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The Scandinavian model—an interpretation*

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Abstract

The small open economies in Scandinavia have for long periods had high work effort, small wage differentials, high productivity, and a generous welfare state. To understand how this might be an economic and political equilibrium we combine models of collective wage bargaining, creative job destruction, and welfare spending. The two-tier system of wage bargaining provides microeconomic efficiency and wage compression. Combined with a vintage approach to the process of creative destruction we show how wage compression fuels investments, enhances average productivity and increases the mean wage by allocating more of the work force to the most modern activities. Finally, we show how the political support of welfare spending is fueled by both a higher mean wage and a lower wage dispersion.

1 Introduction

The Scandinavian countries have done well. Both Norway and Sweden experienced higher growth than the US from 1930 to 2010.[1] Among European countries Denmark rank three, Sweden four, and Norway seven in terms of the share of occupations that intensively use information and communication technologies, all outperforming the US.[2] Scandinavian

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[1]While the US GDP per capita was 4.9 times larger in 2010 than in 1930, Norway's was 6.2, and Sweden's was 6.0 times the 1930 level. The Danish GDP became 4.4 times larger over the same period. Data from `http://www.ggdc.net/Maddison`, first update. Index based on 1990(GK)USD. The Norwegian figure for 2010 is adjusted with the ratio of mainland GDP to total GDP as reported by Statistics Norway, in order to remove oil and gas revenues. One should, however, expect convergence towards the leading country and one may argue that Scandinavia has been slow compared to how fast many Asian countries have been catching up in recent decades.

[2]OECD key Information and Communication Technologies (ICT) indicators. In the Boston Consulting Group's e-intensity index ranking, Denmark is number 2, Sweden number 3, and Norway number 8 in 2012.

Table 1: Employment Population Rates 2007. Percent.

	15-64	15-24	55-64	25 - 54		Ratio Below Upper
				Women	Men	/ Tertiary
Denmark	77.1	65.3	58.6	82.4	90.2	0.76
Norway	76.9	55.1	69.0	82.3	89.2	0.73
Sweden	75.7	46.3	70.1	83.0	89.0	0.75
European Union 15	67.0	41.6	46.4	71.3	87.8	0.63
United States	71.8	53.1	61.8	72.5	87.5	0.70

Notes: Source: OECD Labor Force Statistics, extracted from OECD iLibrary. Ratio of educational groups from OECD Education at a Glance 2010.

employment to population ratios of both young and older workers, and of both prime age men and prime age women, are also high,[3] and so are relative employment rates between low skilled and high skilled workers (Table 1).[4]

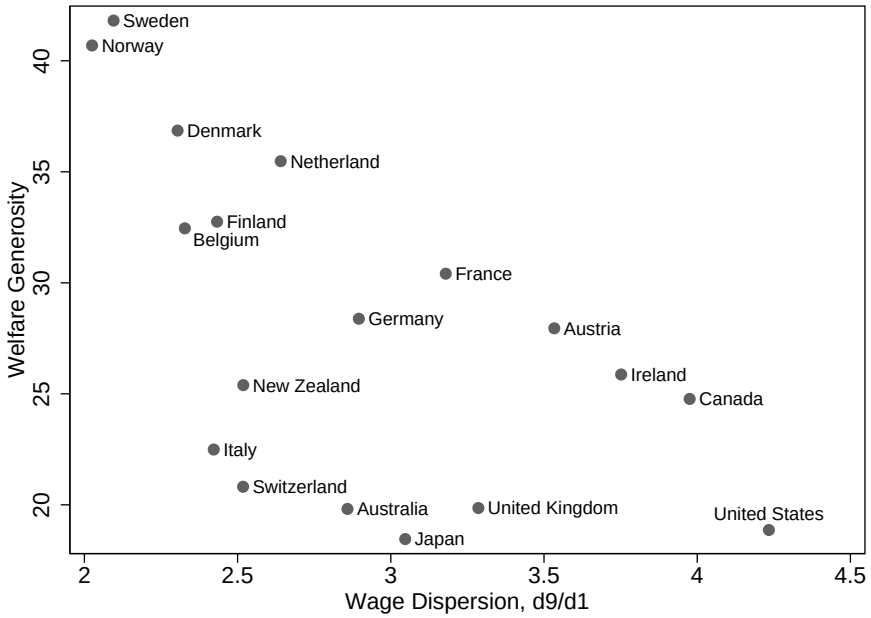
The high levels of work participation, income, growth and technology are the more impressive as these small open economies, with their small wage differentials and big welfare states (Figure 1), face heavy international competition. Thus in the case of Scandinavia we cannot rely on the economists' gut feeling that strong unions and protective safety nets erode incentives for hard work and capitalist investments. Instead, we need to explore more of the details of the Scandinavian model to simultaneously account for the good economic performance, the small wage differentials and the big welfare state. In this paper we emphasize how the two-level bargaining system and a strong union involvement enhance productivity via two channels: worker efforts and capitalist investments. We also argue that there is a positive complementarity between productivity enhancing wage compression and the political support for welfare spending.

Our paper highlights the interconnection between three sets of mechanisms. The first relates to collective bargaining. We argue that the combination of central and local wage negotiations both compresses the wage distribution *and* induces efficiency at the work place, resolving to some extent the conflict between pay and performance. Both socially efficient effort levels and wage compression are equilibrium outcomes. The work autonomy that Scandinavia is famous for, enables local union representatives to enforce effort levels that maximize the value added minus workers' costs of effort, irrespective of the wage distribution. Central wage compression is enforced by restrictions on local industrial actions, making it impossible to completely overturn the small differences in the centrally negotiated wages. The entire wage structure is thus compressed: the wage of a particular

[3]The one exception is Swedish youths, who have employment rates below the US. Note, however, that Swedish youth have very high participation in education.

[4]Even though employment rates are high, working hours per worker are only average or below: While the traditional OECD countries (excluding the current OECD members from Eastern Europe and developing countries such as Mexico and Turkey) have average working hours for prime age workers (25-54) of 37.1 hours per week, Denmark has 35.3, Norway 35.4, and Sweden 37.1.

Figure 1: Wage Compression and Welfare Generosity



Notes: The vertical axis shows Welfare Generosity as measured by the Overall Generosity Index from the Comparative Welfare Entitlements Data set developed by Lyle Scruggs, University of Connecticut (see Scruggs, 2006). Wage Dispersion is measured by the ratio of the 9th to the 1st decile of gross hourly wages from the OECD earnings data base. Both series are averages over available years from 1976 to 2002.

job is made up of the centrally negotiated tariff wage plus a constrained wage drift linked to the productivity of the firm.

The second set of mechanisms relates to capitalist investments. The link from wage compression to investments is best understood within a vintage approach to the process of creative destruction. The wage restraints in local bargaining imply a lower share of wage drift in each vintage of capital investments, ensuring higher expected profits and profit-induced investments. In turn, higher investments push up the demand for labor, and the level of equilibrium wages goes up. As more jobs are created in each vintage, workers become more concentrated in high productivity vintages (enterprises, firms, industries). Surprisingly perhaps, the average wage goes up with more wage restraint at the same time as the expected wage costs for each investment project decline. The explanation is simple: More creative destruction, induced by lower expected wage costs, moves a larger share of the work force to more productive enterprises, thereby raising average wages. In short, wage compression fuels capitalist investments in the process of creative destruction, increasing the average productivity and the average wage for a constant employment level.

The third set of mechanisms relates to welfare spending. We argue that the cradle-to-grave welfare state in Scandinavia obtains higher political support when the income differences in the work force are small, and when the productivity in the private sector is high. The key thing to note is that the welfare state is not a machinery for pure

redistribution from the rich to the poor, but rather a provider of goods and services such as social insurance, health care, and education. As these welfare provisions are normal goods, and wage compression increases the labor income to the majority of workers, the political popularity of higher welfare spending becomes particularly high.

Our paper is part of a literature on comparing welfare states (Esping-Andersen, 1990; Rodrik, 1998), on the differences between Europe and the US (Alesina and Glaeser, 2004; Alesina and Angeletos, 2005), on countries with different wage setting institutions (Calmfors, 1990; Moene, Wallerstein, and Hoel, 1993), and on different varieties of capitalism (Hall and Soskice, 2001). We also connect to the literature discussing the rise and fall of the Scandinavian model, see Lundberg (1985), Lindbeck (1997), and the papers from the NBER project on reforming the Swedish welfare state (Freeman, Topel, and Swedenborg, 1997), and the literature on the pros and cons of the Scandinavian model, see Bosworth and Rivlin (1987), Olson (1990), and Layard (1991). In a recent paper Acemoglu, Robinson, and Verdier (2012) argue that Scandinavia has a form of cuddly capitalism, free-riding on more dynamic economies. We focus on the positive endogenous dynamics of the Scandinavian model, emphasizing the consistency between different parts and highlighting that wage compression induces creative destruction.

Below we offer an interpretation of the Scandinavian model that may add to the understanding of the model's surprising sustainability. Even though there are substantial differences also between the three Scandinavian countries, we emphasize three common features between them.[5] We combine models of collective wage setting (section 2), capitalist investments (section 3), and welfare spending (section 4) to explain why the Scandinavian countries for long periods have had high work effort, small wage differentials, high productivity, and a generous welfare state. The key contribution of this paper is a synthesis of these different elements, emphasizing their institutional complementarity and how the different elements together form a stable whole. To do this we incorporate insights from our earlier work in Moene et al. (1993), Moene and Wallerstein (1997), Barth, Finseraas, and Moene (2014), and Barth, Finseraas, Moene, and Nilsen (2013).

2 Collective bargaining

How are wages set in the Scandinavian countries? And, what are the effects of the wage setting system on efficiency and wage differentials?

[5]Clearly, the features that we emphasize are not exactly equal across the three Scandinavian countries. Several of the features are prominent also in other small open economies in Europe such as Finland, Belgium, and the Netherlands.

2.1 Coordination within a two-tier system

Historically, Scandinavian wage setting is considered highly centralized. In most international rankings the Scandinavian countries used to come out on top. Norway, Sweden, and Denmark (in that order) are for example given top scores by Michael Wallerstein (1999) on the average level of centralization of wage setting in OECD countries over the period 1950 to 1992. In Jelle Visser's average coordination index for the period 1993-2010 Norway is outranked only by Ireland, whereas Denmark and Sweden rank more in the middle among the European countries. Sweden experienced a return to coordination after 1997, but with a less formal bargaining structure at the central level (Fredriksson and Topel, 2010).[6]

In economic theory, decentralized price determination is considered to be better than centralized price setting, whether performed by governments or by collective bargainers. It is important to note, however, that the feasible alternative to coordinated wage setting is not likely to be perfectly competitive labor markets, in part due to labor market frictions. Versions of decentralized bargaining with local or industrial unions are likely alternatives in some sectors, while monopsonistic wage setting and efficiency wages are likely alternatives in others. Even in the largely decentralized labor market of the US, non-competitive wage differentials across industries, firms, and establishments appear to be pervasive.[7] Before one jumps to the conclusion that the Scandinavian system of wage coordination is inefficient, one must therefore get the details and alternatives right. Most importantly, wage setting in Scandinavia is far from purely centralized, it rather combines central and local wage bargaining within a two-tier framework.

