

The Rise and Fall of the Sliding Scale  
or  
Why Wages Aren't Indexed to Product Prices

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**Abstract:**

Schemes that linked wage rates to product prices, generally referred to as sliding scales, were widespread in some industries and tried in others in Britain and the United States from the 1860s through the 1930s. I describe how sliding scales worked in practice and how they were viewed by contemporaries. I argue that sliding scales were not adopted for the reasons suggested by most theories of wage indexation, but rather in order to reduce the frequency of strikes in an institutional setting where there was no third-party enforcement of labor agreements. This helps to explain the disappearance of sliding scales since the 1930s.

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Sometime before the year 1841, a British ironmaster named G.B. Thorneycroft began to pay his puddlers wages that depended on "the price of 'marked bars' - these words indicating a quality of iron that then enjoyed a high reputation...The puddlers received, as a rule, 1 shilling for each pound of the selling price" (Munro, 1889, p.141). By the 1880's, arrangements linking wages to product prices, generally referred to as "sliding scales," covered most skilled workers in British iron and steel and were common in British mining, where wages of about 120,000 men were indexed to coal prices (Munro, 1885, 1889). In the 1890s and 1900s, the "conciliation board" arbitrators who set most British coalminers' wages used sliding scales as the basis for their awards (Pencavel, 1977, p. 142; Treble, 1987). After the First World War, coal mine unions and employers adopted a scheme that linked wages to "the difference between the proceeds from the sale of coal and the production costs other than labor" (Political and Economic Planning, 1936, p. 170), while sliding scales remained standard practice in coking and iron mining and were extended to cover unskilled as well as skilled workers in the metals industries (Pool, 1938, p. 159). As of 1925, product-price sliding scales determined wages of about 220,000 men in British metals, coke production, and iron ore mines (Great Britain Ministry of Labour, 1925, p. 269).

In the United States, sliding scales were adopted in ironmaking beginning in the mid-1860s. By the 1880s they determined skilled workers' wages in most plants manufacturing iron rails, iron sheets or tin plate, and many steel plants (Massachusetts Bureau of Statistics of Labor, 1881, p. 18; Asheley, 1903, p.154; American Iron and Steel Association, 1888, pp. 117, 297; U.S. Industrial Commission, 1901, p. 97). Over the 1900s unions were expelled from most of the iron and steel industry, but where they hung on, they continued to negotiate sliding scales through the 1920s (Robinson, 1920; Chazeau and Stratton, 1937, pp. 143-144). As in Britain, sliding scales were used in coalmining (Jeans, 1902, p. 19; Fisher, 1942, pp. 287-292), and also in zinc and silver mining, as well as in copper mining, smelting and refining (U.S. Bureau of Labor Statistics, 1914; U.S. Bureau of Labor Statistics, 1943, pp. 28-29; Greenfield, 1960, pp. 116-122). Outside mining and metals,

sliding scales were used in the glass industry (both window glass [Davis, 1949, pp. 132, 187] and “flint” glass [U.S. Industrial Commission, 1901, p. 136]), and in the cotton textile mills of Fall River, Massachusetts (Howard, 1920).

Sliding scales fascinated contemporary economists and public officials involved in labor relations. Members of special labor-relations commissions conducted by the British parliament in the early 1890s, and by the U.S. Congress around 1900, frequently inquired about the use of sliding scales (Great Britain Royal Commission on Labour, 1892, 1894; U.S. Industrial Commission, 1901). An Edinburgh University professor named J.E.C. Munro proclaimed the sliding scale to be “the greatest discovery in the distribution of wealth since Ricardo's enunciation of the law of rent. That it has a great future before it, not only in the iron and coal trades, but in other industries, I have no doubt” (1885, p. 26). Alfred Marshall recommended that labor arbitrators “adopt a self-adjusting sliding scale” that accounted for prices of raw materials as well as products (Marshall and Marshall, 1881, p. 216-17), or even better product prices, materials costs, and “the prices of certain amounts of the things chiefly consumed” by workers (letter quoted in Price, 1887a, p. 84). Arthur Pigou judged that a sliding scale “may easily, for all its inaccuracies, do a considerable amount of good” (1905, p. 104), though he later observed that “In an industry engaged in making a number of different articles, particularly if the quality and nature of these varies from time to time - ships, for example, or ladies hats - the technical difficulty of finding any price, or combination of prices, that will correctly indicate variations in the demand for labour is very great...Hence the range over which the remedy of sliding-scales can be applied is restricted somewhat narrowly by purely technical incidents” (1927, p. 287). One noted benefit of sliding scales was the adjustment of wages to monetary shocks:

For there can be little doubt that the appreciation of gold is at present a disturbing factor of no small magnitude in industrial relations, and that in some instances workmen exhibit a somewhat pertinacious insistence upon nominal wages...But the automatic adjustment of wages to prices effected by a sliding scale entirely avoids the difficulty occasioned by a general appreciation of gold; and it would tell in a similar way in favour of the workmen's fair demands, if the monetary

disturbance were caused by a *general* rise in prices and a depreciation in the metal adopted as the standard of value. (Price, 1887a, p. 66; see also Robinson, 1920, p. 158).

Modern economic theory agrees with early economists on the potential usefulness of product-price sliding scales. Weitzman (1984) argues that the widespread adoption of profit-sharing or sliding-scale schemes would dampen the real effects of monetary shocks. Apart from the macroeconomic benefits emphasized by Weitzman, most models of long-term labor contracts imply that employers and employees have strong *private* incentives to index wages to product prices net of materials cost, whether or not wages are also linked to other variables such as prices of consumption goods. Within an efficient contract that specifies employment levels or transfers rents to workers through a lump-sum payment, product-price indexation stabilizes the employer's profit, creating a gain to be shared with workers if the employer is willing to pay for a steadier income stream. In contracts that set above-market wages and leave the employer to choose employment levels, product-price indexation helps prevent inefficient separations in the event that the value of a worker's product in the enterprise is unexpectedly low but still higher than the prospective value of the next-best job. Either way, a sliding scale can offer employees higher expected wages and/or smaller risk of layoff, more than enough to compensate for increased variability in their wages on the job. In many models of long-term employment contracts, product-price indexation must be ruled out by assumption - the product price cannot be defined (Pigou's "technical difficulty") or independently observed by workers - so that negotiators make do with second-best schemes such as indexation to CPI's (for example Blanchard, 1979; Hart, 1983; Azariadis and Stiglitz, 1983; Card, 1986). Of course, many long-term labor contracts are not indexed to CPI's, either. To account for the absence of indexation in general, it is argued that there are "fixed real costs per worker of negotiating or administering indexing clauses," big enough to overcome the potential benefits of indexation (Ehrenberg, Danziger and San, 1983, p. 226).

Theories of long-term labor contracts frame modern discussions of historical sliding scales

(for example Weitzman, 1984 pp. 78-79, 86; Hall and Lazear, 1984, p. 255; Card 1986 pp. s145, s150). Treble (1987) argues that British coal mine operators adopted sliding scales to transfer risk to workers and the industry moved away from sliding scales “as a part of a process by which the burden of the risk induced by shifts in the demand function for the output was shifted from the employees to the employers” (p. 85). South (1990) proposes that sliding scales were adopted in British coalmining and metals because these industries produced homogenous goods, were subject to especially great product-demand shocks, and used production techniques that created especially great costs of inefficient separations (pp. 53, 144).

From this point of view, however, the general history of sliding scales presents some puzzles. Through the 1930s, sliding scales failed to take hold outside mining and metals, even in industries apparently well-suited to their use. In cotton textiles, for example, it was easy for workers to observe open-market prices for many products and for the only important nonlabor input, raw cotton. Yet the sliding scales in Fall River textiles were abandoned after a few years’ trial. In British cotton textiles, unions and employers discussed proposals of sliding scales on at least three occasions, but never adopted one (Price, 1901; White, 1978, pp. 80-84). Why were pre-1930s sliding scales so rare or short-lived outside the mining and metals industries?

After the 1930s, sliding scales disappeared even from the mining and metals industries. For Britain, there is a ready explanation. At the beginning of the Second World War, sliding scales and proceeds-sharing schemes were suspended in response to the imposition of general wage, price and employment controls (Haynes, 1953, p. 26; Burn, 1961, p. 27), which broke the ordinary connection between product prices and labor demand. After the war, the British mining and metals industries remained under various forms of government control through the 1980s, when public subsidies were stopped and the unionized industries simply ceased to exist (Fraser, 1999, pp.235-

36, 241-242).<sup>1</sup>

But what accounts for the disappearance of sliding scales in the United States? In 1940 the U.S. Bureau of Labor Statistics found that “Plans for the automatic adjustment of wages to the price of the commodity produced are rare except in nonferrous metal mining and smelting” (U.S. Bureau of Labor Statistics, 1940, p. 13). In 1951, the BLS observed that even in nonferrous metals “the general practice of gearing wages to prices declined appreciably in the early 1940’s,” and did not revive after the war (U.S. BLS, 1951, p. 49). It is almost (though not entirely) impossible to find examples of product-price sliding scales in recent years.<sup>2</sup> Arguably, the cost of inefficient separations was reduced by some American institutional developments of the 1930s such as the introduction of imperfectly experience-rated unemployment insurance (Goldin, 2000, pp. 614-1615), but sliding scales had spread under Britain’s unemployment insurance scheme of the 1920s, which was extraordinarily generous and entirely unrated (Benjamin and Kochin, 1970), and other

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<sup>1</sup>Coal mines were nationalized in 1947. In the 1950’s, it was observed that the board regulating the industry “clearly does not aim to maximize profit” (Alexander, 1956, p. 165), as “Nobody disputes that the existing output of coal could be sold at a higher price” (p. 174), while the miners’ union maintained a “voluntary renunciation of the strike weapon” (p. 164) because of “the importance attached by influential leaders of the union to the stability of political institutions in general and of the public corporation type of nationalization of coal-mining in particular” (p. 166). The iron and steel industry was under private ownership over most of the 1950’s, following an aborted nationalization at the beginning of the decade, but “As maximum prices were set by the Iron and Steel board for most categories of steel products the producers were unable to raise their prices” (Blair, 1997, p. 573). After the industry was nationalized again in the 1960’s it was “a participant in various counter-inflationary programmes as steel prices were subject to restraint by the government..not able to operate freely in the market..under political pressure not to declare redundancies [layoffs]..refused permission to increase its selling prices ” (p. 575, 576). In the 1970s firms in these industries, supported by public subsidies, employed workforces far larger than any profit-maximizing enterprise would choose (Pryke, 1981, pp. 48, 59, 183-188).

