only occupation-establishment units where both men and women work under piece-rate systems, while the second column includes only units where both sexes work under time-rate systems.

(Table 2 about here)

It is striking that in all three countries the gender wage gap is lower under piece- than time-rate systems. In the U.S., Norway, and Sweden, women earn 1.72, 3.02, and 1.03% less than men under piece rates. Under time-rate work, in contrast, the wage gaps are 2.45, 3.94, and 1.52%. This is higher than under piece-rate work, with 0.73, 0.82, and 0.49 percentage points.

Given the interpretation forwarded here, one may from column 1 or 3 infer that women in the three countries on average are 1.72, 3.02, and 1.03% less productive than men in typically male blue-collar industries. This productivity difference shows up as a legitimate pay difference of 1-3% among piece-rate workers.

Note here that there is no necessary reason why the gap under piece rates should be less than that under time rates. It could in fact be higher, in which case men may be discriminated against under time rates.

One can further conclude, for the interpretation put forth here, that within-job wage discrimination against women in these three countries amounts to as little as one half to a full percent (see col. 4). Among time-rate workers, the legitimate part of the occupation-establishment wage gap due to productivity differences amounts to about two thirds in the three countries. The part due to within-job wage discrimination amounts to about one third. Obviously some of this difference may be due to other factors such as age and experience which may play a larger role in wage setting under time- than under piece-rate systems.

In all three countries there is evidence that women are slightly less productive than men, with about 1-3%, not a large productivity difference, certainly not one that can justify large gender wage gaps. There is also evidence that there could be some residual within-job wage discrimination, of about 0.5-1%.

6 Productivity Gap By Life-Cycle Stage

For all three countries it might be worthwhile to speculate further on the finding that women appear to be about 1-3% less productive than men. One plausible reason for why this appears to be the case may be that women on average have larger responsibilities in the family sphere than men have. We have no information on family obligations in these data. But on average, these are likely to be higher in the age groups 31-40 and 41-50 than among those 30 years

and younger or those 51 years and older. Assuming that innate productivity differences between men and women are very low on average, after having taken into account family obligations, the following argument can be made. The wage gap under piece-rate contracts should be highest among those 31–50 years old, the years where on average the largest toll is taken on women from family responsibilities.¹⁷ This is a particularly strong test if we find that the gap is lower especially among those 51 and older than among those 31–50 years, because the older cohorts may very well work in industries, occupations, or work-settings less favorable to women, as they started their careers at a time when sex discrimination was commonplace.

We therefore computed the wage gap at the occupation-establishment level under time- and piece-rate work separately for each of five age groups. This can be done only for occupation-establishment units that are sex integrated both within the given age group and for the given payment system, where men and women say 31–40 years old work side-by-side on piece rates. We made the relevant computations for Norway and Sweden, but not for the U.S. where we have no information on age.

Table 3 gives for Norway and Sweden the wage gap at the occupation-establishment level by age group for piece- and time-rate workers respectively.

(Table 3 about here)

For Norway the results are mixed. Among piece-rate workers the wage gap is lowest among those 31–40 while highest among those 41–50 years old. Among time-rate workers the expected pattern largely holds except that the gap is higher with 0.09% among those 61–70 than those 31–40 years old. The theoretically expected pattern holds under both wage forms in 1984, the earlier year for which we have information, with the largest gap in the age group 31–50, not shown in table.

For Sweden it is quite striking that the largest wage gap is among those 31–40 and 41–50 years old, precisely the years with highest family obligations. The same holds largely for time-rate workers. This pattern is consistent over time from 1970 to 1990, albeit with some variations, not shown in table.

¹⁷It is well established that there is a family gap in wages for women, a gap that mostly reflects adaptations to family circumstances with time off from career to care for children, etc. (e.g., Waldfogel 1998). There is no computation of such a gap at the occupation-establishment level.

For both Norway and Sweden these results are illustrated further in Figure 1. Here, moving averages for the gaps at the occupation-establishment level, with five-year windows for age are computed separately under time and piece rates. It is quite clear, both in Norway and Sweden, that the gaps are lower among the younger age groups, for both payment forms, and then are bigger among those 31–50 years old, and finally with a slight decrease in the gap again among those 51 years and older. The piece-rate gap is always lower than the time-rate gap, in both countries and for all age groups.