What are called the tariff wages are set first, at the central level. Next, the tariff wages are supplemented by local wage adjustments, or wage drift, bargained over at the local level. These supplementary negotiations are about how the national agreements should be implemented locally. In the period 1995-2010 local wage drift relative to total wage increases in Norway was 40 percent for blue collar workers and 60 percent for white collar workers.[8]

Table 2 outlines key features of the local bargaining systems in Norway and Sweden. Both employers' and employees' organizations are represented in a large majority of workplaces, and about 88 percent of employees work in workplaces covered by at least one collective agreement. More than 70 percent of private sector workplaces undertake local wage bargaining after the central agreements are in place, and the share of wage growth

[6] According to OECD (2012) both Denmark and Sweden have seen a shift towards local level bargaining during the second half of the 2000s, before the crisis. The Scandinavian countries are characterized by both high union membership (Sweden 75, Denmark 72, and Norway 54 percent) and high collective coverage of the collective agreements (Sweden 93, Denmark 82, and Norway 74 percent).

[7] See Gibbons and Katz (1992), Groshen (1991), Krueger and Summers (1988) and Barth, Bryson, Davis, and Freeman (2014)

[8] Source: The Norwegian Technical Calculation Committee for Wage Settlements' annual reports. See Holden (1988) for a discussion of Scandinavian wage drift more generally.

Table 2: Wage Setting Institutions. Characteristics of Workplaces and Workers

	Norway		Sweden
	Workplaces	Employees	Employees
Union(s) present	78	87	
Union membership		54	70
- White collar			73
- Blue collar			67
Employers' organization	70	79	86
Collective agreement	80	87	88
- White collar			86
- Blue collar			93
Local bargaining			
- Covered plants	75	78	83
- Private sector			71
- Public Sector			100
Bargaining topics			
- Covered plants	66	80	
Performance Pay, Main occupation	48	51	
- Private sector	59	59	
- Private, collective	56	60	
Share of wage growth determined locally:			
- Blue Collar		.60	
- White Collar		.44	

Notes: Percent. Norway: Own calculations on the Labor and Enterprise Survey 2003, conducted by Statistics Norway. Non-state employers with more than 10 employees. Bargaining topics include productivity agreements, downsizing, reorganization, on the job training, working hours, and pensions. Performance pay include piece rate, individual and group bonuses, profit sharing, commissions, and pay based on individual performance assessments. Source, share of wage growth: The Norwegian Technical Calculation Committee for Wage Settlements' annual reports 2010. Sweden: Fredriksson and Topel (2010) and the National Mediation Office (2012, 2004 (local bargaining))

determined at the plant level is high for both blue- and white collar workers.

Local bargaining includes a host of other workplace related topics. In Norway, two thirds of workplaces have bargained also over topics such as productivity agreements, reorganization and downsizing, training, working hours and pensions. Performance pay has been on the rise in many countries over the last few decades. This is seen as an important tool to obtain high effort at the workplace. 48 percent of all employers, and 56 percent of all private sector employers with collective agreements, have some performance pay scheme installed for their main occupational group (see Table 2).

Many observers do not recognize the high level and broad scope of local negotiations and union involvement. They focus on the centralization of wage setting and neglect the strong union involvement in local wage setting and decision making more generally at the firm level.

2.2 A theory of wage restraints with local adjustments

How does central and local bargaining interact? To understand the interactions, we first consider the local supplementary bargaining, before we discuss the determination of the central tariff wages.

Local bargaining

In Scandinavia, a typical local union leader is elected by the members of the local union. The leader may function almost as a work foreman, or a work supervisor. In the wage negotiations he may therefore be able to commit to a collective effort level on behalf of the members. This is particularly relevant for the organization of work and the adoption of new techniques that demand greater work effort and where working groups have a high level of autonomy. This aspect suggests that the most important work related issues, such as effort and pay, are decided simultaneously. Thus, our modelling approach is more in line with the so-called efficient bargaining model (McDonald and Solow, 1981) than the right-to-manage model (Dunlop, 1944; Leontief, 1946) where employers decide everything except wages.

When local wage bargaining takes place, the centrally determined tariff wages are already determined. The centrally determined tariff wages are not eroded by local adjustments as both Sweden and Norway have a peace clause contained in the main agreement between the unions and the employer association. Thus, as long as a central agreement is in force, local unions are not allowed to call a strike and employers are not allowed to call a lock-out. Workers can, however, engage in work-to-rule actions where they follow work instructions in a pedantic manner (Moene, 1988; Moene et al., 1993). As the local threats are less severe, local adjustments cannot completely undo the distribution of tariff wages. The restrictions on local industrial actions is a measure of the level of effective coordination.

To highlight the key implications of joint bargaining over pay w and work effort l for a given employment level, let pay-offs to each union member be denoted by $u(w,l)$ and profits to the employer by $\pi(w,l)$. Effort and pay are determined as the solution to the bargaining problem where for now disagreement implies a full work stoppage giving zero pay-off to both. The solution is the levels of effort and pay that maximize the Nash product $N = [\pi(w,l)]^{1-\alpha}[u(w,l)]^{\alpha}$ where α is the bargaining power of the local union. The first order conditions are

$$\frac{1-\alpha}{\pi}\pi_w + \frac{\alpha}{u}u_w = 0 \quad \text{and} \quad \frac{1-\alpha}{\pi}\pi_l + \frac{\alpha}{u}u_l = 0 \tag{1}$$

Now, as long as the benefits of higher wages to the union equal the costs of higher wages to the firm, that is as long as $\pi_w = -u_w$ (both payoffs are linear in w), the two first order

conditions yield $\pi_l = -u_l$, implying that efforts are set at the socially efficient level. This simple exercise demonstrates an important point: independent of the bargaining power, the union and the employer internalize the full costs and benefits of effort and set effort at the socially optimal level where the marginal increase in revenue equals the marginal cost, even though the workers bear the total costs of higher effort and do not receive its full benefits. We denote this *the efficiency of local bargains*.[9] This efficiency holds as long as the the union influence across issues is 'fair' in the sense that the union bargaining power is the same for all issues under consideration.

To incorporate the efficiency of local bargains in the two-level bargaining structure, we need to take into account the restrictions on industrial actions at the local level, where only work-to-rule threats are possible. Consistent with the vintage model in section 3, employment in each production unit is fixed. The total value added of the plant is the collective effort l multiplied by the productivity of the equipment f. The cost of effort v for each union member is increasing and convex in l (and may depend on f as well). The plant productivity f is given when local wage bargaining takes place.

The local wage supplement is denoted Δ and the collective work effort l. In the case of a disagreement, a work-to-rule action would reduce effort to a proportion $(1-\xi) < 1$ of the normal level, and worker pay to the centrally determined tariff wage q, implying that

$$u = \begin{cases} q + \Delta - v & \text{no conflict} \\ q - (1-\xi)v & \text{conflict} \end{cases} \tag{2}$$

Accordingly, the employer receives

$$\pi = \begin{cases} lf - q - \Delta & \text{no conflict} \\ (1-\xi)lf - q & \text{conflict} \end{cases} \tag{3}$$

Applying again the Nash bargaining solution, with union power α, we obtain

$$\frac{dv}{dl} = f \quad \text{and} \quad w = \Delta + q = \alpha\xi lf + \xi(1-\alpha)v + q \tag{4}$$

As in (1), effort is set at the collectively optimal level where the marginal increase in revenue f equals the marginal cost dv/dl, even though the workers bear the full effort costs and receive just a share of the benefits of higher effort.

[9]The efficiency of local bargains also apply to situations where effort may be difficult or costly to observe. In those situations the local bargaining power of unions is decisive for the level of pay, and hence for the level of average wage cost at the firm level, but the two sides agree on how the average pay levels should be implemented in the form of performance pay schemes (see Barth, Bratsberg, Hægeland, and Raaum, 2012, for a detailed analysis). Again, effort is implicitly determined at the socially optimal level as both sides have an incentive to install efficient rewards for higher productivity.

According to (4), high productivity enterprises pay higher wages and obtain higher profits. While work efficiency is unaffected by the level of ξ, pay differentials between plants are lower the lower is ξ.

The essential features of the local bargaining outcome can be captured by what we shall refer to as the normalized simplification where the cost of effort is $v(l, f) = (1/2)(l^2 - 1)f$, giving us the optimal effort level $l = 1$ and a wage equation that simplifies to the tariff wage plus a wage premium $w = q + \alpha\xi f$. As emphasized by (2) and (3), the local wage premium is a concession based on internal threats of industrial actions. Clearly, the wage premium is less tied to the productivity of the plant f the more severe the restrictions on local industrial actions (that is, the lower is $\xi < 1$).

But why is not the wage premium of high productivity jobs bid down by workers employed in less productive jobs with lower f's? On this there seems to be nothing special about Scandinavian labor markets. As elsewhere, transaction and training costs protect insiders' wage premiums. The threat of replacing insiders is only credible if the sum of the lower wage premium, promised by outsiders, plus the transaction costs, broadly defined, is lower than $\xi\alpha f$. If this condition is not fulfilled, employers would know that a new worker hired at a lower wage premium would be in exactly the same position as the present insiders once he is trained for the new job.

This is just a straightforward application of Shaked and Sutton (1984), who "formalize the notion that the firm in practice has an 'existing workforce' at any point in time. It cannot instantly and costlessly switch them for a rival workforce ... and this drives a wedge between the labor market we describe, and that of the Walrasian auction in which the firm can play one worker off against another by making simultaneous offers to each" (p. 1362).

Consider again the wage equation $w = q + \alpha\xi f$. Decentralized wage setting has $\xi = 1$. Thus, for any distribution of productivity f across enterprises, the wage inequality across these enterprises is higher the less restrictions there are on local bargaining. As mentioned, even non-unionized labor markets have in practice high local bargaining power.

So, focussing on the normalized simplification our discussion suggests a wage equation for a group of workers of type i in enterprise j that consists of a common tariff wage q_i plus local additions that depend on the productivity f_j of the local enterprise

$$w_{ij} = q_i + \alpha\xi f_j \tag{5}$$

How are the tariff wages q_i determined?