<sup>2</sup>Union contracts with the Magma Copper Company linked hourly wages to copper prices, along with the CPI, through 1992, when the arrangement was replaced by one linking hourly wages to operating profit (Charlier 1991, 1992) along the lines of the 1920s British coal scheme. In the 1990s union contracts with Inco, a Canadian nickel producer, linked wages to the spot price of nickel (Bagnell, 1997).

American developments should have *promoted* the use of sliding scales. Workers gained new sources of independent information about product prices and materials cost, as the BLS began to publish better, more timely and more industry-specific indexes of wholesale (or producer) prices (Hanes, forthcoming) which have been used to index a variety of long-term contracts other than wage agreements (Stigler and Kindahl, 1970, p. 15; U.S. BLS, 1991). Most importantly, starting in the late 1930s unions returned to iron and steel, and became powerful for the first time in many other industries (Freeman, 1998). But there was no revival of sliding scales in metals and mining, let alone a spread of sliding scales to new industries.

In this paper, I examine contemporary accounts of product-price sliding scales in Britain and the U.S. to describe their structure, problems that arose with them in practice, and reasons some proposed sliding scales were rejected or abandoned after a few years' trial. I identify specific features of product markets, nonlabor input costs, and labor unions that appear to have limited workers' price information and hindered the administration of sliding-scale schemes, even in industries where outputs and nonlabor inputs were homogenous goods with published open-market prices. This helps explain the narrow scope of sliding scales before the 1930s, and points to factors that may have generally discouraged product-price indexation in the long-term labor contracts of the postwar U.S. At the same time, I argue that historical sliding scales were *not* examples of indexation as described in models of long-term employment contracts. They were instead devices to reduce the frequency of costly strikes in settings where long-term labor contracts were not an option. I present a model (related to models of strikes as a result of asymmetric information such as Hayes [1984], Hart [1989]) that illustrates this function of a sliding scale. The model also demonstrates that the potential benefits of a sliding scale over fixed wage rates are *greater* in the absence of long-term contracts. This helps explain why some unions and employers used sliding scales before the 1930s, but not in the postwar U.S.

## **1. Evidence from contemporary accounts of sliding scales**

### 1.1 The structure of sliding scale agreements

Most sliding scales were written agreements negotiated or settled by arbitration between a labor union and a firm or, more often, a trade association of firms in a regional industry. In a few cases, sliding scales were unilaterally adopted by employers in industries where *other* employers negotiated sliding scales with unions (Munro, 1889, p. 132), or were retained by employers after they broke unions that had originally negotiated sliding scales (as in American anthracite [Asheley, 1903, p. 128; Roberts, 1901, p. 181]). The terms of a sliding scale agreement set a relation between a product price or set of prices and money wage rates to be paid for specified jobs, rather than wages for specified employees. They did *not* specify employment levels, fixed payments to workers or the union, or payments to workers in the event of layoff; in this they resembled the vast majority of pre-1930s union agreements (Seastone, 1955). Most sliding-scale jobs were paid by the piece, but sliding scales were also used to determine time rates (Munro, 1890, p. 148, 160; U.S. Industrial Commission, 1901, p. 96; Great Britain Ministry of Labour 1925, p. 270; U.S. Bureau of Labor Statistics, 1940, p. 15). Some agreements were to hold for a fixed duration, rarely longer than one year.<sup>3</sup> Many others stated explicitly that either party could withdraw after a few weeks' notice, not under pre-specified conditions as in modern labor contracts with "re-opener" clauses (Danziger, 1995), but at any time, for any reason (for example Massachusetts Bureau of Statistics of Labor, 1881, p. 16; Munro 1885, p. 18; Massachusetts Bureau of Labor, 1908, p. 264; Robinson, 1920, p. 148).

Wages were adjusted at predetermined points in time on a regular schedule, as a function of prices prevailing in the previous period. The time between wage adjustments could be as short as one week (Massachusetts, 1906, p. 195) but most wagesetting periods ranged between one and six

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<sup>3</sup> Some scales have been described as being in effect for many years, but these were actually re-negotiated from time to time. What held over was some element of the relation between wages and product prices: see for example Carr and Taplin (1962, pp. 72, 139, 278).

months (Price, 1887a, p. 52). Most sliding scales set minimums below which wages could not fall, no matter what happened to prices; many set maximums as well (for example Munro, 1890, p. 50; Massachusetts 1909, p. 259-260; Smart, 1895, p. 104; Jeans, 1894, p. 71; Price, 1898, p. 472; Carr and Taplin, 1962, p. 72; U.S. Industrial Commission, 1901, p. 135). Within the upper and lower bounds, the relation between prices and wages could be continuous, as in scales that gave percent increases over the minimum as a multiple of the difference between the product price and a base level (U.S. Industrial Commission, 1901, p. 89), but many scales specified schedules with wide steps, leaving wages fixed until prices ranged outside the bounds (for example Munro, 1885, p. 6, 10; Jeans, 1894, p. 63; Evans, 1909, p. 124). Some set a limit to the magnitude of a wage change that could take place from one period to the next, whatever the change in prices (Great Britain Ministry of Labour, 1925, p. 271). A given price change could trigger a bigger (Robinson, 1920, p. 146; Jeans, 1894, pp. 63, 65) or smaller (Munro, 1890) wage adjustment once prices rose above a specified level.

To apply a sliding scale to an individual worker's pay, the worker's time- or piece-rate earnings could be calculated at the fixed base or minimum wage rate for the job, then scaled up (or down) by the sliding scale factor. In a British metals scale, a worker's earnings were tallied at the base rates, then the sliding-scale adjustment was made "by adding or deducting the needful percentage at the foot of the pay tickets" (Munro, 1885, p. 11).

The goods whose prices determined a worker's wage were sometimes the same as the goods produced by the worker or the establishment: in a British ironworks scale of the 1870, wages were linked to the average of prices of "the four main products (rails, plates, bars and angles)" (Carr and Taplin, 1962, p. 71). But not always. Wages for workers producing a wide set of goods could also be based on prices of just one or two goods, as in many American iron scales (Robinson, 1920). In a few scales, wages were determined by the price of a good down the chain of production from a worker's establishment. British iron ore miners' wages were set by the price of pig iron (Munro,

1885, p. 8; Great Britain Ministry of Labour 1925, p. 272). Around Wheeling, West Virginia, where the principal industry was the manufacture of nails, nail prices determined wages of coalminers (Massachusetts Bureau of Statistics of Labor, 1881, p. 18).

It was generally recognized that changes in the cost of nonlabor inputs such as materials or transportation required revisions to the terms of a sliding scale (for example Price, 1887a, p. 65). In British metals, during the First World War “the employees accepted a modification of the sliding scale under which the whole of the increase of prices due to shipping was to be left out of the sliding scale calculations” (Birkett, 1922, p. 157). Some schemes anticipated changes in materials costs by including materials prices within the sliding scale formula. In British tinsplate and galvanizing establishments (Pool, 1938, p. 161-62) and U.S. Fall River textiles (Lincoln, 1909), wages were a function of the difference between product prices and prices of raw materials in the required quantity, referred to as the employer’s “margin.” In British coalmining over the 1920s and 1930s, “proceeds” were calculated as total sales revenue *less* actual nonlabor costs and the “cost” of labor at fixed minimum rates; actual wages were equal to the minimum *plus* a share of proceeds (Bowie, 1927).

It was likewise recognized that a sliding scale’s terms, particularly its minimum wage, had to be modified in response to conditions in outside labor markets, though there are no records of attempts to incorporate measures of outside wage rates into a scale’s formula. Munro (1885) observed:

A sliding scale does not bind the miner to remain in the employ of his master. It only fixes the wages whilst the relation of employer and employed continues, and leaves either party free to determine that relation by the usual notice to quit. That there are many obstacles to the free migration of labour is well known, but in so far as it does exist it tends to establish an economic minimum wage for every sliding scale (p. 25).

British coalminers pressed for revisions to their scales when “they found, or thought they found, that their average wage under the sliding scale did not give them the same net advantages as were being earned by other trades with which their labor could be put into comparison. In other cases the

masters have revised the standards for exactly the opposite reason” (Smart, 1895, p. 74). Fall River textile employers once waived a wage cut specified by the sliding scale partly because “Business promised to pick up and to soon become normal, and a full complement of operatives was necessary. The maintenance of the old schedule would hold them” (Massachusetts Bureau of Labor Statistics, 1909, p. 267). British ironworkers agreed to a downward ratchet in their scale “because of their knowledge of the congested condition of the labour market” (Price, 1887a, p. 41). In another British ironworkers scale, arbitrators added or removed “premiums” to sliding-scale rates to keep pay in line with ironworkers’ wages elsewhere (Evans, 1909, p. 125).

What kind of price information went into the formula of a sliding scale? The first sliding scales in ironmaking were based on list prices - “card” or “circular” prices - set by manufacturers’ trade associations. In the U.S., “This scheme caused considerable friction, because iron was frequently reported to be selling above the card rate” (Robinson, 1920, p. 146), while in Britain “in practice the list prices were not effectively binding upon members of the Association, and the prices of ordinary merchant bars (by far the highest proportion of the trade) varied considerably both from the list price and between firm and firm” (Carr and Taplin, 1962, p. 64; see also Price, 1887a, p. 58).<sup>4</sup> One British pig iron scale was “based on the prices declared on the Glasgow Exchange. There is, however, often a difference between realised and quoted prices, and the latter are generally subject to much greater variation than the former” (Jeans, 1894, p. 79).

By the 1890s, regular, frequent (often daily) reports of open-market prices for many minerals, raw materials like cotton, various types of coal at a number of geographic locations, and standard products of the textile and iron and steel industries were published in business and trade journals such as the Iron and Coal Trades Review and the Economist in Britain, and the

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<sup>4</sup>With respect to U.S. anthracite coal, it was observed that the “circular prices” varied considerably from actual selling prices because of “discounts” which varied a lot over time; for some classes of coal circular prices “have little significance” (Sydenstricker, 1914, p. 119).