(Figure 1 about here)

There is thus some but not unambiguous evidence for the claim that family obligations impose a productivity penalty on female workers. The evidence is clearest in Sweden. It would have been desirable had we been able to separate workers according to the family obligations they carry. It is moreover as Weber (1908[1924], p. 174) made clear not obvious that marriage will have a detrimental effect on productivity because it may lead to a more well-ordered life style.¹⁸

7 Male- Versus Female-Advantageous Occupations

As discussed in Section 2.3, one should expect women to be at a productivity advantage in some lines of work, while men to be at an advantage in other lines. Under piece-rate work, where pay is linked to productivity, women should earn more than men when they are at an advantage and less when they are at a disadvantage. Such issues are now explored.

We selected some occupations (industry specific) where we thought men to be at a productivity advantage and some where women were thought to be at an advantage. These selections were made on the basis of external criteria, based on our best judgements, mirroring stereotypes about the kinds of skills needed in different occupations and industries, such as strength, dexterity, and so forth, and how such characteristics may be unevenly distributed between men and women. Such stereotypes have been around for a long time and some are

¹⁸Weber(1908[1924], p. 174) points out various positive effects of marriage on productivity for male workers, but also notes some offsetting effects, including a finding that married men seem to suffer more from stomach and intestinal diseases, which he attributes (p. 173, n. 3) to the “culinary disqualifications of the working-class wives.”

probably accurate statistical generalizations. To identify occupations with the relevant characteristics we often relied on the detailed occupational descriptions for the data.

Tables 4 through 6 report the gender wage gaps under time- and piece-rate systems for selected occupations, with male-advantageous occupations in Panel A and female-advantageous ones in Panel B. Column 1 gives the wage gap among incentive-rate workers, while column 2 gives the gap for time-rate workers. Column 3 gives the productivity gap (col. 1 minus 100) and column 4 the discrimination component (col. 2 minus col. 1), using the same format as in Table 2.

(Tables 4, 5, and 6 about here)

Starting with Table 4 for the U.S., it is quite striking that in male-advantageous occupations there is a large gap in favor of men under piece rates, on average of about 10%. In female-advantageous occupations, there is under piece rates either a gap of zero or one in favor of women, of about 2%. This mirrors precisely our assumption about productivity and pay in the two settings.

In contrast, under time rates, the wage gap is in favor of men in both settings, ranging from 3.08 to 5.67% (the weighted gaps). It is somewhat larger in male-advantageous occupations.

Furthermore, in male-advantageous occupations, where women are thought to be less productive, the gap is 3–5% lower under time- than piece-rate work. Here men do not reap their entire productivity advantage. Conversely, in female-advantageous occupations, where women are thought to be more productive than men, they get penalized under time-rate work, earning 1–3% less than men, while reaping the benefits of their productivity advantages under piece-rate work, earning 0–2% more than men. Thus, under time rates, the more productive sex gets penalized, not reaping its full productivity advantage, in fact being discriminated against. The amount of discrimination is approximately the same for both sexes of about 3% (see col. 4).

Continuing with Norway in Table 5, the pattern of results is exactly the same as in the U.S. Under piece rates it matters quite a bit for the wage gap whether one is in a male- versus a female-advantageous occupation. In male-advantageous settings, women suffer a pay gap of about 4%, while in female-advantageous settings they enjoy a wage advantage, earning on average 4% more

than men.

Under time-rate work it does not matter much for the wage gap whether the setting is male or female advantageous. On average it is in favor of men, of about 2.0–2.5%. It is only slightly higher in male-advantageous settings.

Furthermore, in male-advantageous settings, where women are thought to be less productive, the gap is about 1.5% lower under time- than piece-rate work. Conversely, in female-advantageous settings, where women are thought to be more productive than men, they get penalized under time-rate work, on average earning 2.0–2.5% less than men, while reaping the benefits of their productivity advantages under piece-rate work, earning 4% more than men.

Turning to Sweden, the results in Table 6 follow closely those from Norway and the U.S. In male-advantageous work, the gap is higher under piece than under time rates, women earning about 5% less under piece-rate work, while earning only 2% less under time-rate work.¹⁹ In female-advantageous settings, women earn about 2% more under piece-rate work, while 2% less under time-rate work.

As in Norway, the gap under time rates is relatively independent of whether one works in male- or female-advantageous settings, on average in favor of men with about 2%, whereas it reflects presumed productivity differences under piece-rate work. Thus, women benefit to be paid by the hour when they are employed in male-advantageous settings, while lose when employed in female-advantageous ones.

Also, as in Norway and the U.S., the more productive sex gets penalized under time rates. In Sweden, as in Norway but not the U.S., women seem to suffer higher penalties than men under time rates.

In summary, in all three countries, the wage gap under piece rates follows closely presumed productivity differences: In favor of men in male-advantageous occupations, in favor of women in female-advantageous occupations. Under time rates the gap is relatively independent of whether the work is male or female advantageous, mostly in favor of men. It appears that under time rates the high-productivity group, be that men or women, gets penalized: Its productivity advantage, which shows up under piece rates, does not appear under time rates.