Central bargaining

The central features of centralized wage bargaining stem from the need to remain competitive in international markets. Small open economies need imports, leading to a strong

concern for the traded goods industries. Indeed, in Norway and Sweden the initial steps toward centralization took the form of a conflict between unions in the traded goods and sheltered industries. The centralization of wage setting represented an attempt by workers in the export sector (and the employers) to control wage setting throughout the economy in line with the international competitors.[10] Larger economies, in contrast, sought trade protection as international demand fell. Smaller economies were highly specialized in production for export markets. The possibility to obtain higher employment by protecting own industries was therefore limited by the size of the domestic market.[11]

The relations that emerged between unions in the traded and sheltered industries reflect the distinction between substitutes and complements in production. Coordination among workers who are substitutes in production makes each union more militant, as all competitors demand a similar wage rise. In contrast, coordination among workers who are complements makes each union more moderate. Each union internalizes the consequences for other cooperating unions of higher wages to own workers. The Scandinavian coordination, that started in the 1930s and that was formalized after WWII, should be understood as extending wage coordination beyond each industry across occupations and sectors. It was therefore basically coordination among workers who are complements in production. Cooperating unions therefore had and still have an interest in wage moderation in central negotiations.

Wage moderation also helps in keeping the employers within the folds of wage coordination. If the employers thought they could gain from less centralized wage setting, they could easily dissolve the system by just withdrawing from the central negotiations. As they stay on, they reveal their preferences for wage coordination, because it provides higher profits through wage restraints and high employment.[12] As mentioned, employers were central in the first attempts to establish the centralized system in the 1930s.

How should we then describe the determination of the average wage level? We think it is fair to say that the quest for competitiveness combined with the central willingness to wage moderation and local restraints on industrial actions, lead central negotiators to set wages that are conducive to full employment. They perceive the average wage drift in each branch of industry that comes on top of the tariff wages and adjust the tariff wages to achieve the distribution of total wages that they aim for.

How should we best describe the resulting differentials in the tariff wages? Coordina-

[10] See the early discussions by Edgren, Faxen, and Odhner (1973) and Aukrust (1977). Denmark became less centralized than the other two because the single largest union (organizing low skilled workers) remained opposed.

[11] Willumsen (2011) takes the argument further by arguing how wage compression leads to more export orientation.

[12] Other arguments for why an employer stays on include that national collective agreements imply that his domestic competitors will not have an labor cost advantage, and that for small firms there is no point in spending time and resources on local bargaining when a national contract is available.

Table 3: Inter-Industry Wage Differentials, Selected Countries

	I	II	III
Austria	.037	.033	.054
Norway	.063	.045	.059
Sweden	.	.	.041
Germany	.	.066	.
Canada	.171	.	.
United States	.163	.194	.172

Notes: Figures from Table 4 in Zweimüller and Barth (1994). The table shows calculated wage dispersion across industries after control for human capital and an urban dummy. Three different specifications are run to ensure comparability across countries, see Zweimüller and Barth (1994) for details.

tion alters the influence of different groups in wage setting towards lower paid groups.[13] Unions also care about fairness (Elster, 1989), and it seems to be a general principle that they compress the wage distribution over the bargaining unit. When wages are determined at the firm level, unions compress the distribution of wages within the firm; when wages are set at the industry level, unions compress the distribution of wages across firms within the industry; when wages are set at the national level, unions compress the distribution of wages across firms, industries and occupations throughout the entire nation.

Coordination—or solidarity negotiations as it is called in Scandinavia—is therefore associated with less wage inequality for at least two reasons. First, the distribution of tariff wages is compressed as wage coordination extends the bargaining unit over which fairness norms are applied. Second, the peace clause constrains local wage dispersion as it imposes serious restrictions on local industrial actions.

2.3 Scandinavian wage differentials are less magnified

That the Scandinavian countries have rather egalitarian wage structures, as illustrated in Figure 1, is not controversial. However, we claim that coordinated bargaining mitigates wage differentials of workers with similar characteristics across firms and industries of different productivity. Is this so?

Table 3, which replicates the key figures from Zweimüller and Barth (1994), looks at inter-industry wage differentials across a selected group of countries. In the table, inter-industry wage differentials are calculated after controlling for human capital differences and location-specific factors. From the table we clearly see that inter-industry wage differentials are much more compressed in countries with higher levels of bargaining coordination: Austria, Norway and Sweden have substantially lower inter-industry wage differentials than e.g. the United States.

[13] Whether coordination reflects a majority support for compression is not easy to say. Both contract ratification and the election of union leadership matter (see Flanagan, 1993, for a discussion of voting and union behavior).

Table 4: The Distribution of Hourly Earnings in Sweden and the US, 1989-91

	90/10	10/50
Swedes in Sweden	2.02	.77
Swedish descent in US:		
Any Swedish ancestry	5.59	.38
Only Swedish ancestry	5.05	.41
United States, total	5.53	.39
Non-Swedes in Sweden	2.09	.71
Non-Nordics in Sweden	1.85	.74

Notes: Figures from Table 1.5 in Björklund and Freeman (1997). Data from the 1990 US-Census and the 1991 Swedish LNU-survey.

One may object, of course, that the Scandinavian countries appear to have a much more homogenous population than the US. The role of individual characteristics for inter-industry wage differentials, and for cross-country differences in wage structure more general, is debated.[14] Could the smaller wage differentials of the Scandinavian countries simply be a reflection of a more compressed skill structure? Björklund and Freeman (1997) present convincing evidence that this is not the case. Table 4 shows wage dispersion of Swedes in the US and non-Swedes in Sweden, compared to the overall wage dispersion in Sweden and the US. The picture is clear: In terms of wage dispersion, Swedes in the US look like Americans and non-Swedes in Sweden look like Swedes.

3 Private investments

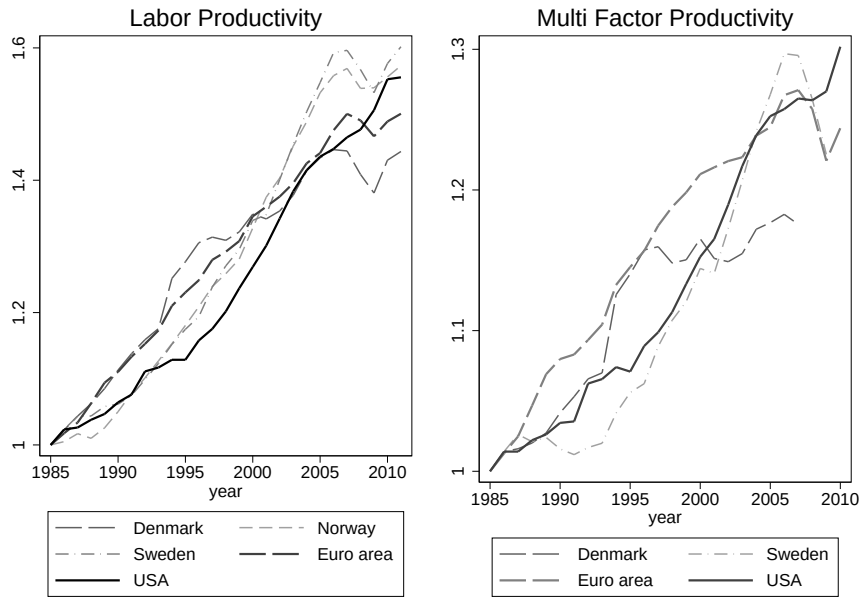
How are capitalist dynamics affected by the low wage differentials and the high union involvement?

3.1 High growth and high productivity

Despite the highly unionized environment and the small wage differentials, Scandinavian investments and labor productivity are high. The left part of Figure 2 shows the development of labor productivity, measured per hours of work, from 1985 to 2010, as reported by the OECD. Both Sweden and Norway show higher levels of growth than the US and the Euro area. In the right part of the figure, we show the development of multi-factor productivity. Here Denmark shows high growth during the first 10 years from the mid 1980s and Sweden shows particularly high growth from the mid 1990s. Denmark has a significantly weaker development after 1995. The high levels of growth are likely caused

[14] See e.g. Gibbons and Katz (1992) on industry wage differentials, and Blau and Kahn (1996), Freeman and Schettkat (2001), and Leuven, Oosterbeek, and van Ophem (2004) on international differences

Figure 2: Productivity Growth. Selected Countries. 1985 = 1.



Notes: Source: OECD iLibrary. Labor productivity is measured per hour. For Norway, oil and gas revenues are excluded from labor productivity using yearly ratios of total and mainland GDP as reported by Statistics Norway.

by large investments in modern technologies.[15] Indeed, the capital ratio of Denmark and Sweden are 24 and 9 percent higher than in the US, and the ICT capital ratio of Sweden is 29 percent higher than in the US (figures from OECD). In this section we aim at an explanation for why capitalists have such strong incentives to modernize and invest under coordinated wage bargaining.

To understand the powerful capitalist incentives, recall that much of the dynamics of the capitalist economy concern the entrance of new firms and the failure of old ones. Expansion is characterized by the creation of new jobs by the building of new plants, contraction by the closure of old ones. New entrants bring new techniques, departing firms leave the most efficient firms behind. In this way, entry and exit alter the mix of firms and increase the average productivity.

3.2 A theory of creative destruction and wage compression

We concentrate the attention on the creation and destruction of jobs that require specific investments and designs. The capital equipment belongs to vintages where newer vintages are more productive than older ones. Creating new jobs, or building new plants, is costly,

[15]The US is still a leading country in terms of the *level* of labor productivity. Among the Scandinavian countries only Norway has higher labor productivity than the US. In 2011, Norwegian labor productivity was 35 percent higher than US labor productivity, or 9 percent higher when oil and gas revenues are excluded (OECD data).

so older designs are not immediately replaced. The key decisions are when to build new plants and when to scrap the old ones.

Our simple model of creative destruction builds on Moene and Wallerstein (1997).[16] It is different from the famous Schumpeterian models by Aghion and Howitt (1992, 1998), which portrays the research sector as involved in a patent race where every new innovation immediately makes the previous innovations completely obsolete. In contrast, we study a process where innovations live on as long as their revenues cover the variable costs. In that way we obtain a distribution in every period of older innovations still in use.[17] These heterogeneous workplaces give rise to wage differences across workplaces. Wage compression affects the productivity distribution and the expected lifetime of each vintage of capital equipment.

Since our focus is on how the distribution of bargaining power affects the process of job creation and job destruction, and since we have just demonstrated that the joint determination of effort and pay at the supplementary wage negotiations at the local level generate a socially efficient effort level, we utilize the normalized simplification such that the wage equation (4) specializes to $w = q + \alpha\xi f$. None of the results below rely of this simplification. We also apply the small open economy assumption that the output prices are exogenously given at the world market.