Engineering and Mining Journal and the Journal of Commerce in the U.S. A number of sliding scales were based on these reports, including some in metals and mining (U.S. Bureau of Labor Statistics, 1914, p. 137; U.S. Bureau of Labor Statistics, 1940, pp. 13-15; Robinson, 1920, p. 148). But *most* scales in metals and coalmining, even those that linked wages to prices of standard products such as pig iron, took prices or margins from employers' account books rather than publications or price lists. When there were a number of firms on the employers' side of an agreement, all wages were based on the same figure, an average of values for individual firms. If there were a large number of firms involved, prices were taken from a sample of firms (Munro, 1890, p. 142; Jeans, 1894, p. 78, 85; Roberts, 1901, p. 177; Great Britain Ministry of Labour 1925, pp. 270).

Who looked at the books and calculated the price averages? In scales overseen by arbitrators, it could be an accountant hired by the arbitrator. In a British iron trades scale of the 1880s, an accountant hired by the arbitration board "takes off from the invoices the discounts and commissions which have to be given by the firms on each special order, and he arrives at the net price of each ton which has left the works...He sends round to the works, and he examines the books himself, or by his officials, and vouches for them and their accuracy" (Price, 1887a, p. 45). In the American anthracite scale established by arbitration between operators and the United Mine Workers in 1903, the accountant was "named by one of the circuit judges of the third judicial circuit of the United States" but "paid by the coal operators, such compensation as the appointing judge may fix, which compensation shall be distributed among the operators in proportion to the tonnage of each mine" (Sydenstricker, 1916, p. 34). More often, the task was performed by committees of firm managers and union representatives (for example Roberts, 1901, p. 178; U.S. Bureau of Labor 1904, p. 238); or by a firm of professional accountants "approved by both parties" (Jeans, 1898, p. 85); or - perhaps most frequently - by one professional accountant hired and paid for by the union, and another accountant hired by employers (Munro, 1885, p. 35; Great Britain Ministry of Labour

1925, pp. 270-272; Jeans 1894, p. 78; Smart, 1895, p. 66).

The costs of professional accountants' services for a sliding scale appear to have been small relative to workers' earnings. In British coalmining scales of the 1870s-1890s, accountants' fees paid by unions were covered by one or two pence per month - the "Sliding scale pence" - deducted from a miner's earnings (Webb and Webb, 1897, p.210-11; Arnot, 1949, p. 60-61), which were about 5 pounds (1200 pence) a month in 1881 and over 7 pounds a month in 1901 (Williamson, 1980, p. 474).

## **1.2. Practical problems with sliding scales**

Contemporaries described several problems that arose when unions and employers attempted to negotiate or operate sliding scale agreements. For a few cases, they give reasons that one side or the other rejected proposals of sliding scales, or abandoned them after a trial.<sup>5</sup> Perhaps surprisingly, they do *not* cite the obvious administrative costs of a sliding scale such as accounting and clerical labor or extra tasks for managers and union representatives, with the exception of Sydenstricker (1916), who states that mine operators wanted to abandon the 1903 American anthracite scale partly because "The cost of the elaborate of system of accounting..was heavy and had to be borne by the operators" (p. 34). Problems mentioned by contemporaries had rather to do with the distribution of information, not only between employers and unions, but also between union leaders, on the one hand, and rank-and-file members on the other.

In the investigations of the British and U.S. labor relations commissions, some witnesses were asked why their industries did *not* use sliding scales. Their answers imply that unions lacked

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<sup>5</sup> Contemporaries voiced a few objections to sliding scales other than those recounted here. Most had to do with features of a few scales that did not hold in general, for example the absence of a minimum wage. Toward the end of the nineteenth century, some unionists and social reformers such as the Webbs argued that sliding scales were inconsistent with a moral principle that a worker's wages should be high enough to guarantee a certain standard of living, because sliding scales were based on a contradictory principle that wages were governed by an employer's ability to pay (Webb and Webb, 1897, p. 237).

information about prices that could not be manipulated by the employers. In Britain, the secretary of a union in the nut and bolt industry told the commission that the sliding scale “does not apply in my trade at all, because it is very difficult to get at the prices...Ours being a trade which embraces a great number of technicalities and specialities it is impossible for us to find out what price the employers get for them (Great Britain, 1892, p. 471). In the U.S., a Massachusetts state labor arbitrator was asked:

Q. Do you think it is possible in the boot and shoe industry in the State to establish between the workmen and the employers...a sliding scale agreement, changable, say, in 90 days by the working committee on each side. Would that be more advantageous to the business in giving stability of employment to the men, and a perfect knowledge on the part of the employers as to what would be the cost of the goods and what they could market them for?

A. Theoretically, I should say yes; practically, I should have little expectation of anybody carrying it out in good faith...I can conceive of a shoe manufacturer meeting his workmen to make up a new list, as you say, on a sliding scale that would take into consideration the present cost of production and stock, but the first difficulty you would run against would be this, that the workmen would not believe a word of what the manufacturer said as to what his goods cost him or what he sold his goods for (U.S. Industrial Commission, 1901, p. 918).

The president of a glassworkers' union stated that his union had accepted a sliding-scale piece rate for one particular product (tumblers), but preferred to negotiate fixed piece rates for all other products:

Q. Does your union think it is better to make [a fixed-wage] arrangement for 12 months than a sliding scale?

A. Yes; our union does not like the sliding scale...The sliding-scale system must be based now on certain rebates and discounts that you can hardly find out. You must depend a great deal on the honesty and integrity of the manufacturers. It is hard to reach. They have an understanding among themselves that they will sell a certain amount of glass to a dealer, and if he buys so much he will get a certain rebate.

Q... And they do not like to expose that to their men to see what they are making?

A. No, I suppose not. (U.S. Industrial Commission, 1901, p. 934).

Sometimes union and firm negotiators agreed to a sliding scale in principle and settled on a representative set of prices, but could not agree to any specific relation between those prices and

wages. “The initial difficulty lies in determining the ‘standards’; that is, the the price which may be considered normal and the wage which may be considered normal when this price rules” (Palgrave, 1896, p. 410). According to the British Industrial Commission, “The frequent failure of attempts to establish a permanent sliding scale seems to be chiefly due to the difficulties of agreeing upon a basis price” (1894, p. 42). In British cotton textiles, sliding scales linking wages to the margin between prices of products and raw cotton inputs were proposed by the manufacturers’ association in 1899, by unions in 1906, and by government officials in 1909. All proposals specified that prices were to be taken from the open market: “As margins were practically a matter of public knowledge, no cumbersome procedural apparatus would be required” (White, 1978, p. 80). In all three cases, negotiations broke down because employers demanded that the schedule be set to give an initial wage cut at the current value of the margin, while unions insisted that the scale be anchored at current values of wages and margins (Price, 1901, p. 241; White, 1978, pp. 82-83). In the 1899 negotiations, both sides agreed that the scale should be based such as to give employers a 5 percent rate of return on capital, but they could not agree on the corresponding value of the margin. The employers proposed to settle the question by examination of their books, but “the men appear to have felt, whether rightly or wrongly, suspicion of the trustworthiness of the books which would be examined” (Price, 1901, p. 241).

In the cotton textile mills of Fall River, Massachusetts, unions and employers adopted a sliding scale in October 1905 following a state government investigation of the relation between employers’ profits and the margin between cloth and cotton prices (Howard, 1920, p. 20-21).<sup>6</sup> The agreement linked wages to the difference between prices for two standard types of “plain” print cloth and the spot price of the raw cotton needed to produce those cloth types, as published daily in

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<sup>6</sup>As early as 1879, a “plan for a sliding scale was discussed by both mill owners and operatives” (Lincoln, 1909, p. 453). About the same time, Carroll Wright had recommended their general adoption in the Massachusetts textile industry (Massachusetts Bureau of Statistics of Labor, 1881, p. 74).

the New York Journal of Commerce. Wages were scaled one percent above minimum rates for every cent of the spread between this margin and a fixed base level, and adjusted once a week, based on the average daily price figures over the previous week (Massachusetts, 1906, p. 195).

According to a local observer, this scheme “introduced an element of uncertainty in the rate of wages which the workers could not understand” (Lincoln, 1909, p. 456). Wage adjustments simply applied the specified formula to the newspaper’s price reports, but:

These figures were quite beyond of the understanding of the mass of operatives. Those few who did understand the working of the scale contended that an advance in the price of cotton did not mean an increase in the cost of manufacturing unless the agents actually bought cotton at the higher price, and that a reduction in the price of cloth by 1-16th a cent per yard did not mean smaller profits, unless goods were actually sold at the lower price. The mills had been stocked with cotton, so that it was unnecessary to buy at the higher quotation. A large part of the goods produced by the mills consisted of fabrics other than print cloth, the prices of which were in no way regulated by the price of prints; and even if they were, the goods had been sold ahead at a higher price (p. 458).

These objections to the scale’s measures of product price and materials cost appear reasonable in light of the industry’s structure. Mill operators *did* actively manage stocks of raw cotton and time their purchases to minimize materials cost, in response to somewhat-predictable variations in spot prices (Stanwood, 1913, p. 372). According to the Massachusetts state labor bureau, the scale’s “method of figuring the margin in cotton manufacturing originated many years ago when the product of the mills of Fall River was almost exclusively print cloths, while at the present time probably less than one-third of the product consists of such cloth...the main product being ‘fancies’ and ‘odds’ Under the present system a fall in the price of print goods would lower wages, even though the mill was not running on prints at all and indeed it might be making a large profit on fancies” (Massachusetts, 1906, p. 195-196). This problem arose even though Fall River was “the center of the plain rather than of the fine goods manufacture...products are less diversified than elsewhere” (Howard, 1920, p. 14). In June 1906, this sliding scale was abandoned and replaced with fixed wage rates “at the request of the textile unions” (Massachusetts 1908, p. 259).