¹⁹Incidentally, note the big gap under piece rates among cutters in the Food and beverages industry, where women earn 14.14% less than men. Then recall the report in which Alva Myrdal played a central wrote. It pointed out a male productivity advantage in meat cutting "where women cannot manage the cutting knife as well as men" (Kock 1938).

8 Sorting Into Payment Schemes

If there is wage discrimination against women under time but not under piece rates, women could sort into piece-rate work in order to avoid the discrimination. This could induce a wage gap against women under both time- and piece-rate work, even in the absence of any productivity differences between the sexes. The precise mechanism was explained in Section 2.4.

This scenario gives rise to exactly the same wage gaps under the two payment systems as observed in the previous sections, but for an entirely different reason than the one proposed there. We now investigate whether there is evidence for the corresponding differential sorting of men and women.

Table 7 gives in Panel A the percent of the men and women working in occupations, establishments, and occupation-establishment units where piece-rate work is available. Availability means that at least one worker is employed on incentives at the relevant level. Panel B gives the percent who actually are paid on incentives, first for all workers, then at each of the three levels, occupation, establishment, and occupation-establishment. At the occupation level, we first computed the percent on incentives in the occupation. Then we took an unweighted average of this percent across the occupations, with analogous computations for the two other levels.

(Table 7 about here)

In the U.S., 19.1% of the men and 45.8% of the women are paid on piece rates, according to Panel B. Once one controls for occupation, this large difference between men and women becomes smaller. Across the occupations, on average 20.9% of the men and 25.1% of the women work on piece rates. At the establishment level, the percent on piece rates is much higher for women than men and the same is true at the occupation-establishment level. Looking at the presence in settings offering piece rates (Panel A), both at the establishment and occupation-establishment level it is much higher for women than men.

There is thus clear sorting of women into piece-rate work in the U.S. This sorting is to a large extent due to women being present in occupations where piece rates are common. This in turn reflects the distribution of men and women on industries, with much higher percentages of women in classic 19th century piece-rate industries such as Men's and boys' shirts, Wool textiles, and so forth.

For Norway, the situation is the same as in the U.S. This is to a large extent due to women being in occupations (and industries) where piece rates are common. Controlling for occupation, the average percent on piece rates is about the same for men and women.

For Sweden, the situation is the opposite. Men are more likely to be paid on piece rates. Again this is mostly due to their distribution on occupations. Men are more present in occupations, establishments, and occupation-establishment units offering piece rates.

So, in the U.S. and Norway, women sort more often into piece-rate work than men, whereas in Sweden the opposite is the case. The pattern of the wage gaps across time- and piece-rate work is the same across the countries. And in the U.S. and Sweden, where sorting on payment schemes is extensive, the wage gaps are still very small. Though hardly definitive, the unresponsiveness of the pattern of wage gaps to sorting indicates that sorting into pay schemes does not account for the gender wage gaps observed. Even with opposite sorting patterns, the wage gaps remain the same.²⁰

9 Discussion: The One Percent Solution

It is extraordinarily difficult to determine the extent to which the gender wage gap reflects discriminatory behaviors by employers or differences in productive capacities between men and women. We noted that where piece-rate work is performed, wages should in principle reflect productivity differences and that it is more difficult to discriminate on the basis of gender because one is paid for what one produces as opposed to for being available for producing as under time-rate work. With this as our point of departure, we compared men and women working in the same occupation in the same establishment, the level

²⁰We also investigated whether women tend to concentrate their employment in occupations where they are at a productivity advantage relative to men. Productivity advantage was measured by the gender wage gap. Concentration in occupations was measured several ways, including by the proportion of the women who are employed in an occupation and by the proportion of the employees in an occupation who are women. Regressing the latter two measures, as well as other measures of female concentration in an occupation, on the gender wage gap yielded no results. The coefficients were small in substantive magnitude, so that a major change in the gender wage gap, by for example 40 percentage points, yielded a negligible change in the concentration of women in an occupation. Moreover, less than one of three coefficients reached statistical significance at the 10% level. For analyses of sorting into occupations see Bielby and Baron (1986) and for complex econometric analyses see Foster and Rosenzweig (1996).

at which productivity differences can be assessed most meaningfully, focusing on four outcomes. First we compared the gender wage gap at the occupation-establishment level among piece- and time-rate workers. If the gap is smaller under the former, then part of the wage gap is due to discrimination. If there is a wage gap under piece rates, women are less productive than men. There is also the possibility that the gap is larger under piece than time rates, in which case men may be discriminated against under time rates. Second, we studied the degree to which the gap varied with life-cycle stage, postulating that women may suffer a productivity penalty during years with extensive family obligations. Third, we studied the wage gap in lines of work that are female versus male advantageous with respect to assumed relative productivity, hypothesizing that women will do comparatively better than men in female-advantageous settings and comparatively worse in male-advantageous ones. This comparison also gives an indirect "test" of whether wage differences under piece-rate work reflects productivity differences. Fourth, we studied the extent to which females tend to sort themselves into piece-rate schemes more often than men.