Let the average pace of technological change be λ (to be discussed below). As we shall see, the rate of technological advances affects the economic lifetime of each job created at time t, denoted $\theta(t)$. Abstracting from discounting, the profits of a job invested in at time t is written

$$\Pi(t,t) = \theta(t)F(t) - \sum_{s=t}^{t+\theta(t)-1} W(s,t) \tag{6}$$

Here $F(t)$ is the productivity of the job, determined by best practice production techniques available at time t. Once invested, the productivity of the job remains fixed until it is scrapped. Wages in vintage t at time s is the 'tariff wage' $Q(s)$ plus the local wage premium Δ. Using the wage equation derived in (4), we have that the wage in period s to workers employed in a plant of vintage t is

$$W(s,t) = Q(s) + \alpha\xi F(t) \tag{7}$$

As seen, the local addition to the tariff wage is tied to the productivity of the plant,[18]

[16] The model incorporates the mechanisms of the so-called Rehn-Meidner model (Rehn, 1952), see also Agell and Lommerud (1993).

[17] Seminal papers that have industry equilibria where firms of different productivities co-exist include Jovanovic (1982) and Hopenhayn (1992).

[18] As discussed in the previous section, the wage is determined by both parties' threat points and how much they stand to lose from a conflict. Implicitly, some frictions are assumed leaving room for negotiation for the two parties. High productive establishments pay more because they have more to lose

and it remains constant throughout the plant's life. The tariff wage, however, changes as the aggregate productivity changes during the process of creative destruction. Inserting the wage equation into the profit equation, we have

$$\Pi(t,t) = (1-\alpha\xi)\theta(t)F(t) - \sum_{s=t}^{t+\theta(t)-1} Q(s) \tag{8}$$

Free entry in job creation implies

$$\Pi(t,t) = B\left(t, n(t)\right) \tag{9}$$

Here $n(t)$ is the number of jobs created in period t and B is the cost of entry, increasing in n. The share of the workforce recruited to vintage t is thus $n(t)$, which can be denoted the 'fatness' of vintage t.

Free exit implies a termination of jobs of age $\theta(t)$:

$$F\left(t-\theta(t)+1\right) - w\left(t-\theta(t)+1, t\right) = (1-\alpha\xi)F\left(t-\theta(t)+1\right) - Q(t) = 0 \tag{10}$$

The central wage negotiators set the tariff wage Q subject to full employment, $\theta(t)n(t) = 1$, as discussed in Section 2.2.

Along the steady state path we have $\theta(t) = \theta$, $n(t) = n$, $F(t) = (1+\lambda)^t f$, $Q(t) = (1+\lambda)^t q$, and $B(t,n) = (1+\lambda)^t b(n)$, where $b(n)$ is increasing in n.[19] Similarly, we have $Q(s) = (1+\lambda)^s q$ where q is endogenous, and $\sum_{s=t}^{t+\theta-1} Q(s) = \frac{(1+\lambda)^\theta - 1}{\lambda} q(1+\lambda)^t$. To express the different income concepts along the steady state path it is useful to express income per vintage at time s as $x(\theta)$ implicitly defined by

$$\sum_{\tau=s-(\theta-1)}^{s} (1+\lambda)^\tau f = (1/\lambda)[1+\lambda-(1+\lambda)^{1-\theta}]\,(1+\lambda)^s f \equiv x(\theta)\,(1+\lambda)^s f \tag{11}$$

which is increasing in θ.

Straightforward calculations, using $\theta n = 1$ and the above expression for income per vintage, allow us to express some of the core variables as functions of n along the steady state path. We express all variables net of the growth in λ, i.e. normalized by $(1+\lambda)^{-t}$. First, the economic lifetime of each investment, $\theta = 1/n$, is declining in n. Second, the average income per capita, $nx(1/n)f$, is increasing in n. Third, the tariff wage $q = (1-\alpha\xi)(1+\lambda)^{1-1/n} f$ is increasing in n. Fourth, the average wage per worker $\bar{w} = q + \alpha\xi nx(1/n)f$ is increasing in n. Finally, the total wage cost over the life of each

from a conflict.

[19] The investment cost B is increasing in λ as there is no technological improvement in the building of capital equipment, implying that the unit cost of capacity is increasing at the same rate as the average wage.

investment is $\tilde{w} = (1/n)\alpha\xi f + (1 - \alpha\xi)x(1/n)f$, which is declining in n.

We now need to pin down the 'fatness' parameter n. The free entry condition $(1/n)f - \tilde{w} = b(n)$ can, using (11), be expressed as

$$\pi(n, \lambda) \equiv (1 - \alpha\xi)\left[(1/n) - x(1/n)\right] f = b(n) \tag{12}$$

This equation determines a unique level of n, since (for a given λ) the left-hand side is decreasing in n, while the right hand is increasing in n.

Wage inequality, expressed by the gap between the highest and lowest pay along the steady state path, is given by

$$\frac{\max w - q}{q} = \frac{\alpha\xi}{1 - \alpha\xi}(1 + \lambda)^{\theta - 1} \tag{13}$$

Notice that this wage gap is increasing in workers' local bargaining power $\alpha\xi$, in the age of the oldest equipment in use θ, and in the pace of technological change λ.

We can now show the following results:

Employment-preserving wage compression increases investments and income per capita. What we denote employment-preserving wage compression is captured by the effects of a lower ξ with $n\theta = 1$ (full employment). This compression implies higher investments, fatter vintages n, shorter economic lifetime θ of each investment, and as a consequence a higher level of income per capita nx and a higher average wage $\bar{w}$ in the work force. Observe that a lower ξ has a direct wage compressing effect that is strengthened by an increase in the share of the work force n in each vintage, and thus a higher concentration of workers in the most modern vintages, that further compresses the wage structure by rising the lowest (tariff) wage q.

This result deserves some comments. It is based on a comparisons of two steady states, one with high local bargaining power and the other with low local bargaining power. Comparing the two we find that wage restraints in local bargaining imply lower expected wage costs and thus higher expected profits over the lifetime of an investment. As a consequence investments go up, implying that the lowest wage is raised without creating unemployment. Since this wage rise goes to everybody in the form of a higher tariff wage, it benefits all workers.

Wage restraint also implies that more jobs are created in each vintage. Workers are therefore more concentrated in high-productivity vintages (enterprises, firms, industries). It might be puzzling that the average wage in the work force goes up with wage restraint, at the same time as the expected wage cost of each vintage declines. The puzzle is resolved once we account for the fact that lowering the expected wage costs leads to more creative destruction that moves a larger share of the work force to more productive enterprises. So even though the local bargaining power of work groups decline, they are moved to more

productive vintages where even a lower bargaining power yields a higher average wage.

The reallocation of workers contributes to wage compression. The highest paid workers receive a smaller rise as they work in the best enterprises, and cannot gain from the reallocation of workers in other ways than through a higher tariff wage. Their total wage may thus decline as their local wage supplement might go down more than the tariff wage increases.

The clearest beneficiaries of wage restraint are low paid workers together with employers. The policy of wage restraint, or solidarity bargaining as the wage policy was called after 1958, was supported by an implicit coalition between employers and low-paid unions, a coalition of the ends against the middle.

A higher level of basic productivity leads to wage compression. A higher level of basic productivity, the level of f in each enterprise, implies higher average incomes with lower economic lifetime θ and a higher concentration of workers n in modern vintages. All this leads to more wage compression as the tariff wage q goes up.

A higher level of basic productivity can be interpreted as a result of efficient work effort at the local level. It can also be caused by welfare spending connected to education and health. If the latter is the case, there is a positive link from welfare state provisions and the productivity of private enterprises. In addition, welfare spending that increases the level of basic productivity f also compresses the wage structure, as investments and wages adjust to the new circumstances with better welfare state provision. If so, this is an example of the complementarity between worker security and capitalist dynamics.

A higher rate of technological change increases the share of workers in each vintage in operation. A higher rate of technological change λ lowers the economic lifetime of each investment θ and increases the share of workers n in each remaining vintage. Speeding up the process of creative destruction implies that the distance in productivity between each vintage goes up, but that the distance in age between the least and the most efficient plant in use declines. As a result each vintage become fatter, and, as a consequence, the economy becomes more modernized with higher average productivity.

To the extent that λ depends on n, wage compression implies higher growth. The rate of technological change λ can be thought of as a spillover from more innovative economies to less (Acemoglu et al., 2012). Yet, the small open economies assumption of a given pace of technological change λ can be questioned. Making λ endogenous, we can assume that innovations are done in the expectation of profits. To illustrate, the value of a productivity increase λ is $(1+\lambda)\pi - \pi = \lambda\pi$. Let the arrival rate of new technological ideas be Poisson distributed with the rate ρ per unit of resources R invested in R&D. Thus, the 'production function of innovations' is $\lambda = \rho R$. Profits in the research sector is simply the value of the innovation $\lambda\pi$ minus the costs of research resources, that is $\pi\rho R - (a/2)R^2$, where we for simplicity assume that the costs of resources for innovation is quadratic, with a as a given constant. Maximizing profits in the research sector and combining it with the free

entry condition (12), we obtain the following two equations

$$\lambda = (\rho^2/a)\pi(n,\lambda) \quad \text{and} \quad \pi(n,\lambda) = b(n)$$

From the two equations we have that $\lambda = (\rho^2/a)b(n)$, demonstrating that any policy or institutional change that increases n, would also increase the pace of technological change. In particular, we have that wage compression leads to higher economic growth.

Creative destruction with heterogeneous workers

So far we have considered the effects of wage compression in the case where wage differentials only have distortive effects caused by local rent sharing. This distortion implies that a compression of the wage structure will, by taking wages out of market competition and placing it in a system of collective decision making, increase efficiency, profits and investments. We now briefly consider the other extreme case, where wage differentials play a crucial role for efficiency by sorting the most productive workers to the most productive workplaces.

To make the basic point clear it is sufficient to consider two skill groups: a high skill group with productivity p_H that constitutes a fraction γ of the labor force, and a low skill group with productivity $p_L < p_H$ that constitutes a fraction $1-\gamma$ of the labor force.

Efficient sorting requires that the high skill group is allocated to the most efficient plants. Let us consider the allocation in one specific period t. In the efficient allocation high skill workers occupy the θ_H most modern vintages where $\theta_H n = \gamma$, while low skilled workers occupy the rest of the jobs, namely those in the vintage interval $\{\theta_H, \theta_H + \theta_L\}$, where $\theta_L n = 1-\gamma$.