In May 1907 unions agreed to another sliding scale after “The margin..was found to have widened quite substantially, and the advantages which might have accrued to the operatives had they not insisted upon abandonment of the sliding scale appeared great” (Howard, 1920, p. 25). The second scale based wages on the same prices from the Journal of Commerce (which did not publish quotations for “fancies” and “odds”), but was a stepped schedule with wages held fixed as long as the margin remained within five-cent bands, and revised wages only “in May and November of each year, the revision being based on the average margin between the cost of the raw material and the price of the finished product for the previous six months. The new rate was to be binding for six months, thereby avoiding the weekly fluctuations which were found unsatisfactory under the old system” (Massachusetts 1908, p. 259-60; see also Howard, 1920 p. 25-26). However, it was still the case that “because of the speculative element in the cotton market the existing method of figuring the margin was not considered to be a fair one” by some on the unions’ side (Massachusetts 1908, p. 262).

There is not much object in averaging raw cotton prices for a week or even for six months with a view to determining wages unless it is known that the cotton used in production was actually bought at the prices averaged. Examination of commercial statistics shows that by far the heaviest buying of cotton stocks by mills..is in the months of October, November, December and January of each year...It is evident that any system of basing wages on margins averaged for six-month periods ending in May and November does not fairly allow for the uneven distribution of cotton purchases throughout the year. And yet an adjustment of the dates of margin and wage calculations to meet this seasonal fluctuation is not easy for the fluctuation is not regular (Howard, 1920, p. 35-36).

Consistent with this argument, when the manufacturers waived their rights to a wage cut in November, 1908, they “explained that supplies of cotton were secured much below recent quotations; had the manufacturers been forced to buy raw materials and sell products at current quotations, the waiving of the rights would not have been possible” (p. 28). In 1910, the unions and employers again reverted to negotiation over fixed wage rates, finally abandoning any efforts to operate sliding scales.

In coal mining, materials costs were negligible, and each establishment produced just one

(more or less) undifferentiated good. But long-term sales contracts were a “constant source of irritation” in the operation of sliding scales (Smart, 1895, p. 86), because “the rise of wages which might be expected from the current newspaper quotations for coal does not come at the end of the revision-period, and may never come at all if prices fall again before the contracts expire” (Palgrave, 1896, p. 411). “The colliers complained, again, that when wages were down, and under ordinary circumstances the men could have forced a rise, the coal owners kept them down by taking large orders at low prices for far into the future” (Chapman, 1903). “To the objection that the argument cut both ways, inasmuch as the men would obtain the benefit of contracts at high prices, it was replied that long contracts were usually entered into when prices were low and not when they were high” (Munro, 1890, p. 126). To deal with these issues, one agreement specified that “any contract for the sale of coal for a period of more than twelve months shall not be taken into account for more than six successive audits of two months each” (Chapman, p. 192; see also Smart, 1895, p. 86).

Another set of problems arose from the costs of transporting coal to users or coastal shipping points. Because these had a big effect on the value of any particular mine’s output, operators often insisted that sliding scales be based on prices at the “pithead” or on market-center prices *less* transport costs. But in some cases local buyers, railroad or canal companies were owned by the same companies that operated the mines, and miners suspected that the companies manipulated the terms of transactions to lower the sale prices on the mines’ books. In U.S. anthracite scales of the 1890s, wages were based on prices of coal at a location within the mining region, but the region’s railroads were owned by the same companies operating the mines, and miners “thought themselves victimized by the high freight rates which the large companies..as common carriers charged themselves as operators” (Virtue, 1900, p. 7).<sup>7</sup> In the British coal proceeds-sharing scheme of the 1920s and 1930s, “the miners’ representatives” alleged that “colliery companies, by selling their

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<sup>7</sup> When arbitrators established a sliding scale for anthracite mines in 1903 they were careful to base wages on coal prices “at New York Harbor” (Fisher, 1942, p. 292).

coal cheap to subsidiary companies which they own (e.g. coal merchants, exporters, patent fuel manufacturers, iron and steel companies, fuel process plants, etc.) are able to show a loss for the purpose of the ascertainment by depressing the pithead price, yet can recover profits from the enhanced profits of their subsidiaries” (Political and Economic Planning, 1936, p. 176).

The metals industries appear to have been free of most factors that complicated the use of sliding scales elsewhere. According to Asheley (1903), “the ‘long contract’ or ‘selling-ahead’ system, which..has always endangered the sliding scale in the coal industry, does not exist at all” (p. 150). According to Marshall (in Price 1887), the “cost of raw materials is heavy...As however these prices are subject to very much the same influences as that of iron, the plan of basing the scale on the price of iron simply seems not to work badly” (Marshall, in Price 1887, p. xx). An establishment could produce many different items but all products’ prices were strongly correlated: “when anything goes up on one piece of iron, no matter what its shape, it comes up all along the line in the same degree” (U.S. Industrial Commission, 1901, p. 98); the price of one standard pig iron type “approximates the average price of all the numbers [products] combined” (Munro, 1885, p. 6).

However, for both metals and mining, observers described two problems with the practice of basing wage adjustments on prices taken from employers’ books. First, because of “the time occupied in the clerical work of abstracting, compiling, and checking the return,” wage adjustments had to be based on prices prevailing some weeks earlier (Evans, 1909, p. 128). But that meant when metal products’ prices were rising “the workmen have to wait for the advancement of wages, if there is to be one, to be effected by the regular periodical ascertainment of realised selling prices provided for under the scheme, and this they have often declined to do. Numerous cases might be cited where strikes have occurred owing to the impatience of the workmen in reference to this matter” (Jeans, 1898, pp. 52-53; see also Price, 1887a, p. 52). In the other direction, arbitrators operating one British metals scale made ad-hoc reductions in base wage rates when the scale’s lag put them “in an awkward position - the right of the men to an increase at a time when prices had

declined and were still declining” (Evans, 1909, p. 129). In coalmining:

when prices rise, wages do not follow them until the end of the revision period...the colliers become impatient...their attention is attracted by additional men being drafted into the pits in order that their masters may secure the rise in price over a larger output. They thus become aware that, if not bound by the sliding scale, this would have been a favourable opportunity to press for an advance of wages, and they perhaps throw off the scale (Smart, 1895, p. 94)

To avoid such problems,

The Lancaster Coal Master’s Association felt the necessity of making the scale as sensitive as possible as regards intervals of time, as well as intervals of prices; and hence they altered..the monthly adjustment to a fortnightly adjustment. The difficulty of adjusting wages at short intervals of time lies in the fact that the prices have to be ascertained from employers’ books; and in a large coal firm the frequent examination of books would probably cause much inconvenience (Munro, 1889, p. 144).

Apart from any inconvenience to employers, it took time for the union side to interpret the books. In the coalmining proceeds-sharing scheme of the 1920s, “At first the returns were called for monthly, but, early in 1923, the miners’ leaders urged that two-monthly periods be adopted with a view to enabling the accountants to make a more thorough examination of the accounts” (Bowie, 1927, p. 387).

Second, because firms did not want to reveal sales information to competitors, they insisted that the accountants or committees who examined the books of sampled firms report only the figure for the *average* price or margin used in the wage formula. The calculations and individual firms’ books could be inspected by a small set of union representatives, but not by rank and file members (for example Munro, 1890, p. 170; Jeans, 1898, p. 78; Smart, 1895, p. 66). In U.S. ironworkers’ scales, as described by the union president to the U.S. Industrial Commission, the “manufacturers are very jealous of the prices at which they sell, so that we are in secrecy ourselves. We appoint a committee and they determine it for our men..the manufacturers themselves do not know what the others have sworn to except as they gather it on the outside - on the market” (U.S. Industrial Commission, 1901, p. 96). In a British scale, “even the average price is kept secret, and the rate of

wages due by the scale is alone made known” (Price, 1887a, p. 59). But this meant that most union members could not monitor the process that determined their wage adjustments, even if they had the mathematical skills needed to operate the sliding scale’s formula. In the 1903 anthracite scale, for which the firms’ books were examined by accountants appointed by Federal judges; “its intricacy was a prolific cause of suspicion on the part of the employees...it could not be understood by the great majority of the workers and the increase could not be computed by them or checked up. It created a feeling of suspicion against the operators” (Sydenstricker, 1916, p. 34-35).

Workers were suspicious even when the books were examined by their own accountants and union representatives, especially when the resulting price figures varied from published open-market prices. An ironmaster told the British Industrial Commission that problems arose when employees “saw, say, [a price of] 66 s[hillings per ton] quoted in the newspapers, they only found (I am instancing a specific case) 45 s realized over the quarter” on the employers’ books. The union’s leaders believed the books because they understood the nature of the product market, but they “have behind them a large body of persons not very familiar with the operations of the trade whom they have to persuade” (Great Britain, 1892, volume 1 p. 77).<sup>8</sup> In coal “It is somewhat difficult to convince miners of the necessity, and sometimes even of the existence, of contracts. When market prices of coal rise, and the miner, expecting an advance of wage, is told that half or more of the output of the colliery has been sold for months ahead at the previous low price, it is very natural that

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<sup>8</sup>According to Price (1887a), ironworkers were often suspicious that their union leaders had betrayed them in arbitration about sliding scales and other issues:

the comment of one of the workmen’s delegates at the board upon this is very significant, and can hardly be suspected of excessive exaggeration. “Puddlers,” he says, “as a class are not very intelligent, and if they were very intelligent they would not be puddlers.” We need not therefore be astonished, the wonder would rather be that it should be otherwise, if we meet with evidence..of the difficulty experienced in some instances by the representatives of the men in obtaining the adherence of their constituents to the decisions of the board (p. 23)

he should either disbelieve the figures, or ask by what right his labour has been thus disposed of' (Smart, 1895, p. 95). Considering these problems, the British Industrial Commission concluded: "The only remedy seems to be..that the workmen at large should implicitly trust their representatives, and delegate the fullest powers to them" (Great Britain, 1894, p. 42). The U.S. ironworker's union president claimed that his members "are satisfied with the determination of the thing" by their representatives (U.S. Industrial Commission, 1901, p. 96), but a sufficient degree of trust was obviously lacking in some cases. For the American anthracite scale of 1869, prices were secured by an operator and the president of the W.B.A. [the union] going to Philadelphia to get figures from the books of the selected operators. In October, the committee reported that the price of coal was below \$3 a ton at Port Carbon. The cry was immediately raised that the committee had been bought by the companies, and some collieries went on strike (Roberts, 1901, p. 178)

## **2. What factors limited the spread of sliding scales before the 1930s?**

The accounts of pre-1930s sliding scales that I have described are consistent with the general notion that product-price indexation offers potential benefits to unions and employers but fails to occur partly because workers lack independent information about product prices and materials costs, or because there are extra costs of negotiating product-price indexing clauses. The accounts also help explain the narrow scope of pre-1930s sliding scales, in that they point to specific features of product markets, nonlabor inputs and labor unions that hindered their use in industries that at first appear relatively well-suited to sliding scales, or at least as well-suited as mining and metals.