Our findings are easy to summarize. First, the gender wage gap is smaller under piece- than under time-rate work, about 1–3% versus 1.5–4%. According to the argument put forth here, about one third of the gap at the occupation-establishment level is therefore due to pure discrimination, while about two thirds of the gap is due to productivity differences. Were men and women to be paid according to their productivity, women would at the occupation-establishment level earn about 1% (Sweden), 2% (U.S.), or at most 3% (Norway) less than men.²¹ These conclusions hold across three countries and are based on accurate occupation-establishment wage data on about 1.1 million workers covering the period 1970–1990.

The extensiveness of the data, its quality, matched with identical patterns of results across countries, all combine to make the findings more than plausible. And plausibility is unfortunately about all one can expect to attain in a broad study of an important topic that has eluded exact investigations from Weber's

²¹Incidentally, this is much lower than the productivity gaps found by Goldin (1990, p. 104) for U.S. blue-collar workers around 1890, with a lower bound of about 15%, or for those computed by Weber (1908[1924], p. 163) from a German textile factory at the turn of century, of about 17%. It is possible that women have increased their productivity relative to men over the last century. That would be consistent with our findings from Sweden where the wage gaps under piece rates declined from 1970 to 1990, not shown in tables.

time to the present.²²

One can thus conclude that men and women for all practical purposes are equally productive. It is in fact somewhat surprising that the wage gap among piece-rate workers is as small as it is, given women's well-documented higher efforts in household work, which may take its toll in terms of productivity in the labor market and which *ceteris paribus* may translate into a large gap. Moreover, we have investigated productivity advantages in blue-collar work, the setting where women stereotypically have been seen to suffer their greatest disadvantages, thus stacking the case in favor of men. But only negligible male advantage was found. One may thus speculate whether women in the lines of work where they stereotypically are seen to be at a productivity advantage, such as in much clerical, office, and caring work, in fact are more productive than men. This is the kind of work that has grown in importance over the last 50 years.

It is instructive to discuss our first finding in light of other research. In a unique study, Mastekaasa and Olsen (1998) analyze differences in sick-days taken among employees in the public sector in Norway, using data on about 16,000 individuals. They study differences between men and women working in the same occupation-establishment unit, thereby keeping working conditions constant, unlike all other studies of sick-days. They find that women working in the same occupation-establishment unit as men take about 50–70 percent more sick-days. On average men spend about 2 percent of their possible working days sick while women spend an additional 1–2 percent as sick. In the aggregate this may show up as a productivity difference between men and women of 1–3 percent, as found in the current study. The comparison is unquestionably speculative, but lends credence to the overall argument and results put forth above.

Our second finding is that the wage gap appears to be somewhat higher among 31–50 years old workers than among those 30 and younger or those 51 and older. This finding was especially pregnant in Sweden. It illustrates that family obligations may impose a productivity penalty for women. If such is the

²²Totally precise conclusions may be obtained only from production records, such as in clerical work done on computers where productivity sometimes is easy to measure. But this can be done only for highly specialized jobs, such as in the regression analyses in Burawoy (1979, chap. 10) on the output of 185 production workers in a machine shop in 1975, not covering a large number of employees, a broad array of occupations, or several countries.

case, this penalty does not amount to much, a percent at the most, and may moreover likely be removed by a more equal distribution of work in the family.

Our third finding is that under time-rate work, the wage gap is more or less independent of supposed productivity differences between men and women, while under piece-rate work, the wage gap mirrors closely assumed productivity differences, with women receiving a wage premium in female-advantageous settings and a penalty in male-advantageous ones. Under piece-rate work, the high-productivity group thus gets rewarded. Under time-rate work it gets penalized, not reaping its productivity advantage in terms of higher wages.