The wage distribution that can support this efficient sorting must obviously pay a wage premium to high skill workers. The premium must be so high that it is only profitable for high productivity firms to employ high skill workers. Along the steady state path, the wage premium can be written as

$$\frac{w_H - w_L}{w_L} = \beta \frac{p_H - p_L}{p_L}(1+\lambda)^{\theta_L} \tag{14}$$

where $\beta = 1$ is the case with efficient sorting. We see that in this case the distribution of wages is more unequal than the distribution of workers productivity p_i. The wage differentials are magnified by allocating the most productive workers to the most productive workplaces. The wage differences are higher the higher the rate of technological change λ, since a higher rate of technological change increases the productivity differences between each vintage. It is also clear that the wage differentials become smaller by increasing the fraction of high skill workers. For a given distribution of productivity, a higher supply of high skill workers imply that they on the margin are employed in less productive

workplaces.

Now, wage compression can be studied by deriving the implications of a lower β. A more compressed wage distribution will obviously distort the efficient allocation of workers. Yet, the efficiency loss can be small as a decline in the high skill wage only enables marginal firms with a bit lower productivity than the threshold θ_H to hire skilled workers with a profit.

In Appendix A, we show that $\beta < 1$ raises the fatness parameter n. The intuition is straightforward. Compression can be achieved by wage constraint in high skill jobs. A lower w_H means that a newly invested firm would benefit from lower wage costs in the first θ_H periods. Expected profits go up. Wage compression therefore induces inefficient investments of a special kind—over-investments rather than under-investments. Higher investments and thus higher demand for low skill workers is therefore accompanied by a rise in the lowest wage w_L as well. As a consequence we get wage compression from both sides.

The effects of wage restraints also speak to the discussion of why high skilled groups can support wage coordination that also lead to a compression between high skilled and low skilled workers. The steady state with wage restraint and wage compression can provide higher average wages, and higher wages for substantial groups of high skilled workers. The higher concentration of workers in more productive workplaces (higher n) implies that the wages of high skilled workers can be higher than they would have been without wage restraint, as wage restraint implies that more of the high skilled workers become employed in more modern firms with higher productivity.

3.3 Supporting evidence for a lower productivity dispersion

Our small model shows that Scandinavian industrial relations and union involvement do not hamper capitalist investments. On the contrary, the two-level bargaining system facilitates coordination between wage setting, savings and investments. We claim that the system implies smaller wage differentials, higher average wages, and higher profits, leading to higher investments. If the system is inefficient, it is because investments are too high, not too low.

Our model emphasizes the process of creative destruction, where older plants are replaced by newer and more productive plants. Is the process of creative destruction active in the Scandinavian countries? One piece of evidence is given by the share of employment in entry workplaces, exiting workplaces and continuing workplaces. Table 5 shows figures for Sweden, the Euro area and the US.[20] The share of employment in continuing workplaces is highest in the Euro area, and lowest in Sweden, which is suggestive of an active process of creative destruction.

[20]Industries are weighted by European-level employment shares, to control for differences in industry structure.

Table 5: Employment shares, Entry/Exit/Continuing firms

	Entry	Exit	One-Year	Continuers
Sweden	.065	.052	.016	.867
EU15/Euro zone	.048	.040	.006	.912
United States	.049	.044	.010	.897

Notes: Data from EUKLEMS Distributed Micro Data. Average values 1990-2004.

Next, we look more directly at the distribution of firm-level productivity. An important result in our model is that the productive distance between the least and the most productive plant in use should be lower under coordinated wage bargaining. We hence expect the dispersion of productivity across plants to be smaller in countries that have more coordinated wage bargaining.

In Table 6, we look at the dispersion in firm level total factor revenue productivity (hereafter TFPR) within narrowly defined (4 digit NACE) industries in Norway and the United States for some selected years. To be comparable to dispersion measures calculated on US data, we follow the approach of Hsieh and Klenow (2009) and back out firm level productivity using a Cobb-Douglas production function with industry specific capital shares α_S calculated from the labor share of value added in the NBER productivity database.[21] We then measure dispersion in log TFPR relative to the industry mean of TFPR, after trimming the 1% tails of this relative productivity across industries. The US figures are taken from Hsieh and Klenow (2009), while the Norwegian figures are calculated on Norwegian manufacturing data in the same way as the US figures. It should be noted that while Hsieh and Klenow use plant level data, we use firm level data as measures of value added and capital are only available at the firm level in the Norwegian manufacturing data.[22] Industries are weighted by their value added shares.[23]

From Table 6, we clearly see that the dispersion in TFPR is lower in Norway than in the US, no matter what kind of measure is used to measure dispersion. This is consistent with the model presented above: with coordinated wage bargaining the spread in the distribution of firm-level productivity should be smaller, which is what drives the result of higher average productivity under coordinated wage bargaining. Relatedly, it should be noted that a central result of Hsieh and Klenow (2009) is that the spread in the distribution of TFPR is related to aggregate TFP, with a larger spread in the distribution leading to lower aggregate TFP. We find that the Nordic countries have even lower TFPR dispersion than the US, Hsieh and Klenow's competitive benchmark.

[21] We follow Hsieh and Klenow (2009) and scale the wage bill up by 3/2 since the wage bill in the NBER productivity database does not include fringe benefits and Social Security contributions.

[22] As a robustness check, we have also tried to calculate the dispersion on the plant level after allocating capital and value added from firms to plants using employment and sales shares. The dispersion measures increase somewhat, but they are still below their US equivalents.

[23] Weighting by US value added shares or firm level employment do not substantially alter the results.

Table 6: Dispersion of TFPR in Norway vs. United States

United States	1977	1987	1997
S.D.	.45	.41	.49
75 – 25	.46	.41	.53
90 – 10	1.04	1.01	1.19
Norway	1997	2001	2005
S.D.	.35	.34	.33
75 – 25	.37	.34	.34
90 – 10	.8	.74	.73

Notes: Dispersion in TFPR in the United States is taken from Table II in Hsieh and Klenow (2009), while the Norwegian figures are calculated using Hsieh and Klenow's approach on Norwegian manufacturing data. $TFPR_{si} = PY_{si}/K_{si}^{\alpha_S} L_{si}^{1-\alpha_S}$, and the statistics are for $\log\left(TFPR_{si}/\overline{TFPR}_s\right)$. K_{si} is measured using the book value of capital. L_{si} is measured using the wage bill, to crudely control for human capital differences. Industries are weighted by their value-added shares.

Table 7: Coefficient of Variation Within Industries

	Labor Productivity		Multi Factor	Total Factor
	Sales	Value Added	Productivity	Productivity
Sweden	.081	.085	.148	.163
EU15/Euro zone	.109	.103	.378	.356
United States	.146	.161	.253	.339

Notes: Data from EUKLEMS Distributed Micro Data, average values 1990-2004. Multi-factor productivity is calculated conditioning sales on material inputs as well as labor and capital, whereas total factor productivity is calculated from value added conditioning on labor and capital. See also Bartelsman, Haltiwanger, and Scarpetta (2009).

We find similar results for Sweden. Table 7 shows the average coefficient of variation of log productivity within industries for various productivity measures for Sweden, the average for the Euro area, and for the US.[24] We find lower within-industry dispersion in labor productivity, calculated both in terms of sales and in terms of value added, in Sweden than in both the US and the EU. Also the two measures of multi-factor productivity give the same picture, a more narrow within-industry dispersion of productivity in Sweden than in both the US and the EU.

Our model on the one hand implies that Scandinavian industrial relations and union involvement speed up the process of creative destruction. On the other hand our model shows that the process of creative destruction compresses the wage structure further by destroying low productivity jobs and allocating workers to more productive jobs. Thus, consistent with our empirical findings, the level of average productivity is high and the dispersion in productivity across plants is small. On top of this compression of wages through labor market institutions and structural change comes redistribution through

[24]Industries are weighted by European-level employment shares, to control for differences in industry structure.

the welfare state, to which we now turn.

4 Public welfare spending

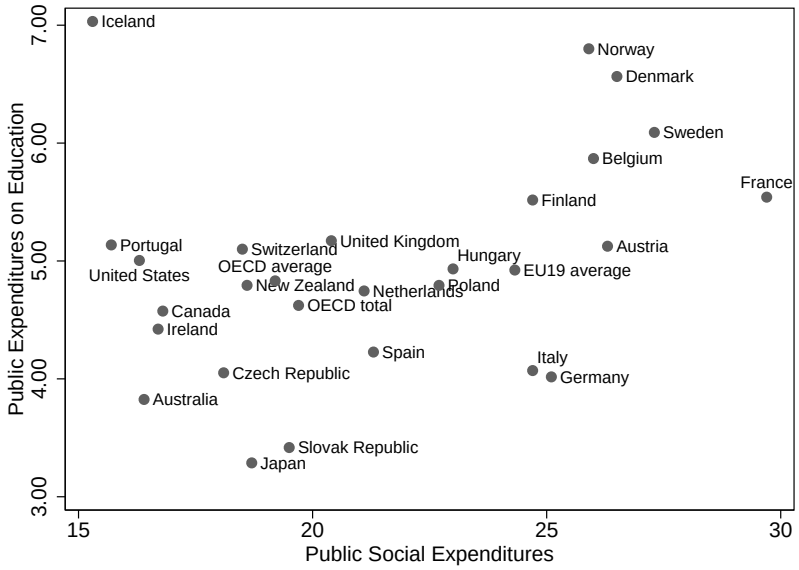
Given the redistributive effects of the labor market institutions, why do the Scandinavian countries also have such big welfare states? In other words, why do Scandinavian countries redistribute twice, first by the organizations in the labor market and then by the welfare state? Could the same outcomes have been achieved by redistribution through the political system only? To address these questions more fully, we now incorporate the basic results of coordinated wage bargaining into a simple model of political competition between the right and the left over the size of the welfare state.

Our claim is that the same outcomes could not have been achieved via voting over taxes and transfers only. First, as we now will show, wage compression changes individually optimal political choices, implying a more left-leaning electorate. Thus, more wage compression is likely to increase the vote share of the left if the political programs of the left (Social Democratic) and the right blocs are given. Second, political programs change in response to the new wage distribution. In order to show this, and more generally how political competition reinforces the conditions in the labor market through the welfare policies of both blocs, we present a simple model of political competition over public welfare policies.

A premise for both these arguments is that the Scandinavian welfare states do not simply take from the rich and give to the poor. Such direct money transfers have weak legitimacy. The Scandinavian welfare states should rather be seen as important providers of services. Figure 3 demonstrates that the Scandinavian countries rank high not only on social expenditures as a share of GDP, but also in public provisions of private goods, here exemplified by the public expenditures on education.[25] The public provision of services and commodities have normal goods properties in the sense that political demand goes up with income. The provision is done on terms that are better for the poor than the rich. Wage compression therefore leads to higher political support for welfare spending as wage compression, as shown, raises the wage of the majority of workers, including the average wage.