The Fall River experience, and the usual practice of basing metals and mining scales on figures taken from employers' books rather than available published prices, show that open-market prices for standard products and materials were not necessarily adequate measures of output value and materials cost for a sliding scale. Standard products' prices could be weakly correlated with prices of an employer's other products. Spot prices in market centers could differ significantly from prices received by employers selling through long-term contracts, or subject to transport costs. Spot prices for materials could differ from true materials cost, even in an industry with a relatively simple

input structure like cotton textiles, simply because employers held stocks. Thus, workers' information about product values and nonlabor input costs was incomplete and noisy to a practically significant degree even in an industry with a simple input structure, competitive product market and relatively abundant sources of published price information, such as cotton textiles.

Union leaders and employers found ways to link wages to sale prices on employers' books rather than open-market or list prices. They could structure complex indexing rules with features to deal with noisy price information, such as averaging across individual price observations, ranges for price movements that did not trigger wage adjustments, and maximum wage changes from one period to the next (in addition to minimum and maximum values for wage rates). The administrative costs of such schemes do not appear to have been important deterrents to the use of sliding scales. But the quality of price information taken from employers' books was necessarily limited: it could at best indicate prices prevailing some weeks in the past, because it took time to collect and interpret the figures. More importantly, schemes relying on employers' account books, and perhaps complex indexing rules *per se*, required the union rank and file to accept figures produced by union leaders, whom union members did not always trust to act in their best interests. Thus, apart from the nature of product markets and nonlabor inputs, sliding scales were practically restricted to unions where, for whatever reason, members were willing to delegate tasks of monitoring and interpreting price information to union leaders.

To the degree that these factors limited the scope of pre-1930s sliding scales, they also help explain the lack of product-price indexation in the long-term labor contracts of the postwar U.S. According to Ashenfelter and Johnson (1969), the behavior of postwar unions was affected in costly ways by union members' unwillingness to trust the decisions of better-informed leaders. Long-term sales contracts remained common in goods-producing industries (Blinder et. al., 1998, p. 92-95), while a producer's cost of materials subject to transport and storage costs and uncertainty about future spot prices remains hard to define even in theory, under unrealistically simple assumptions

(Husted and Kollintzas, 1987). The introduction of more BLS wholesale or producer price series may have done little to improve the type of information needed for sliding scales. According to Stigler and Kindahl (1970), wholesale price series published the 1950s and 1960s differed significantly from prices actually received by producers, and indeed bore no stable relation to them (p. 9), for many of the same reasons that prevented unions and employers from using open-market prices in many pre-1930s sliding scales. BLS series were measures of spot prices, while many sales transactions were governed by long-term contracts and firm- (or even transaction-) specific factors such as transport costs.

But that adds to another puzzle. If these factors were *always* present and were important in preventing the use of sliding scales in the postwar U.S., why were sliding scale used at all before the 1930s? To put it another way, why were the potential benefits of sliding scales great enough to overcome the extra costs of negotiating or administering them in at least some industries before the 1930s, but not in the postwar U.S.?

### **3. Why did unions and employers adopt sliding scales before the 1930s?**

#### **3.1 What contemporaries said**

The potential benefits of sliding scales were discussed by many contemporary observers. A few mentioned stabilization of profits and/or employment, the obvious advantages of a sliding scale over fixed wage rates within a long-term contract. In 1882, a British labor arbitrator noted that “in times of depression its tendency must be to enable the capitalist to keep his works going, and his hands employed until brighter times dawn again upon them” (quoted in Price, 1887b, p. 79). The chairman of the U.S. Industrial Commission asserted that a sliding scale “makes labor more stable in its hours and days” (U.S. Industrial Commission, 1901, p. 386). According to a 1940s BLS bulletin, the sliding scale in copper mines “tends to stabilize company earnings and may contribute somewhat toward regularity of employment (U.S. BLS, 1943, p. 8).

However, according to nearly all contemporary observers, the most important reason to adopt a sliding scale - usually, the *only* one mentioned - was to reduce the frequency of strikes and

lockouts, or “industrial warfare” in the language of the time. One judged that “sliding scales have succeeded..in doing that for which they were chiefly proposed, in making the process of distribution more peaceful” (Chapman, 1903, p. 195). According to Munro (1885), sliding scales gave “a steadiness to trade; at least in so far as disputes between employers and employed tend to render trade unsteady” (p. 26). According to Marshall, “The Sliding Scale, when working at its best, arranges that those influences which short-period fluctuations in the price of a commodity are bound to exercise on the current wages (the Quasi-rents) of the labour by which they are made, shall work themselves out smoothly and easily” (quoted in Price, 1895, p. 63). Similar statements include Great Britain (1894, p. 41), U.S. Industrial Commission (1901, p. 344), Price (1901, p. 239), Pool (1938, p. 172). Indeed, one objection to the sliding scale expressed by unionists was that “whilst the scale lasts, it renders the chief work of the union superfluous” (Great Britain, 1894, p. 43; see also Arnot, 1949, p. 60-61).

By all accounts, the unions and employers that actually adopted sliding scales did so in order to reduce the frequency of strikes. Jevons (1915) describes the development of the sliding scale in British coalmining:

During the nineteenth century, whenever a slump of trade set in, coal owners found the margin of profit being turned into a loss, and were forced to try and economise by reducing wages. More often than not this led to a strike, in which the men had to give way,..The men, finding that they had to accept a reduction of wages from time to time, took care to agitate for an increase when trade improved, with the result that there were sometimes also strikes when trade was improving as well as when it was collapsing..a colliery owner would give way after resistance because with increasing prices there was ample room for higher wages.

The frequency with which labour disturbances arose solely from the rise and fall of the market, led to a general desire to make some arrangement between masters and men which would allow for, and regulate, changes in wages in accordance with the state of trade.

After a good deal of local discussion, the idea of the Sliding Scale, in which wages varied automatically with the price of coal, took definite shape (p. 490).

Read (1894) argued that sliding scales were used in the coal mines of South Wales at times when they had been rejected in other mining areas because the peculiar market for South Wales coal made

strikes especially costly (p. 332; see also Morris and Williams 1960, p. 175). Sydney and Beatrice Webb (1897) claimed that arbitrators' decisions based on sliding scales were especially likely to be accepted without a strike (pp. 232-33).

It was often claimed that a particular sliding scale had effected wage cuts that would have taken place otherwise only after strikes (for example Smart, 1895, p. 64; Birkett, 1922, p. 156; Pool, 1938, pp. 172-173), or that the use of sliding scales had reduced the frequency of strikes in an otherwise strike-prone industry (Jeans, 1894, p. 75; Price, 1887a, p. 79). In Fall River textiles, the first sliding scale had been adopted soon after the "Great Strike of 1904", when workers struck for nearly six months because employers had cut wages 12.5 percent following a prolonged decrease in demand for their cloth (Howard, 1920, p. 20). The second sliding scale was in force when the demand for output fell again after the Panic of 1907.

The events of the next six months, ending in May 1908, illustrate best of all the chief benefit to be derived from a sliding scale of wages...the sullen preparations for resistance to an expected reduction of wages, which usually marked a sharply declining market, were entirely absent..When on May 25 the time again came for the semiannual adjustment of wages,...it was found that [the scale] called for a reduction in wages..amounting to a general reduction in wages of all the workers of 17.94 per cent (Lincoln, 1909, p. 463).

There was no strike, even though this was "the heaviest reduction that has ever been made at one time in the history of Fall River" (Massachusetts Bureau of Labor Statistics, 1908, p. 260).

### ***3.2 Sliding scales and strikes in theory***

Why did contemporaries describe sliding scales in this way? Before the 1930s, agreements between unions and employers were not binding contracts. As far as the state was concerned, employees were equally free (or equally forbidden) to strike whether or not they had a written agreement with the employer (Tomlins, 2000, 659-687). A concern for reputation may have discouraged some unions from striking within the term of a fixed-duration agreement (for example Arnot, 1949, p. 135), and some employers "feel that a more settled condition of the trade would obtain under a long term wage contract" (Robinson, 1920, p. 149; see also Price, 1887a, p. 46),

suggesting they believed agreements had some force. But it is easy to find examples of unions abandoning agreements and going on strike before the end of an agreed-upon duration (such as Fisher 1942, p. 283; Read, 1894, p. 334; Jeans, 1894, p. 53), and, as noted above, many agreements had no fixed duration. Overall, it appears that most agreements between unions and employers were under a constant threat of renegotiation and strikes (or lockouts).

Over the late 1930s and 1940s, this condition changed in the United States, though not in Britain (Shackleton, 1998), as a result of the Wagner Act of 1935, the Taft-Hartley Act of 1947 and related court decisions. A union that strikes in violation of a contract recognized by the National Labor Relations Board faces significant penalties (Mills and Brown, 1950, pp. 470-513). After the Second World War, “the underlying goal of bargaining strategy..was to minimize industrial strife by negotiating long-term contracts...a multi-year contract without periodic reopenings” (Garbarino, 1962, p. 10), “to avoid repeated negotiations and potential strikes” (p. 81). Contracts with liberal re-opener clauses became extremely rare (p. 117), while fixed durations as long as three years became common in steel and mining, as well as other industries (Taylor, 1983, Table 5). Long-term contracts that protected employers against strikes tended to promote capital investment in the enterprise. In the late 1950s, for example, steel firms pushed for a longer-term contract because “The industry had underway a substantial program of long-range capital investment and desired to avoid strikes as well as wide fluctuation of production and prices while the program was being effectuated” (Livernash, 1961, p. 295); a three-year contract allowed the industry to “go ahead with its expansion and modernization program without fear of industrial warfare” (p. 299).