Our fourth finding is that in the U.S. and Norway women sort more often into piece-rate work than men, whereas in Sweden the opposite is the case. The pattern of the wage gaps across time- and piece-rate work is the same across the countries. The unresponsiveness of the pattern of the gender wage gaps to sorting indicates that sorting into pay schemes does not account for the gaps observed. Even with opposite sorting patterns, the wage gaps remain the same. There could obviously be sorting of men and women into different occupations, which in turn might depend on productivity differences, with low-productivity employees sorting into low-paying occupations. But this was not investigated here and is in fact very difficult to study. As pointed out in the introduction, in most employment relationships productivity gets determined neither by the person nor the job alone but jointly by the person and the job, as argued by Granovetter (1981). This makes across-job comparisons hard to interpret.

In summary, then, women are slightly less productive than men in these typically male-dominated blue-collar occupations. For all practical purposes, in terms of how to remunerate men and women, this may be taken as evidence of equal productivity. Part of the gender wage gap under time rates at the occupation-establishment level in these kinds of occupations reflects discrimination, about a third of the gap, while two-thirds of the gap reflects productivity differences, according to the interpretation made here. So in absence of discrimination, the gap would be reduced to 1-3%, rather than the current 1.5-4% gap as found under time rates. Moreover, in terms of reducing the gap, it would clearly be advantageous if more work was to be performed under piece rates, because under this wage form it becomes harder to discriminate on the basis of gender, which in our data showed up as a lower wage gap.²³ The main problem

²³Goldin (1990, pp. 117-18), discussing the period 1900 to 1940 and the shift from piece-

under piece-rate work is who gets to do it, not what happens once it is being done. Under time-rate work, one may ask whether it might not as well make sense to reduce the gap to zero percent, because according to the analysis done here, a gap of about 1 to 3% would overall be justifiable on the basis of productivity differences, but these differences are so small to start with that they may as well be reduced to no difference. Under piece-rate work, the differences may remain whatever the differences in productivity dictate, being legitimate regardless of whether they are to the advantage of men or women.²⁴

(spot market) to time-rate wages, claims that "The origins of "wage discrimination" are thus to be found in various policies that transformed labor from the spot market of the manufacturing sector to the wage-setting of modern firms, in which earnings do not contemporaneously equal a worker's value to the firm."

²⁴This is captured precisely in the U.S. Equal Pay Act of 1963, §206(d). It clarifies that paying unequal wages for the same work for the same employer is illegal "except where such payment is made pursuant to [...] (iii) a system which measures earnings by quantity and quality of work.."

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TABLE 1
Relative Wages Between Women and Men for Time-Rated and Incentive-Rated Workers, According to
Productivity Differences and Discrimination Regime

Discrimination	Productivity Differences		
	No	Men More Productive	Women More Productive
No	No Wage Gap	Wage Gap in Favor of Men, Same Under Time and Piece Rates	Wage Gap in Favor of Women, Same Under Time and Piece Rates
Yes	Wage Gap in Favor of Men Under Time Rates, No Wage Gap Under Piece Rates	Wage Gap in Favor of Men, Larger Under Time Than Piece Rates	Wage Gap in Favor of Women Under Piece Rates, Direction of Wage Gap Under Time Rates Is Undecidable

Note: For description of the issues see Section 1. When a wage gap equals 100, women and men earn the same average wages. When a wage gap is less than 100, women on average earn less than men, and when a gap is greater than 100, women on average earn more than men.

TABLE 2 Gender Wage Gap at the Occupation-Establishment-Level Among Workers on Piece-Rate Versus Time-Rate Contracts, in the U.S., Norway, and Sweden

	Piece Rate	Time Rate	Productivity Differential	Discrimination Component
	1	2	3	4
U.S.	98.28	97.55	-1.72	-0.73
Norway	96.98	96.16	-3.02	-0.82
Sweden	98.97	98.48	-1.03	-0.49

Note: The gender wage gap is first computed for each occupation-establishment units which employ workers of both genders and offer the same pay scheme to both genders (piece rate or time rate). Then an average of this gap is computed across all relevant occupation-establishment units. Column 3 is computed as the number in column 1 minus 100. It gives the estimated productivity gap between men and women. Column 4 is computed as column 2 minus column 1. It gives the estimated discrimination component of the wage gap between men and women. The number of cases, in terms of occupations (N_o), establishments (N_e), occupation-establishment units (N_{oe}), number of women (N_f) and number of men (N_m), are as follows: For the U.S., under piece rates, $N_o=136$, $N_e=486$, $N_{oe}=1,161$, $N_f=19,000$, $N_m=13,400$, and under time rates, $N_o=239$, $N_e=1,231$, $N_{oe}=3,101$, $N_f=35,361$, $N_m=29,205$; For Norway, under piece rates, $N_o=95$, $N_e=256$, $N_{oe}=414$, $N_f=4,235$, $N_m=8,231$, and under time rates, $N_o=200$, $N_e=2,266$, $N_{oe}=3,394$, $N_f=22,656$, $N_m=55,606$; For Sweden, under piece rates, $N_o=500$, $N_e=2,300$, $N_{oe}=5,653$, $N_f=62,174$, $N_m=112,709$, and under time rates, $N_o=772$, $N_e=6,797$, $N_{oe}=13,114$, $N_f=107,597$, $N_m=130,179$. Note that in each country the database itself is larger. The numbers above refer to units that are sex integrated for the given payment system, deleting all totally sex-segregated units.