[25]Public social expenditures include both central and local government expenditures related to old age, survivors, incapacity-related benefits, health, family, active labor market programmes, unemployment, housing, and other social policy areas. Norwegian figures are re-calculated to be relative to mainland GDP, excluding oil and gas revenues, since oil and gas revenues are not brought into the Norwegian economy as they materialize, but are channeled into the growing Norwegian Government Pension Fund Global, and invested outside of Norway. A crude adjustment for this is undertaken by adjusting the figures with the ratio of Mainland GDP, as defined by Statistics Norway, over total GDP. A measure of the generosity of the welfare system would ideally abstract from differences in factors like the unemployment rate, demographic composition etc. that may influence spending for a given generosity. Such a measure, obtained from The Comparative Welfare Entitlements Data Set, is provided in Figure 1 in the introduction, where all the Scandinavian countries again are ranked at the very top.

Figure 3: Public Social and Educational Expenditures, percent of GDP in 2007



Sources: Social Expenditure Statistics, OECD iLibrary. OECD Education at a glance, 2010, table B2.4.

4.1 Preferences for welfare spending

To show how wage compression changes political preferences, we draw on a model of Moene and Wallerstein (2001). The welfare state offers goods and services that may not be readily available in the market place, such as social insurance and health care, i.e. goods that may suffer from moral hazard or adverse selection under private provision. A voter's preferred level of welfare spending is affected by both his income and his marginal benefit of public spending. The marginal benefits can differ among voters because of differences in the evaluation of the goods and services provided and in the exposures to risk of, say, income loss. The evaluation of the public good may also reflect the concern for others. Even though welfare spending is likely to be an inferior good as we move up the income distribution, changing both the income and risk of the voter, welfare spending is likely to be a normal good within each income class, as the preferred level of welfare spending goes up with the income of the voter for a given exposure to risks.

More specifically, let τ be the tax rate and k the cost of welfare spending, where k is related basically to the number of benefit receivers relative to contributors. The balanced budget constraint can then be written $\tau\bar{w} = kg$, where $\bar{w}$ is the average income per capita. The preferences of a voter in income class i are given by the quasi-concave utility function

$$V_i = v(c_i, g; h_i) \quad \text{with} \quad \tau\bar{w} = kg \tag{15}$$

where $v_1 > 0$, $v_2 > 0$, and h_i is a parameter affecting the marginal benefit of public spending.

The most preferred level of welfare spending is determined by the first order condition $v_1(-w_i k/\bar{w}) + v_2 = 0$, where $v_1 w_i k/\bar{w}$ is the marginal cost of welfare spending, and v_2 the marginal benefit. The assumption that welfare spending is a normal good for given h_i requires that the marginal cost $v_1 w_i k/\bar{w}$ is declining in the income of the voter w_i—that is that the coefficient of relative risk aversion $\mu_i \equiv -v_{11} c_i / v_1$ is greater than one. As long as this is the case, welfare spending is a normal good for given h_i.

Important for our argument that wage compression leads to a larger welfare state, is that the ideal policy g_i^* is increasing both in one's own income and in the average income, as wage compression in our model increases both the median voter's income and the average income. A rise in one's own wage increases g_i^* due to the normal goods nature of the welfare state, while a rise in the average income, keeping w_i constant, comes through a bigger tax base.

So, the welfare state does not only offer redistribution, it also offers goods and services that may be difficult to organize through private markets only. Such goods are inferior goods across social classes with different marginal benefits of public spending, but are normal goods within social classes for given marginal benefit. When average income increases, the demand for the welfare state increases as well. These preferences obviously also influence the political equilibrium, i.e. the programs it is optimal for the political parties to run on. Next we show how both right-wing and left-wing parties will shift their policies in response to a shift in the income distribution brought about by wage compression.

4.2 Political competition

The center of political gravity is determined by voters' preferences. To show how each party, both on the left and right side of the political spectrum, shifts its policy towards the center of political gravity, we follow Barth et al. (2014) and model the parties' policy platforms as an outcome of a simple game with probabilistic voting (see e.g. Lindbeck and Weibull, 1987; Dixit and Londregan, 1996). We assume that parties have a given ideology, represented by the preferred level of welfare generosity $g = g_P^*$, for each party $P = R, L$, right or left. Voters have interests given by our model presented above, in addition to ideological sympathies. The distribution of sympathies is not correlated with class characteristics. The cumulative distribution function for ideological sympathies ϵ_i is $F_i(\cdot)$, where higher values mean more right-wing sympathies. In addition, the election will be influenced by random popularity waves affecting the outcome after the political programs are written.

When parties run on platforms g_L and g_R, and $V_i(g_P, w_i)$ represents the social prefer-

ences for each voter, all voters in income class i for whom

$$V_i(g_L, w_i) - V_i(g_R, w_i) - \epsilon_i \geq 0 \tag{16}$$

votes left. In (16) a voter with $\epsilon_i > 0$ must evaluate the left sufficiently above the right platform in order to vote left.

Letting Δ_i be the critical level of ϵ_i that makes voters of income class i indifferent between the two parties, voters with $\epsilon_i \leq \Delta_i$ vote left, we can express the expected vote share of the left by $s_L = \sum_{i \in J} n_i F_i(\Delta_i)$, where n_i is the vote share of group i. We call $\Delta_i \equiv V_i(g_L; w_i) - V_i(g_R; w_i)$ the left-right utility threshold. Keeping policies $g_L > g_R$ and the distribution of marginal benefits of public spending constant, the expected vote share of the left is higher the higher is income: The left vote share increases with the left-right utility threshold Δ_i of each income class i, and all these thresholds increase with higher average incomes. Within each income class, individual thresholds increase with higher incomes. For given policy platforms, the probability that the left party wins must therefore go up with higher income per capita.

But the platforms are unlikely to stay constant. Denote the parties political preferences by $Z_P(g)$. The ideal party policies are $g_L^* > g_R^*$, where $Z_L'(g_L^*) = Z_R'(g_R^*) = 0$. The parties will not necessarily run on these preferred policies, however, as the parties are also interested in winning elections. Their objective is rather to maximize expected party utility, $qZ_L(g_L) + (1-q)Z_L(g_R)$ for the left party and $(1-q)Z_R(g_R) + qZ_R(g_L)$ for the right party, where $q = q(g_L, g_R)$ is the probability that the left wins.

The first order conditions for the parties' problems can be written as

$$q_1 \left[Z_L(g_L) - Z_L(g_R)\right] + qZ_L(g_L) = 0 \tag{17}$$

$$-q_2 \left[Z_R(g_R) - Z_R(g_L)\right] + (1-q)Z_R'(g_R) = 0 \tag{18}$$

where q_P is $\partial q(g_L, g_R)/\partial g_P$ for $P = L, R$. We see that the left reduces its welfare ambitions from their preferred policy to increase the probability of winning until the gain of winning, $Z_L(g_L) - Z_L(g_R)$, times the increase in winning chances equals the marginal costs of a less ambitious program, $-qZ_L'(g_L)$. Similarly, the right party increases its welfare program until its gain of winning times the increase in its winning chances equals the marginal ideological cost of more welfare spending.

The policy proposals diverge in equilibrium since the parties have different policy preferences. Thus, which party eventually wins the election matters. However, both $g_L > g_R$ and g_R shift with the preferences of the electorate; for a given mean wage, a more compressed wage structure means that a majority of the voters increase their income, and their demand for social insurance increase. An increase in the average wage yields a similar prediction.

We hence obtain the following result: Both the left party, i.e. the Social Democrats, and the right party, i.e. the Conservatives, may increase their policy stance towards a more generous welfare state in the face of wage compression.[26] Thus, a generous welfare state is not dependent on a Social Democratic party being in power, but rather the other way around: in order to win elections, political parties from the whole spectrum of parties have to shift their policies in a social democratic direction as wage compression shifts the political center of gravity.

It is not the case that only Social Democratic parties have been in power in the Scandinavian countries either. Since the 1960's in Norway, the 1970's in Sweden and the 1980's in Denmark, power has alternated between the left and the right. Prominent right and center governments like the Schlüter and Fogh Rasmussen governments in Denmark, the Willoch and Bondevik governments in Norway, and the Bildt and Reinfeldt governments in Sweden have ruled between one and two thirds of the years since 1980. Even though there has been significant changes to policies with shifting governments, the key ingredients of a generous welfare state has remained prominent in all the countries.

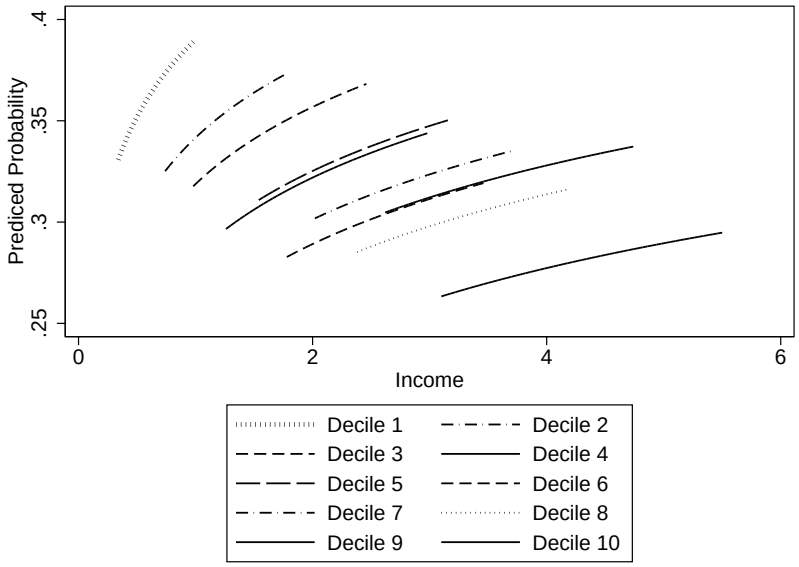
4.3 Does wage compression affect political outcomes?

The challenge in estimating the relationship between wage compression and political outcomes is that the marginal benefit of public spending and income are correlated. Ideally, one would like to estimate the effect of income on the support for welfare spending for a given exposure to risks.