Existing theoretical literature on employment bargaining and contracts, with assumptions tailored to match post-1930s U.S. conditions, implies no direct relation between strikes and product-price indexation. In “asymmetric-information” models of strikes such as Hayes (1984) and Cramton and Tracy (1992), strikes can occur if one side or the other has private information about the value of the employment transaction, such as managers’ view of product demand. “Profitable firms lose

more from a strike than unprofitable firms and hence will settle early for high wages, while unprofitable firms will be prepared to delay agreement until wages fall. The reason that the parties cannot do better by avoiding the strike and sharing the gains from increased production is that there is no way for an unprofitable firm to ‘prove’ that it is unprofitable except by going through a costly strike” (Hart, 1989, p. 25). From the union’s point of view, a strike threat is part of “a mechanism that allows workers to extract higher wages from more profitable employers” (Card, 1990). For an employer, a strike is a cost of pressing down wages worth paying (only) when the value of the union’s labor is relatively low. Unions and employers that sign long-term contracts give up the ability to adjust wages to subsequent conditions through the strike mechanism, presumably in order to gain something else, such as a solution to a “hold-up” problem (Williamson, 1985): if the union is free to extract the highest possible wages *after* the employer has incurred sunk costs, the employer will refrain from some fixed investments that could increase both wages and profit. Grout (1984) shows that the union’s wage gain from attracting more capital to the enterprise can be enough to bring about a long-term contract, even in the absence of strike costs. Finally, a union and employer can consider product-price indexation as an element of their long-term contract. Thus, except for unions and employers that would be unwilling to enter long-term contracts *without* sliding scales, the alternative to a sliding scale is a long-term contract without product-price indexation, not continual bargaining subject to strikes. The negotiators will adopt a sliding scale only if its extra costs are exceeded by the benefits of product-price indexation described by models of long-term employment contracts. Any benefits of avoiding strikes *per se* do not enter this reckoning, as they also accrue to a long-term contract without product-price indexation.

I argue that the potential role of a sliding scale was different in the pre-1930s U.S. and Britain, where unions were unable to enter binding contracts. In the absence of a long-term contract, an employer with private information about product demand, faced with a properly-designed sliding scale, would choose a level of employment with resulting wages that were at least as good - perhaps

better - for union members *and* employers as those that would eventually result from continual bargaining over fixed wage rates, subject to strikes. But there could be *no strikes* under the sliding scale, apart from strikes caused by private information about factors other than product demand. In other words, a sliding scale could serve like strike threats to reveal the employer's private information about the current state of product demand, but at lower cost. This explains why contemporaries described sliding scales as devices to prevent strikes.

It also helps explain why sliding scales were used in at least some industries before the 1930s, but not in the postwar U.S. Because a sliding scale prevented strikes, it gained some of the benefits that accrued to long-term union contracts *per se* in the postwar U.S., such as attracting more capital to the enterprise. These benefits of avoiding strikes are an *extra* reason to adopt a sliding scale when unions cannot enter long-term contracts. Thus, in some industries the potential benefits of sliding scales were great enough to overcome the extra costs of negotiating or administering them before the 1930s, but not when unions had the option of long-term contracts.

To make my argument, I present a model in the next section of the paper. The variables in the model denoting wages, prices and product-demand shocks can be assumed to be denominated in money, or in consumption goods. Under the latter assumption, the model's "fixed wages" correspond to wages indexed to consumption-good prices only, while "sliding-scale" wages are indexed to consumption-good prices *and* the product price.

The model is meant to illustrate the role of a sliding scale as a device to avoid strikes in an environment where unions cannot sign long-term contracts, and to demonstrate that the potential advantages of a sliding scale are smaller in an environment where unions can sign long-term contracts, *apart from* information imperfections and any special costs of negotiating or operating product-price indexation. Thus, I assume for simplicity that union members have perfect information about product prices and materials costs, and there are no costs of operating any kind of contract. Other assumptions are chosen to match the simplest asymmetric-information strike models: the union proposes terms of employment which the employers can accept or reject (making

this a “screening” model in the terms of Kennan and Wilson [1990]), and the union can commit itself to strike for an interval of time or equivalently there is a fixed interval between the union’s offers (for a discussion of this see Hart [1989]). Specific assumptions about product-market structure and union rules are chosen to reproduce features of historical sliding scale agreements. Agreed-upon terms of employment set the wage per worker and leave employers free to choose the employment level, rather than set employment levels or structure payments to achieve efficient levels of employment (for a discussion of this point see Farber [1986]). Finally, I assume that the union negotiates with a group of employers who otherwise behave competitively in their product market. This is realistic for some cases of sliding scales. An assumption that the union bargains with a product-market monopolist or cartel is more complicated, but gives similar results.<sup>9</sup>

In the text I present only the assumptions and results of the model. The appendix gives details.

## **4. Model**

### ***4.1 General assumptions and notation***

The industry is a set of many identical profit-maximizing, risk-neutral firms that produce a homogenous, nonstorable good. Time is divided into three periods. In period zero each firm chooses its capital stock  $K$  subject to a unit cost of capital (or required expected return)  $\underline{R}$ . In each of the following two periods - period one and period two - a firm’s capital stock remains fixed while it can produce output  $Y$  from labor and a raw material. A unit of output requires one unit of the raw material, while capital and labor are subject to diminishing marginal productivity. The cost of the

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<sup>9</sup>Results are similar as long as short-run marginal cost is increasing and the firm’s profit-maximizing price markup over marginal cost is constant, or increasing with the firm’s own output. They are more complicated in that, with or without long-term contracts, the sliding scale has the extra advantage extensively discussed by Weitzman (1984): because a sliding scale makes the marginal cost of labor to the firm a decreasing function of employment, it allows the union to engage in a form of price-discrimination that improves the available combinations of wages and employment.

raw material relative to the product price is  $M < 1$ . Labor can be hired on an open competitive market at a going wage  $\underline{W}$  per period, or from a set of workers belonging to a union. Effective labor input is higher if the firm employs the members of the union (perhaps because they have special skills, or because they are incumbents and it is costly to bring new workers into a firms' plants). Thus, if a firm employs union members its production function is:

$$Y = \min(X, K^\Theta L^\Lambda) \quad \text{where } \Lambda + \Theta < 1 \quad (1)$$

where  $X$  is the number of units of raw material and  $L$  is the number of workers employed. If the firm does *not* employ the union members, the production function is:

$$Y = \min(X, K^\Theta (L/\Phi)^\Lambda) \quad \text{where } \Phi > 1 \quad (2)$$

In addition to costs of labor and materials, a firm is subject to a fixed operating cost  $\Omega > 0$  every period in which production takes place. The quantity of a firm's output demanded in each period is:

$$Y^D = (D/P)^\Gamma \quad \text{where } \Gamma > 1 \quad (3)$$

where  $P$  is the price of the good and  $D$  is a demand variable. As of period zero, the value of  $D$  and the raw materials cost  $M$  that will prevail in periods one and two are uncertain.

The members of the union can coordinate their behavior in a limited way: they can make a common demand - a take-it-or-leave-it offer - of employment conditions to the firms in the industry, and commit to withdraw their labor for a period if the firms do not accept this demand. If the firms accept the union's demanded conditions but choose to employ fewer workers than the number of union members, union members are laid off in a predetermined order (for example, by seniority). Any union demand must be approved by a certain number  $N$  of union members - for example, just more than half the members under majority rule, or *all* of the members if union actions require a consensus. Each member acts to maximize the expected value of his wage income. The union

cannot enforce transfers of income between members, or prevent a member from leaving the union to take employment on the outside competitive labor market.

The firms in the industry are *unable* to collude in product sales or capital investment, but they *can* respond to the union's demands as a group to maximize expected profit. If the firms do not accept the union's demand, they can replace the union workforce with new workers hired from the outside labor market, in which case they pay the going wage  $\underline{W}$  and produce according to expression (3), while union members must take other jobs at the going wage. Alternatively, they can wait for another offer from the union, in which case there is a *strike*: for one period union members receive no labor income (they cannot take other jobs during a strike) while the firms' plants are closed, producing no output and incurring no costs other than the required return to capital, but losing the period's potential sales.

What would happen if the firms accepted a fixed wage  $W$  in period one or two? Each firm would produce the quantity of output that equates price to marginal cost with labor cost  $W$ , taking as given the capital stock installed in period zero. The resulting level of employment per firm would be:

$$L(W, Z, K) = \left[ \Lambda^\Gamma K^{(\Gamma-1)\Theta} \left( \frac{Z}{W} \right)^\Gamma \right]^{\frac{1}{\Lambda + \Gamma(1-\Lambda)}} \quad \text{where} \quad Z = D (1-M)^{\frac{\Gamma-1}{\Gamma}} \quad (4)$$

$Z$  summarizes the effects of product demand and raw materials cost on the firms' demand for labor. Assume that  $Z$  can take one of two values: a high value  $Z_H$  and a low value  $Z_L$ . This would be true if, for example, product demand  $D$  takes two values, high or low, while low product demand is sometimes offset by low raw materials prices. As of period zero, the probability that  $Z$  will turn out to be low is  $\Pi$ .

What fixed wage rate would the union demand if workers could observe the realized value of  $Z$ , taking the capital stock as given? The union would demand the highest wage that ensures

employment to the marginal member. If  $Z$  is high, that is the wage for which expression (4) equals  $N$  for  $Z = Z_H$ , unless that wage exceeds an upper bound  $\underline{W}\Phi$  - the wage that would make it cheaper for the firms to hire replacement workers. To simplify notation, we can scale the other variables to  $N$  so that the marginal member is employed as long as  $L \leq 1$ . Thus the union's wage in a state of high labor demand would be:

$$W_H(K) = \Lambda K^{\frac{(\Gamma-1)\Theta}{\Gamma}} Z_H \quad \text{for} \quad \Lambda K^{\frac{(\Gamma-1)\Theta}{\Gamma}} Z_H < \underline{W}\Phi \quad (5)$$

$$W_H(K) = \underline{W}\Phi \quad \text{otherwise}$$

If  $Z$  is low, the union's wage demand would be subject to the *lower* bound  $\underline{W}$ :

$$W_L(K) = \Lambda K^{\frac{(\Gamma-1)\Theta}{\Gamma}} Z_L \quad \text{for} \quad \Lambda K^{\frac{(\Gamma-1)\Theta}{\Gamma}} Z_L > \underline{W} \quad (6)$$

$$W_L(K) = \underline{W} \quad \text{otherwise}$$

Assume, however, that the workers *cannot* observe the realized value of  $Z$ .