TABLE 3 Gender Wage Gap at The Occupation-Establishment-Level Within Age Cohorts, By Wage Form. Norway and Sweden.

Age	Norway		Sweden	
	Piece Rate	Time Rate	Piece Rate	Time Rate
21-30	97.05	97.69	98.49	98.04
31-40	97.42	95.86	97.95	96.95
41-50	96.31	95.08	98.00	96.71
51-60	97.12	96.06	98.47	96.92
61-70	96.93	95.77	98.18	97.35

Note: The wage gaps reported represent the unweighted mean of the wage gaps within every occupation-establishment unit which is gender integrated, i.e., which employs at least one woman and one man within an age cohort, for the given wage form, piece-rate or time-rate system. The number of observations in each cell above is lower than the number of observations reported in the note to Table 2. Included above are only observations that are sex integrated not only for the given payment system but also within the given age group. In Norway the number of women and men under piece rates are $N_f=3,294$ and $N_m=5,167$, while in Table 2 they were $N_f=4,235$ and $N_m=8,231$. Under time rates we have $N_f=6,200$ and $N_m=34,503$, while in Table 2 they were $N_f=22,656$ and $N_m=55,606$. In Sweden the number of women and men under piece rates are $N_f=43,594$ and $N_m=74,241$, while in Table 2 they were $N_f=62,174$ and $N_m=112,709$. Under time rates we have $N_f=63,795$ and $N_m=75,611$, while in Table 2 they were $N_f=107,597$ and $N_m=130,179$.

TABLE 4 Gender Wage Gap at the Occupation-Establishment Level Among Workers on Piece-Rate versus Time-Rate Wage Contracts in Male- and Female- Advantageous Occupations. U.S.

Occupation by Industry	Piece Rate	Time Rate	Productivity Differential	Discrimination Component
	1	2	3	4
PANEL A: "MALE-ADVANTAGEOUS OCCUPATIONS"				
NONFERROUS FOUNDRIES				
Grinder	97.25	90.52	-2.75	-6.73
Core Assemblers and Finishers	92.85	98.00	-7.15	5.15
Filers, heavy (die casting)		90.48		
Polishers and buffers, metal	90.67	95.92	-9.33	5.25
TEXTILE DYEING AND FINISHING				
Layout workers, grey goods	83.05	100.00	-16.95	16.95
MEN'S AND BOYS' SHIRTS				
Cutters, machine	90.13	98.11	-9.87	7.98
WOODHOUSEHOLD FURNITURE				
Complete furniture pieces, assemblers	94.90	94.73	-5.10	-0.17
Cut-off-saw operators, assemblers	73.59	94.24	-26.41	20.65
Double-end operators, assemblers	89.98	92.27	-10.02	2.29
Across Occupations (Unweighted)	89.05	94.92	-10.95	5.87
Across Occupations (Weighted)	91.53	94.33	-8.47	2.80
PANEL B: "FEMALE-ADVANTAGEOUS OCCUPATIONS"				
NONFERROUS FOUNDRIES				
Filers, light (die casting)	100.00	100.68	0.00	0.68
TEXTILE DYEING AND FINISHING				
Doubling-and-rolling machine operator	105.10	100.00	-4.90	-5.10
COTTON AND MANMADE FIBER TEXTILES				
Card tenders (finishers)	103.26	103.89	3.26	0.63
Battery hands	103.31	99.09	3.31	-4.22
Loom winder tender	105.42	100.24	5.42	-5.18
Weavers, box looms, automatic	100.19	97.99	0.19	-2.20
WOOL TEXTILES				
Winders, yarn	104.35	100.00	4.35	-4.35
MEN'S AND BOYS' SHIRTS				
Dress shirts, sewing department	102.60		2.60	
MISCELLANEOUS PLASTICS				
Blow molding machine operator	99.97	96.61	-0.03	-3.36
WOODHOUSEHOLD FURNITURE				
Subassemblies	97.05	95.12	-2.95	-1.93
Across occupations (unweighted)	102.13	99.29	2.13	-2.83
Across occupations (weighted)	99.95	96.92	-0.05	-3.02