To get at this question, Barth et al. (2013) use the Norwegian Election Survey from 1977 to 2001 to examine voters' attitudes towards social insurance. Individuals are asked "What is your opinion? Should social insurances be reduced in the future, should they be maintained at the current level, or should they be expanded?". Barth et al. (2013) utilize the quasi-panel structure of the data to distinguish between one's income and one's place in the income distribution, since they have observations of individuals with the same income, observed at different places in the distribution and vice versa over the 24 periods of the surveys. The estimated coefficient for one's place in the income distribution is interpreted as the effect of moving across the income distribution in a given cross-section of individuals. According to our model above, this effect should be negative, reflecting different levels of risks across income classes. The coefficient for income, conditional on one's place in the income distribution, is interpreted as the income effect for a given level of risks, and should thus be positive, in accordance with the result that social insurance is a normal good.

[26] This effect would be enforced for the left party by a shift in their ideal position, g_L^*, assuming that their ideals reflect the interests of poor voters, whereas the ideal position of the right, g_R^*, would be mediated, assuming that the right's ideals reflect the interests of voters above the mean income. Accounting also for changes in the ideal positions of the parties thus leads us to expect that the left party is more sensitive to changes in the wage distribution than the right party is.

Figure 4: Social Welfare Should be Expanded. Predicted probabilities



Notes: Predicted probability by income classes, calculated from a probit model of wanting to expand social welfare. 'Decile i' refers to members of decile group i. The model also includes controls for gender, age, socioeconomic status, education, household composition, spouse working, trend and expectations for the immediate future (see Barth et al., 2013, for details). The horizontal axis shows annual household income per consumption unit in 100,000 2000-NOK. Number of observations: 11,046.

Figure 4 illustrates the results. Here we have drawn the predicted probability of wanting to expand social welfare for individuals with different income in different income classes.[27] Each line illustrates one income class, and the path along the line illustrates the effect of an increase in income for that particular income class. We have drawn the lines in such a way that the lower income classes are only drawn out for lower incomes and so on.[28] The figure clearly shows that the probability of wanting to expand the social insurance is declining across income classes, but increasing within an income class, supporting the normal goods assumption made above.

A stark example of how the right wing parties have adopted typically social democratic ideas is given in a recent ideas' programme for the conservative party of Sweden, "Nya Moderaterna".[29] Under the heading "An orderly economy, full employment and securing welfare" it reads among other things that "Publicly funded welfare is an important part of our modern history and a springboard into the future" and that pre-schools, schools, health care, social assistance, and elderly care are at the core of the Swedish welfare state that the Moderates want to safeguard and develop. Furthermore, "The Moderates believe

[27]Income is measured as income per consumption unit in the household. Income class is measured as the decile of the household income distribution.

[28]The lines overlap in terms of income to illustrate that the same income level may be observed for different income classes in our data, because the model is estimated on surveys every fourth year from 1977 to 2001. The lines fan out since we use income in logs in the regression model, see Barth et al. (2013) for details and more specifications

[29]Available at `http://www.moderat.se/sites/default/files/ideprogram_2011_a4.pdf`.

Table 8: Welfare Support
Dependent variable: Party bloc position on welfare

	Left bloc	Right bloc
Wage inequality	-0.723***	-0.231
	(0.215)	(0.477)
Economic growth	0.076*	0.079
	(0.044)	(0.063)
Country FE	Yes	Yes
R-squared (within)	0.235	0.345
Number of countries	22	22
Number of elections	120	120

Notes: *** p<0.01, ** p<0.05, * p<0.1 Results from Barth et al. (2014). Data for party bloc position from The Comparative Manifesto Project, derived by extensive analyzes of party manifestos prior to each election. Robust standard errors adjusted for country clustering in parentheses. All models include controls for Percentage elderly, Trade openness, Union density, Union density-sq., Trend, Trend-sq. and Country fixed effects.

that schools, health services and social services should be publicly financed."

A more careful empirical assessment of our claim that wage compression and higher average incomes lead parties to propose more left-leaning policies, may be obtained from studying party platforms. The Comparative Manifesto Project[30] has collected and coded a huge number of party platforms. Barth et al. (2014) use information on policy platforms of left and right parties prior to 120 elections in 22 countries to assess the relationship between policy responses and wage inequality. One of their main results is shown in Table 8. The table shows regression coefficients from a regression of party block position on welfare. A positive number shifts the party position to the right, whereas a negative number shifts the position to the left. We only show the coefficients for two variables: Wage inequality and economic growth. Consistent with our theoretical model of the behavior of political parties, higher inequality is associated with a shift towards the right, significantly so for the left block parties,[31] and economic growth is associated with a shift towards the left.

5 Concluding remarks on complementarity

Why has the Scandinavian model worked so well? And, why has its institutions and policies survived, in spite of changing economic and political circumstances? Our answer to both questions is that there is a strong complementarity between the Scandinavian

[30] `http://manifestoproject.wzb.eu/`.

[31] The point estimates for the right wing parties have the same sign as the point estimates of the left party. As discussed (in footnote 26), we expect the effect of wage inequality to be weaker for the right block, but it may also be the case that the right block is comprised of more diverse parties across countries than the left block, see Barth et al. (2014) for more discussion.

non-market institutions and capitalist dynamics.

Our paper emphasizes the political-economic equilibrium between three set of mechanisms. Encompassing organizations in the labor market follow a policy of wage coordination and wage compression, with a strong preference for full employment in central bargaining and microeconomic efficiency in local bargaining. Wage compression leads to a higher pace of creative destruction and further wage compression with an increasing average wage. More wage equality and higher average wages fuel the political support for welfare spending. There might even be a feedback from public welfare policies to productivity rise and further wage compression. This complementarity explains why the same outcomes—efficiency and a high level of equality—could not have been achieved by redistribution through the political system alone.

This political-economic equilibrium path has benefitted from consistent policies that have supplemented market forces. Active labor market programmes and moderations on employment protection have been important policies to facilitate structural change and reallocation of labor without excessive wage differentials.[32] While Sweden innovated active labor market policies, Denmark has become famous for its "flexicurity" system, which combines low employment protection with generous social insurance, with an explicit aim at facilitating structural change. The other Scandinavian countries have medium levels of employment protection, and, in particular, an employer may downsize or shut down plants based on considerations of profitability and economic outlook without significant severance pay.

A similar concern for consistency is evident from the extensive use of 'work-fare' policies, which are used in Denmark, Norway and Sweden to ensure that work pays in the presence of generous welfare benefits. High employment reduces the cost of a generous benefit system and increases the tax base. Active job search or qualification efforts are for example required in order to obtain unemployment benefits.[33]

In sum, the complementarity between the non-market institutions and capitalist in-

[32] A central policy element of the Scandinavian model has been a combination of active labor market programmes (ALMP) aimed at upgrading the skills of unemployed workers with only moderate employment protection legislation (EPL). ALMP were promoted in Sweden as part of the "Rehn-Meidner Model" in the 1950's (Rehn, 1952) with the explicit aim of facilitating structural change. ALMP have been extensively evaluated, in particular with respect to employment prospects of unemployed workers, see e.g. Røed and Raaum (2006) who concludes that "programme participation, once completed, improves employment prospects, but that there is often an opportunity cost in the form of a lock-in effect during participation" and that the favorable effects outweigh the negative lock-in effects for participants with low employment prospects. Card, Kluve, and Weber (2010) provide an extensive meta-analysis, concluding that "[j]ob search assistance programmes yield relatively favourable programme impacts, whereas public sector employment programmes are less effective. Training programmes are associated with positive medium-term impacts, although in the short term they often appear ineffective."

[33] See Boone and Ours (2009) for a discussion of activation policies and Bennmarker, Skans, and Vikman (2013) for a recent evaluation of workfare policies during unemployment. An example is given by the very generous maternal leave support in Norway: while it is very generous, eligibility is based on previous employment and the size of the benefit is directly proportional to previous pay, thus providing young women with very strong incentives to work before they start a family.

vestments help explain why the main institutions and policies have survived over 80 years. The gains are spread widely across groups. There are many winners and few losers. Both low paid groups and employers are clear winners as wage compression and rising profits are two sides of the same coin. High skilled workers are potential losers. But also high skilled workers may gain from wage moderation, as the average productivity goes up.

The stability of the Scandinavian model can in part be explained by the good performance, and the good performance must have been helped by the stability of the model. The key is that both depends on the egalitarian aspects of the Scandinavian model that share the gains of good performance on almost all groups. Since the interactions between wage coordination, investments, and welfare spending all strengthen the egalitarian aspects of the model, it would not be possible to achieve the same egalitarian results by redistribution through the welfare state only.

References

Acemoglu, D., J. A. Robinson, and T. Verdier (2012). Can't we all be more like Scandinavians? Asymmetric growth and institutions in an interdependent world. NBER Working Papers 18441.

Agell, J. and K. E. Lommerud (1993). Egalitarianism and growth. *Scandinavian Journal of Economics 95*(4), 559–79.

Aghion, P. and P. Howitt (1992). A model of growth through creative destruction. *Econometrica 60*(2), 323–51.

Aghion, P. and P. Howitt (1998). *Endogenous Growth Theory*. Cambridge, MA: MIT Press.

Alesina, A. and G.-M. Angeletos (2005). Fairness and redistribution: Us vs. europe. *American Economic Review 95 913-35.*(September), pp. 913–35.

Alesina, A. F. and E. L. Glaeser (2004). *Fighting poverty in the US and Europe: a world of difference*. The Rodolfo DeBenedetti Lectures. Oxford: Oxford University Press.

Aukrust, O. (1977). Inflation in the open economy: A Norwegian model. In L. B. Krause and W. S. Salant (Eds.), *Worldwide inflation: Theory and recent experience*, Washington, D.C. Brookings institution.

Bartelsman, E., J. Haltiwanger, and S. Scarpetta (2009). Measuring and analyzing cross-country differences in firm dynamics. In *Producer Dynamics: New Evidence from Micro Data*, pp. 15–76. Cambridge, MA: National Bureau of Economic Research, Inc.

Barth, E., B. Bratsberg, T. Hægeland, and O. Raaum (2012). Performance pay, union bargaining and within-firm wage inequality. *Oxford Bulletin of Economics and Statistics 74*(3), 327–362.

Barth, E., A. Bryson, J. C. Davis, and R. B. Freeman (2014). It's where you work: Increases in earnings dispersion across establishments and individuals in the u.s. Paper presented at the 2014 Journal of Labor Economics Conference in honor of Edward Lazear, Stanford Graduate School of Business, CA.

Barth, E., H. Finseraas, and K. Moene (2014). Political reinforcement: How rising inequality curbs manifested welfare generosity. forthcoming in American Journal of Political Science.

Barth, E., H. Finseraas, K. Moene, and K. M. Nilsen (2013). Social insurance vs. redistribution. Mimeo, Institute for Social Research.