## 4.2 Outcomes

The outcome of bargaining between the union and the employers depends on whether the workers can observe the product price and raw materials cost, so that the union can offer a sliding scale. The outcome also depends on whether the union can bind its future behavior in a contract. If it can enter a contract and does so in period zero, firms choose the capital stock assuming that the contract's terms will hold and there will be no strikes. If the union *cannot* enter a contract, firms must choose the capital stock in period zero based on a rational expectation of the relation between the installed capital stock and the union's bargaining behavior in the subsequent periods, while the union takes the capital stock as given in subsequent bargaining with the firms.

### 4.2.1 Fixed-wage bargaining and strikes in the absence of contracts

Suppose that the union cannot sign a contract *or* offer the firms a sliding scale. Then for a range of values for the model's parameters, firms will install a capital stock  $K_{STR}$  in period zero, correctly expecting the following sequence of events. In period one, the union will demand  $W_H(K_{STR})$ : the highest wage that allows for employment of the marginal member given  $K_{STR}$  assuming  $Z$  is high. If  $Z$  is indeed high, the firms will accept this demand in the first period; in the second period the union will make the same demand and the firms again accept it. If  $Z$  is *low* the firms will reject the union's first demand but continue to negotiate: there is a *strike*. After a strike, in the second period the union will cut their wage demand down to  $W_L(K_{STR})$  : this is the highest wage that allows for employment of the union member for low  $Z$  . The firms accept the second offer. Looking forward from period zero, the union member's expected wage income is:

$$I_{STR}^e = (1-\Pi) W_H(K_{STR}) + \frac{\Pi}{2} W_L(K_{STR}) \quad (7)$$

Meanwhile firms choose the capital stock to equate the required real return  $\underline{R}$  to the expected value of the marginal product of capital accounting for the probability of a strike, which means:

$$K_{STR} = \left( \Lambda^{\Lambda(\Gamma-1)} \left( \frac{\underline{R}}{\Theta} \right)^{-\Lambda-\Gamma(1-\Lambda)} \left[ (1-\Pi) Z_H^\Gamma W_H(K_{STR})^{-\Lambda(\Gamma-1)} + \frac{\Pi}{2} Z_L^\Gamma W_L(K_{STR})^{-\Lambda(\Gamma-1)} \right] \right)^{\frac{1}{\Theta+\Lambda+\Gamma(1-\Theta-\Lambda)}} \quad (8)$$

The next-best strategy available to the union would have been to offer the low wage  $W_L(K_{STR})$  immediately in the first period. Any wage demand *less* than  $W_H(K_{STR})$  but *greater* than  $W_L(K_{STR})$  would just reduce the marginal member's income in the event that  $Z$  is high, without gaining him first-period employment when  $Z$  is low. The union follows the strike strategy because  $W_L(K_{STR})$  is less than (7).

#### 4.2.2 Fixed-wage contracts

Now assume that the union can offer the firms a long-term contract, but not a sliding scale, in period zero. If the firms reject the contract offer, the union reverts to wage demands in periods

one and two as described above. Within a range for the model's parameters (again, see the appendix), in period zero the union will offer the firms a contract wage equal to  $W_L(K_{CON})$ , that is the highest wage that ensures the marginal member's employment in the event that  $Z$  is low, given the capital stock  $K_{CON}$  that firms choose in response to the contract. This is the only possible contract, because the firms will not accept a contract wage unless it is less than  $W_H(K_{STR})$  - otherwise, better to bargain without a contract - while the union will never offer a contract wage less than  $W_H(K_{STR})$ , but greater than  $W_L(K_{CON})$  - that would just reduce the marginal member's income in the event that  $Z$  is high, without gaining him first-period employment when  $Z$  is low.

$W_L(K_{CON})$  can exceed  $I_{STR}^e$ , even though  $I_{STR}^e$  exceeds  $W_L(K_{STR})$ , because  $K_{CON}$  exceeds  $K_{STR}$ : firms invest more if they have a contract.  $K_{CON}$  satisfies:

$$K_{CON} = \left( \Lambda^{\Lambda(\Gamma-1)} \left( \frac{R}{\Theta} \right)^{-\Lambda-\Gamma(1-\Lambda)} \left[ (1-\Pi) Z_H^\Gamma W_L(K_{CON})^{-\Lambda(\Gamma-1)} + \Pi Z_L^\Gamma W_L(K_{CON})^{-\Lambda(\Gamma-1)} \right] \right)^{\frac{1}{\Theta+\Lambda+\Gamma(1-\Theta-\Lambda)}} \quad (9)$$

(9) must be greater than (8) for two reasons: under the contract there are no strikes, and the union forgoes the ability to extract a higher wage when the value of labor is especially high.

#### 4.2.3 Sliding scales

What if the union *cannot* sign a binding contract but the workers *can* observe the product price and materials cost? Then under any parameter values the marginal union member is better off if the union demands a sliding scale rather than fixed wage rates. The sliding scale that maximizes the marginal member's expected earnings, taking the capital stock as given, is:

$$\begin{aligned} W_{SS} &= \Lambda K_{SS}^\Theta (P - P_M) \quad \text{for} \quad \underline{W} \leq \Lambda K_{SS}^\Theta (P - P_M) \leq \underline{W}\Phi & (10) \\ W_{SS} &= \underline{W} \quad \text{for} \quad \Lambda K_{SS}^\Theta (P - P_M) < \underline{W} \\ W_{SS} &= \underline{W}\Phi \quad \text{for} \quad \Lambda K_{SS}^\Theta (P - P_M) > \underline{W}\Phi \end{aligned}$$

where  $K_{SS}$  is the capital stock firms chose in period zero anticipating a sliding scale. Note that (10) matches the form of many historical sliding scales: the wage is scaled to the manufacturer's margin - the product price *less* materials cost - with a minimum and a maximum.

Subject to this sliding scale, the employment level chosen by each firm, taking the wage and product price as given, is sufficient to ensure employment to the marginal union member, while the resulting wage depends on the realization of  $Z$ . In the event that  $Z$  is high, the sliding-scale wage  $W_{SS}$  is equal to  $W_H(K_{SS})$ , that is the wage that would have been gained by the fixed-wage strike strategy *given* a capital stock  $K_{SS}$ . If  $Z$  is low, the sliding-scale wage will equal  $W_L(K_{SS})$ , that is, the wage the union would eventually receive, given  $K_{SS}$ , following a strike. But *there will be no strikes under the sliding scale*. The firms will always accept the union's sliding-scale demand in the first period, even in the event that  $Z$  is low: because the sliding scale will deliver the low wage in that event, firms have nothing to gain by waiting for a second offer. Once the firms have revealed the state of demand through the sliding scale wage, the union has nothing to gain by demanding a different wage in the second period.

Looking forward from period zero, anticipating no strikes, firms choose a capital stock that satisfies:

$$K_{SS} = \left( \Lambda^{\Lambda(\Gamma-1)} \left( \frac{R}{\Theta} \right)^{-\Lambda-\Gamma(1-\Lambda)} \left[ (1-\Pi) Z_H^\Gamma W_H(K_{SS})^{-\Lambda(\Gamma-1)} + \Pi Z_L^\Gamma W_L(K_{SS})^{-\Lambda(\Gamma-1)} \right] \right)^{\frac{1}{\Theta+\Lambda+\Gamma(1-\Theta-\Lambda)}} \quad (11)$$

This defines a capital greater than the capital stock subject to strikes in (8). (At any given values of  $W_H$  and  $W_L$ , (11) implies a higher value of  $K$ .) The marginal union member's expected labor income is:

$$I_{SS}^e = (1-\Pi) W_H(K_{SS}) + \Pi W_L(K_{SS}) \quad (12)$$

which means:

$$I_{SS}^e - I_{STR}^e = \frac{\Pi}{2} W_L(K_{STR}) + (1-\Pi)(W_H(K_{SS}) - W_H(K_{STR})) + \Pi(W_L(K_{SS}) - W_L(K_{STR})) \quad (13)$$

$I_{SS}^e$  exceeds  $I_{STR}^e$  for two reasons. As shown by the first term on the right-hand side, in the event that  $Z$  is low the sliding scale allows the union member to receive the low wage, rather than nothing, in the first period. As shown by the remaining terms, he will also gain the general increase in wages resulting from a greater capital stock. *Both of these reasons can be described as consequences of the elimination of strikes.*

Finally, suppose that the workers can observe the product price and materials cost, *and* the union can sign a long-term contract. Under these circumstances, for any parameter values the result of bargaining must be a sliding scale rather than fixed wage rates, consistent with standard models of contract indexation. The best sliding scale for the marginal union member is exactly the same as the scale the union would offer *absent* a contract. This is because there are no strikes under the sliding scale, with or without a contract. The only way the union could attract more capital to the firms through a long-term contract would be to commit to a sliding scale that would deliver a lower wage in at least one state of  $Z$ , which cannot make the marginal member better off. But note that the advantage to the union member of a sliding scale over a fixed-wage contract must be *smaller* than the advantage of a sliding scale over continuous bargaining subject to strikes:  $I_{SS}^e - W_L(K_{CON})$  must be smaller than  $I_{SS}^e - I_{STR}^e$ , simply because  $I_{STR}^e < W_L(K_{CON})$  (otherwise, the union would not be willing to sign a fixed-wage contract). Thus, *the advantage of a sliding scale is smaller if a union can sign a long-term fixed-wage contract, and would choose to do so in the absence of sliding scales.*

## 5. Conclusion

Pre-1930s sliding scales were not adopted for the reasons suggested by modern theories of long-term employment contracts, but rather to avoid strikes caused by employers' private information about the current state of product demand in an environment where unions did not have

the option of long-term fixed-wage contracts. This explains why contemporaries described sliding scales as devices to prevent strikes. It also helps explain why some unions and employers adopted sliding scales before the 1930s, but not in the postwar U.S. The potential advantages of sliding scales over continual bargaining subject to strikes are greater than the advantages of sliding scales over long-term fixed-wage contracts (or contracts indexed to consumption-goods prices alone). Thus, any special costs of operating sliding scales or limits on workers' information could be enough to block the use of sliding scales in the postwar U.S., but not in the pre-1930s U.S. or Britain.