Note: The table gives in columns 1 and 2 the wage gap between men and women at the occupation-establishment level separately for workers on piece- and time-rate payment systems within selected occupations. The gaps were computed first for each sex-integrated unit where a given payment system was in use, and then an average of this number was taken across all sex-integrated units for the given payment system in the given occupation. The occupations were chosen in order to mirror stereotypes about sex-related productivity advantages. When doing this, we used the detailed descriptions available for each occupation. Column 3 is computed as the number in column 1 minus 100. It gives the estimated productivity gap between men and women. Column 4 is computed as column 2 minus column 1. It gives the estimated discrimination component of the wage gap between men and women. The number of cases, in terms of occupation-establishment units (N_{oe}), number of women (N_f) and number of men (N_m), are as follows: In male-advantageous occupations, under piece rates, $N_{oe}=46$, $N_f=2,186$, $N_m=2,023$, and under time rates, $N_{oe}=143$, $N_f=20,118$, $N_m=13,286$; in female-advantageous occupations, under piece rates, $N_{oe}=87$, $N_f=15,748$, $N_m=5,849$, and under time rates, $N_{oe}=156$, $N_f=32,867$, $N_m=10,141$.

TABLE 5 Gender Wage Gap at the Occupation-Establishment Level Among Workers on Piece-Rate versus Time-Rate Wage Contracts in Male- and Female- Advantageous Occupations. Norway 1990.

Occupation by Industry	Piece Rate	Time Rate	Productivity	Discrimination
	1	2	Differential	Component
			3	4
PANEL A: "MALE-ADVANTAGEOUS OCCUPATIONS"				
GENERAL, MAINTENANCE				
Freight Handlers, Truck Operators	96.09	97.69	-3.91	1.60
Mining and Quarrying Laborers	90.07	98.74	-9.93	8.67
MINING				
Miners	97.08		-2.92	
MEAT				
Apprentice	94.07	96.61	-5.93	2.54
Butcher	92.75	99.58	-7.25	6.83
Machine Operator	93.51	91.48	-6.49	-2.03
FISHERIES				
Fish Receiving	99.64	97.47	-0.36	-2.17
FORESTRY				
Sawmill worker	100.89	96.93	0.89	-3.96
METALS				
Skilled Workers	98.98	98.38	-1.02	-0.60
Across Occupations (Unweighted)	95.89	97.11	-4.11	1.21
Across Occupations (Weighted)	95.48	97.17	-4.52	1.68
PANEL B: "FEMALE-ADVANTAGEOUS OCCUPATIONS"				
FISHERIES				
Filet Cutters	107.77	100.69	7.77	-7.08
Filet packing and weighing	103.42	99.59	3.42	-3.83
Thawing and cleansing of shrimp	98.54	86.57	-1.46	-11.97
TEXTILES				
Knitters	98.18	94.80	-1.82	-3.83
CLOTHING				
Seamstress whole cloth	106.07	97.96	6.07	-8.11
Assembly seamstress	109.96	104.47	9.96	-5.49
Across occupations (unweighted)	103.99	97.34	3.99	-6.65
Across occupations (weighted)	104.47	98.11	4.47	-6.36

Note: For procedures, see text and note to Table 4. The number of cases, in terms of occupation-establishment units (N_{oe}), number of women (N_f) and number of men (N_m), are as follows: In male-advantageous occupations, under piece rates, $N_{oe}=47$, $N_f=210$, $N_m=1,610$, and under time rates, $N_{oe}=202$, $N_f=1,841$, $N_m=4,865$; in female-advantageous occupations, under piece rates, $N_{oe}=27$, $N_f=463$, $N_m=192$, and under time rates, $N_{oe}=57$, $N_f=627$, $N_m=290$.

TABLE 6 Gender Wage Gap at the Occupation-Establishment Level Among Workers on Piece-Rate versus Time-Rate Wage Contracts in Male- and Female- Advantageous Occupations. Sweden 1990.