Bennmarker, H., O. N. Skans, and U. Vikman (2013). Workfare for the old and long-term unemployed. *Labour Economics 25*, 25–34.

Björklund, A. and R. B. Freeman (1997). Generating equality and eliminating poverty, the Swedish way. See Freeman et al. (1997).

Blau, F. D. and L. M. Kahn (1996, August). International differences in male wage inequality: Institutions versus market forces. *Journal of Political Economy 104*(4), 791–836.

Boone, J. and J. Ours (2009, September). Bringing unemployed back to work: Effective active labor market policies. *De Economist 157*(3), 293–313.

Bosworth, B. P. and A. M. Rivlin (Eds.) (1987). *The Swedish Economy*. Washington, D.C.: Brookings Institution.

Calmfors, L. (Ed.) (1990). *Wage Formation and Macroeconomic Policy in the Nordic Countries*. Oxford University Press.

Card, D., J. Kluve, and A. Weber (2010). Active labour market policy evaluations: A meta-analysis. *The Economic Journal 120*(548), F452–F477.

Dixit, A. and J. Londregan (1996, November). The determinants of success of special interests in redistributive politics. *Journal of Politics 58*(4), 1132–1155.

Dunlop, J. (1944). *Wage determination under trade unions*. New York. MacMillan.

Edgren, G., K.-O. Faxen, and C.-E. Odhner (1973). *Wage Formation and the Economy*. London: George Allen & Unwin, Ltd.

Elster, J. (1989). *Cement of Society: A Survey of Social Order*. London: Cambridge University Press.

Esping-Andersen, G. (1990). *The Three Worlds of Welfare Capitalism*. Cambridge: Polity Press.

Flanagan, R. J. (1993). Part I: Can political models predict union behaviour? In R. J. Flanagan, K. O. Moene, and M. Wallerstein (Eds.), *Trade Union Behaviour, Pay Bargaining and Economic Performance*. Oxford: Clarendon Press.

Fredriksson, P. and R. H. Topel (2010). Wage determination and employment in Sweden since the early 1990s: Wage formation in a new setting. In *Reforming the Welfare State: Recovery and Beyond in Sweden*, pp. 83–126. Chicago, IL: The University of Chicago Press.

Freeman, R. and R. Schettkat (2001, July). Skill compression, wage differentials, and employment: Germany vs the us. *Oxford Economic Papers 53*(3), 582–603.

Freeman, R. B., R. H. Topel, and B. Swedenborg (1997). *The Welfare State in Transition: Reforming the Swedish Model*. National Bureau of Economic Research, Inc.

Gibbons, R. and L. F. Katz (1992, July). Does unmeasured ability explain inter-industry wage differentials? *Review of Economic Studies 59*(3), 515–35.

Groshen, E. L. (1991, August). Sources of intra-industry wage dispersion: How much do employers matter? *Quarterly Journal of Economics 106*(3), 869–84.

Hall, P. A. and D. Soskice (2001). *Varieties of Capitalism. The Institutional Foundation of Comparative Advantage*. Oxford University Press.

Holden, S. (1988). Local and central wage bargaining. *Scandinavian Journal of Economics 90*(1), 93–99.

Hopenhayn, H. A. (1992). Entry, exit, and firm dynamics in long run equilibrium. *Econometrica 60*(5), 1127–1150.

Hsieh, C.-T. and P. J. Klenow (2009). Misallocation and manufacturing TFP in China and India. *Quarterly Journal of Economics 124*(4), 1403–1448.

Jovanovic, B. (1982). Selection and the evolution of industry. *Econometrica 50*(3), 649–670.

Krueger, A. B. and L. H. Summers (1988, March). Efficiency wages and the inter-industry wage structure. *Econometrica 56*(2), 259–93.

Layard, R. (1991). *Why Abandon the Swedish Model?* Trade Union Instiute for Economic Research.

Leontief, W. (1946). The pure theory of the guaranteed annual wage contract. *Journal of Political Economy 54*(1), 76–79.

Leuven, E., H. Oosterbeek, and H. van Ophem (2004, 04). Explaining international differences in male skill wage differentials by differences in demand and supply of skill. *Economic Journal 114*(495), 466–486.

Lindbeck, A. (1997). The Swedish experiment. *Journal of Economic Literature 35*(3), 1273–1319.

Lindbeck, A. and J. W. Weibull (1987). Balanced-budget redistribution as the outcome of political competition. *Public Choice 52*(3), 273–297.

Lundberg, E. (1985). The rise and the fall of the Swedish economic model. *Journal of Economic Literature 23(1)*, 1–36.

McDonald, I. M. and R. M. Solow (1981, December). Wage bargaining and employment. *American Economic Review 71*(5), 896–908.

Moene, K. O. (1988). Union's threats and wage determination. *Economic Journal 98*(391), 471–483.

Moene, K. O. and M. Wallerstein (1997). Pay inequality. *Journal of Labor Economics 15*(3), 403–430.

Moene, K. O. and M. Wallerstein (2001). Inequality, social insurance and redistribution. *American Political Science Review 95*(4), 859–874.

Moene, K. O., M. Wallerstein, and M. Hoel (1993). Part II: Bargaining structure and economic performance. In R. J. Flanagan, K. O. Moene, and M. Wallerstein (Eds.), *Trade Union Behaviour, Pay Bargaining and Economic Performance*. Oxford: Clarendon Press.

OECD (2012). *OECD Employment Outlook*. Paris: OECD.

Olson, M. (1990). *How Bright are the Northern Lights? Some Questions about Sweden*. Institute of Economic Research.

Røed, K. and O. Raaum (2006). Do labour market programmes speed up the return to work? *Oxford Bulletin of Economics and Statistics 68*(5), 541–568.

Rehn, G. (1952). The problem of stability: An analysis of some policy proposals. In R. Turvey (Ed.), *Wage Policy under Full Employment*. London: W. Hodge.

Rodrik, D. (1998). Why do more open economies have bigger governments? *Journal of Political Economy 106*(5), 997–1032.

Scruggs, L. (2006). The generosity of social insurance, 1971–2002. *Oxford Review of Economic Policy 22*(3), 349–364.

Shaked, A. and J. Sutton (1984). Involuntary unemployment as a perfect equilibrium in a bargaining model. *Econometrica 52*(6), 1351–1364.

Wallerstein, M. (1999). Wage-setting institutions and pay inequality in advanced industrial societies. *American Journal of Political Science 43*(3), 649–680.

Willumsen, F. (2011). Trade and wage equality. Mimeo, University of Oslo.

Zweimüller, J. and E. Barth (1994). Bargaining structure, wage determination, and wage dispersion in 6 OECD countries. *Kyklos 47*(1), 81–93.

A Additional theoretical results

A.1 Wage compression and investments with labor sorting

Consider period t. Efficient sorting requires that the high skill group is allocated to the most efficient plants, implying $\theta_H n = \gamma$ and $\theta_L n = 1 - \gamma$. The wage distribution that can support this efficient sorting requires a sufficient wage premium so that it is only profitable for high productivity firms to employ high skill workers. The least productive enterprise that employs high skill workers (vintage $t - \theta_H$)) is on the margin indifferent between employing a high skill worker and paying the wage premium $[W_H(t) - W_L(t)]$, and employing a low skill worker:

$$p_H F(t - \theta_H) - W_H(t) = p_L F(t - \theta_H) - W_L(t) \tag{A.1}$$

Clearly, the wage $W_L(t)$ just clears the labor market, implying $W_L(t) = p_L F(t - \theta_H - \theta_L)$. Thus we have $W_H(t) = w_H(1 + \lambda)^t$ and $W_L(t) = w_L(1 + \lambda)^t$, where the parameters w_H and w_L are endogenous. The efficient wage premium is given by

$$w_H - w_L = \frac{(p_H - p_L)f}{(1 + \lambda)^{\theta_H}} \text{ and } w_L = \frac{p_L f}{(1 + \lambda)^{\theta_L + \theta_H}} \tag{A.2}$$

and the wage differential becomes

$$\frac{w_H - w_L}{w_L} = \frac{p_H - p_L}{p_L}(1 + \lambda)^{\theta_L} \tag{A.3}$$

We have the following results:

- The efficient distribution of wages is more unequal than the distribution of workers productivity p_i. The wage differentials are magnified by allocating the most productive workers to the most productive enterprises.

- The wage differences are higher the higher the technological change, since a high technological change enhances the productivity differences between each vintage.

- The wage differentials become lower by increasing the fraction of high skill workers, as a higher supply of high skill workers imply that they on the margin are employed by less productive enterprises.

Along the steady state path, the profits of investing (in period $t = 0$, using (11)) are $\pi = (\theta_H p_H + \theta_L p_L)f - (w_H - w_L)x(\theta_H) - w_L x(\theta_H + \theta L)$. Using $\theta_H = \gamma/n$, and $\theta_H + \theta L = 1/n$, the free entry condition becomes

$$[(p_H\gamma + p_L(1-\gamma)(1/n) - (p_H - p_L)x(\gamma/n) - p_L x(1/n)]f = b(n) \tag{A.4}$$

where the left hand side is decreasing in n and the right hand side is increasing in n.

Wage compression would distort the most efficient allocation of workers. If the wage premium is a fraction β of the efficient premium $(w_H - w_L)$ given by (A.2), workplaces with θ in the interval $\theta_H \leq \theta \leq \hat{\theta}$ would also be able to compete for high skill workers, where $\hat{\theta}$ is determined by the indifference condition (A.1) (with $t = 0$)

$$(w_H - w_L) = \beta(p_H - p_L)f(1+\lambda)^{-\hat{\theta}} \tag{A.5}$$

Workplaces with $\theta \leq \hat{\theta}$ compete for high skill workers. With equal chances of actually hiring the worker, total production is given by the sum

$$(p_L f x(1/n) + \left[\frac{\theta_H}{\hat{\theta}}p_H + (1 - \frac{\theta_H}{\hat{\theta}})p_L - p_L\right] fx(\hat{\theta}) < p_L f x(1/n) + (p_H - p_L)fx(\theta_H) \tag{A.6}$$

The costs from less efficient sorting can be small if $\hat{\theta}$ is close to θ_H. Yet, in any case there is a clear effect on new investments. Future revenues of the investment are

$$p_L f(1/n) + \left[\frac{\theta_H}{\hat{\theta}}p_H + (1 - \frac{\theta_H}{\hat{\theta}})p_L - p_L\right]\hat{\theta} + (\theta H + \theta_L - \hat{\theta})p_L f = (1/n)p_L f + \theta_H(p_H - p_L)f \tag{A.7}$$

Since future revenues are not affected directly by β, but wage costs decline, we have that $dn/d\beta < 0$. Hence, wage compression (lower β) increases modernization n.