Outside the mining and metals industries, sliding scales were rare or short-lived primarily because it was hard for rank-and-file union members to observe product prices and materials costs, even in industries where outputs and materials were homogenous goods with observable open-market prices. Open-market prices for standard products could be significantly different from prices actually received by any employer, because most production was for long-term sales contracts rather than spot markets, or there were significant transport costs to market centers, or standard products' prices were only weakly correlated with prices of other industry products. Spot prices for materials could differ from true materials cost simply because employers held stocks. Prices could be taken from employers' books rather than from spot markets. But this required suspicious union members to trust figures produced by their leaders or other representatives delegated to monitor and interpret the information on the books. Consequently, industries that at first glance appear suited to the use of sliding scales, or at least as well-suited as mining and metals, may actually have been ones where the potential benefits from adopting sliding were no greater than in ladies' hats or shipbuilding.

Though I have argued that pre-1930s sliding scales were not examples of long-term contract indexation, the historical experience with sliding scales does help explain the absence of sliding scales in postwar U.S. union contracts, as the factors that limited the use of sliding scales before the 1930s remained present despite the introduction of better wholesale price indexes.

### Appendix: Model details

Starting from expression (3) in the text, the variable cost of production in a period at a fixed wage  $W$  is:

$$C = \Omega + MPY + WL = \Omega + MPY + W Y^{\frac{1}{\Lambda}} K^{-\frac{\Theta}{\Lambda}} \quad (14)$$

This is less than the cost of producing with a replacement workforce as long as  $W < \underline{W} \Phi$ . Taking the capital stock as given, setting the product price equal to marginal cost  $\partial C/\partial Y$  determines the quantity of output for the period as a function of the wage, the capital stock, product demand and the relative price of raw materials. The resulting product price is:

$$P(W,Z,K) = \left[ \Lambda^{-\Lambda} K^{-\Theta} Z^{\Gamma(1-\Lambda)} W^{\Lambda} \right]^{\frac{1}{\Lambda+\Gamma(1-\Lambda)}} \quad (15)$$

The marginal revenue product of capital, taking the product price as given, is:

$$R(W,Z,K) = P \frac{\partial Y}{\partial K} = \Theta \left[ (\Lambda/W)^{\Lambda(\Gamma-1)} K^{-(\Theta+\Lambda)-\Gamma(1-\Theta-\Lambda)} Z^{\Gamma} \right]^{\frac{1}{\Lambda+\Gamma(1-\Lambda)}} \quad (16)$$

A firm's operating profit *before* deducting the fixed operating cost is:

$$OP(W,Z,K) = \Lambda^{\frac{1}{\Lambda+\Gamma(1-\Lambda)}} (\Lambda^{\Lambda(\Gamma-1)} - \Lambda^{\Gamma}) \left[ K^{(\Gamma-1)\Theta} Z^{\Gamma} W^{-\Lambda(\Gamma-1)} \right]^{\frac{1}{\Lambda+\Gamma(1-\Lambda)}} \quad (17)$$

and employment is given by expression (4) in the text.

For strikes to occur it must be true that the marginal union member is willing to run the danger of a strike rather than immediately offer  $W_L(K_{STR})$ . This requires:

$$I_{STR}^e - W_L(K_{STR}) = -\frac{\Pi}{2} W_L(K_{STR}) + (1-\Pi) (W_H(K_{STR}) - W_L(K_{STR})) > 0 \quad (18)$$

It must also be true that the firms accept the union's first offer if and only if demand is high, and

accept the second offer if demand is low. These conditions require:

$$OP(W_L, Z_L, K_{STR}) - \Omega > 0 \quad (19)$$

$$OP(W_H, Z_H, K_{STR}) - \Omega > OP(W_L, Z_H, K_{STR}) - OP(W_H, Z_H, K_{STR}) \quad (20)$$

$$OP(W_H, Z_L, K_{STR}) - \Omega < OP(W_L, Z_L, K_{STR}) - OP(W_H, Z_L, K_{STR}) \quad (21)$$

Assuming that these conditions are satisfied so that strikes occur, in period zero firms choose  $K^{STR}$  such that:

$$\underline{R} = (1-\Pi) R(W_H(K_{STR}), Z_H, K_{STR}) + \frac{\Pi}{2} R(W_L(K_{STR}), Z_L, K_{STR}) \quad (22)$$

Substituting (16) into (22) gives (8) in the text. The condition that  $W_L(K_{CON})$  exceeds  $I_{STR}^e$ , so that the union offers a fixed-wage contract, is:

$$W_L(K_{CON}) - I_{STR}^e = \frac{\Pi}{2} W_L(K_{STR}) - (1-\Pi)(W_H(K_{STR}) - W_L(K_{STR})) + (W_L(K_{CON}) - W_L(K_{STR})) > 0 \quad (23)$$

The parameter ranges that satisfy (23) along with (18)-(21) depend on whether the union's wage demands are always within the upper and/or lower bounds determined by  $\underline{W}$  and  $\underline{W}\Phi$ , or are sometimes at a bound. Rather than go through all the possibilities, I show that the conditions *can* hold by examining the case where the wages are always within the bounds. For that case:

$$K_{STR} = \left( \frac{\Theta Z_L}{\underline{R}} \left[ (1-\Pi) \frac{Z_H}{Z_L} + \frac{\Pi}{2} \right] \right)^{\frac{\Gamma}{\Gamma - (\Gamma-1)\Theta}} \quad (24)$$

$$W_H(K_{STR}) = \Lambda \left( \frac{\Theta Z_L}{R} \left[ (1-\Pi) \frac{Z_H}{Z_L} + \frac{\Pi}{2} \right] \right)^{\frac{(\Gamma-1)\Theta}{\Gamma - (\Gamma-1)\Theta}} Z_H \quad (25)$$

$$W_L(K_{STR}) = \Lambda \left( \frac{\Theta Z_L}{R} \left[ (1-\Pi) \frac{Z_H}{Z_L} + \frac{\Pi}{2} \right] \right)^{\frac{(\Gamma-1)\Theta}{\Gamma - (\Gamma-1)\Theta}} Z_L \quad (26)$$

$$OP(W_L, Z_L, K_{STR}) = \Lambda^{\frac{1-(\Gamma-1)\Lambda}{\Gamma-(\Gamma-1)\Lambda}} (\Lambda^{\Lambda(\Gamma-1)} - \Lambda^\Gamma) \left( \frac{\Theta Z_L}{R} \left[ (1-\Pi) \frac{Z_H}{Z_L} + \frac{\Pi}{2} \right] \right)^{\frac{(\Gamma-1)\Theta}{\Gamma-(\Gamma-1)\Theta}} Z_L \quad (27)$$

$$I_{STR}^e = \Lambda K_{STR}^{\frac{(\Gamma-1)\Theta}{\Gamma}} \left[ (1-\Pi) Z_H + \frac{\Pi}{2} Z_L \right] = \Lambda \left( \frac{\Theta}{R} \right)^{\frac{(\Gamma-1)\Theta}{\Gamma-(\Gamma-1)\Theta}} \left[ (1-\Pi) Z_H + \frac{\Pi}{2} Z_L \right]^{\frac{\Gamma}{\Gamma-(\Gamma-1)\Theta}} \quad (28)$$

Expression (19) requires:

$$(1 - \Pi) \left( \frac{Z_H}{Z_L} \right) + \frac{\Pi}{2} > 1 \quad (29)$$

Expressions (20)-(23) require:

$$Z_H/Z_L < 2^{\frac{\Lambda(\Gamma-1)}{\Gamma-(\Gamma-1)\Lambda}} \quad (30)$$

$$2 \left( \frac{Z_H}{Z_L} \right)^{\frac{-\Lambda(\Gamma-1)}{\Lambda+\Gamma(1-\Lambda)}} - 1 < \frac{\Omega}{OP(W_L, Z_L, K_{STR})} < \left( \frac{Z_H}{Z_L} \right)^{\frac{\Gamma}{\Lambda+\Gamma(1-\Lambda)}} \left( 2 \left( \frac{Z_H}{Z_L} \right)^{\frac{-\Lambda(\Gamma-1)}{\Lambda+\Gamma(1-\Lambda)}} - 1 \right) \quad (31)$$

$$\frac{\Omega}{OP(W_L, Z_L, K_{STR})} < 1 \quad (32)$$

Either (32) or the left-hand side of (31) may be binding. Expression (23) requires:

$$(1 - \Pi) \left( \frac{Z_H}{Z_L} \right) + \frac{\Pi}{2} < \left( (1-\Pi) \left( \frac{Z_H}{Z_L} \right)^{\frac{\Gamma}{\Gamma-(\Gamma-1)\Lambda}} + \Pi \right)^{\frac{(\Gamma-1)\Theta}{\Gamma}} \quad (33)$$

where:

$$K_{CON} = \left( \frac{\Theta Z_L}{R} \left[ (1-\Pi) \left( \frac{Z_H}{Z_L} \right)^{1 + \frac{(\Gamma-1)\Lambda}{\Lambda + \Gamma(1-\Lambda)}} + \Pi \right] \right)^{\frac{\Gamma}{\Gamma - (\Gamma-1)\Theta}} \quad (34)$$

The point is that (33) can hold *along with* (29): the union offers a long-term fixed-wage contract even though, in the absence of a contract, the marginal union member would rather risk a strike than offer the low wage right off.

Finally, under the sliding scale:

$$K_{SS} = \left( \frac{\Theta Z_L}{R} \left[ (1-\Pi) \frac{Z_H}{Z_L} + \Pi \right] \right)^{\frac{\Gamma}{\Gamma - (\Gamma-1)\Theta}} \quad (35)$$

and:

$$I_{SS}^e - I_{STR}^e = \frac{\Pi}{2} W_{L,K_{STR}} + \left( (K_{SS}/K_{STR})^{\frac{(\Gamma-1)\Theta}{\Gamma}} - 1 \right) \left( (1-\Pi)W_{H,K_{STR}} + \Pi W_{L,K_{STR}} \right) \quad (36)$$

$$\text{where } K^{SS}/K^{STR} = \left( \frac{(1-\Pi)\frac{Z_H}{Z_L} + \Pi}{(1-\Pi)\frac{Z_H}{Z_L} + \frac{\Pi}{2}} \right)^{\frac{\Gamma}{\Gamma - \Theta(\Gamma-1)}} > 1$$

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