Occupation by Industry	Piece Rate	Time Rate	Productivity Differential	Discrimination Component
	1	2	3	4
PANEL A: "MALE-ADVANTAGEOUS OCCUPATIONS"				
QUARRIES				
Production workers	98.62	102.77	-1.38	4.15
METALS				
Adult workers	94.67	91.75	-5.33	-3.22
MACHINE SHOPS				
Melters	99.27	104.25	-0.73	4.98
Metal drawers and extruders, production	98.84	98.99	-1.16	0.15
Metal workers	98.96	100.15	-1.04	1.19
MINING				
Miners	87.34	92.44	-12.66	5.09
FOOD AND BEVERAGES				
Butchers	97.05	97.10	-2.95	0.05
Cutters	85.84	80.05	-14.16	-5.79
Truck operators	82.07	97.61	-17.93	15.55
MOTOR VEHICLES				
Automobile mechanics	97.95	85.47	-2.05	-12.49
PRINTING AND BOOKBINDING				
Truck operators	93.51	99.25	-6.49	5.73
Across Occupations (Unweighted)	94.04	95.44	-5.96	1.40
Across Occupations (Weighted)	97.81	99.06	-2.19	1.25
PANEL B: "FEMALE-ADVANTAGEOUS OCCUPATIONS"				
FOOD AND BEVERAGES				
Production workers, fish processing	103.32	94.35	3.32	-8.97
Production workers, vegetable canning	101.50	95.81	1.50	-5.70
Packers, butcheries	98.85	96.72	-1.15	-2.13
Canners, butcheries	100.28	99.15	0.28	-1.14
Sorters, breweries	102.62	98.95	2.62	-3.67
Production workers, eggs	102.23	96.06	2.23	-6.17
TEXTILE AND CLOTHING				
Textile workers	97.55	97.22	2.45	-0.33
Clothing	99.59	95.31	-0.41	-4.27
Across occupations (unweighted)	100.74	96.70	0.74	-4.05
Across occupations (weighted)	98.96	96.35	-1.04	-2.61

Note: For procedures, see text and note to Table 4. The number of cases, in terms of occupation-establishment units (N_{oe}), number of women (N_f) and number of men (N_m), are as follows: In male-advantageous occupations, under piece rates, $N_{oe}=351$, $N_f=1,716$, $N_m=6,446$, and under time rates, $N_{oe}=259$, $N_f=1,038$, $N_m=2,411$; in female-advantageous occupations, under piece rates, $N_{oe}=151$, $N_f=3,651$, $N_m=2,082$, and under time rates, $N_{oe}=292$, $N_f=4,372$, $N_m=2,487$.

TABLE 7 Distribution on Occupations, Establishments, and Occupation-Establishment Units Offering Piece-Rate Work (Panel A) and Percent Being Paid Piece Rate by Overall, Occupation, and Occupation-Establishment (Panel B). By Country.

Variable	Overall		Occupation		Establishment		Occupation-Establishment	
	Men	Women	Men	Women	Men	Women	Men	Women
	1	2	3	4	5	6	7	8
PANEL A:	Percent of Men and Women Who Work in Occupations, Establishments, and Occupation-Establishment Units Offering Piece-Rate Work, by Country ^a							
U.S.			93.1	99.4	43.5	64.5	19.9	47.8
Norway			98.0	99.9	21.0	30.5	16.3	25.9
Sweden			96.5	92.4	63.8	48.5	57.9	45.0
PANEL B:	Percent of Men and Women Being Paid on Piece Rates, by Overall, Occupation, Establishment, and Occupation-Establishment, by Country ^b							
U.S.	19.1	45.8	20.9	25.1	12.7	27.8	13.4	32.3
Norway	12.6	18.2	17.5	19.2	7.5	8.6	8.4	10.3
Sweden	48.8	37.9	32.6	30.6	23.4	18.2	32.5	25.3

Note: See text for explanation. The number of women (N_f), men (N_m), and workers (N) on which these analysis are based are: In the U.S., $N_f=142,222$, $N_m=156,775$, $N=298,997$; In Norway, $N_f=31,437$, $N_m=133,812$, $N=165,249$; In Sweden, $N_f=188,540$, $N_m=445,809$, $N=634,349$. Across the three countries the analyses are based on information on 1,098,595 workers. In Sweden, the number of workers for which the sorting into payment systems analysis is based is somewhat higher than the number of workers for which we compute the wage gap, 634,349 versus 612,252. For the latter analyses 20,147 observations with incomplete wage information were dropped.

^aEach occupation, each establishment, and each occupation-establishment unit where at least one worker was employed on piece rates is defined as offering piece-rate work to its employees. The numbers in Panel A then give the percent of the men and the women who worked in such units. For example, at the establishment level, the number 43.5 for the U.S. (col. 5) means that 43.5% of the male workers in the U.S. worked in establishments offering piece-rate work.

^bIn Panel B the numbers are computed as follows. Columns 1 and 2 just give the percent of the men and women who were paid on piece rates. At the occupation level (in cols. 2-3), it was first computed for each occupation the percent of the men and the percent of the women who were paid by piece rate. Then an average of this percent was taken across the occupations. The computations for establishment and occupation-establishment are similar.