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Downsizing nature: managing risk and knowledge economies through production subcontracting in the Oregon logging sector

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Abstract. The logging sector in Oregon is characterized by extensive subcontracting between wood-commodity manufacturing firms and independent logging contractors. Why is this so? Considerable recent scholarship has examined the dynamics of flexible production systems, including regional contractor networks, as prominent aspects of late capitalism. Although useful, existing accounts of flexibility are inadequate to explain why logging in particular would be subject to contract production relations. A second literature emphasizes the 'difference' of nature-centered sectors, particularly industrial agriculture. I argue that a similar logic applies to logging. That is, natural sources to unpredictable variation and extensive, inconstant geographies restrict the predictability and calculability of production, and the imposition of labor monitoring and discipline. Contracts are a strategy for firms to displace resulting risks and costs onto contractors, while at the same time inducing expert-based rationalization of production. Repeat contracting provides a means of capturing expert knowledge among reliable contractors with knowledge of the parent firm's lands and mills. This is a particularly appealing strategy for vertically and horizontally integrated firms with complex operational portfolios. However, though contracting is one flexibility strategy, Weyerhaeuser's Competitive Logging Program featuring restructured wage relations provides an alternative path to more flexible production, one that further illuminates some of the problems of nature-based production.

"Bring me some whistle punks ..."

In the state of Oregon, most logging is accomplished via the practice of subcontracting. This involves wood-commodity manufacturing firms tendering contracts to quasi-independent logging contractors—referred to in the industry as 'gyppos'—to secure logging services. Although some wood-products mills continue to run their own logging crews (referred to in the industry as logging 'sides'), subcontracting has increasingly become the dominant form of industrial relation linking the factory floor to the woods during the period after World War 2. Given that the industry is not otherwise characterized by the existence of contract production networks (reforestation notwithstanding), *why is contract logging so prevalent*?

In this paper, I explore why many wood-products firms undertake logging by means of relatively arms-length industrial relations. I explain the incentive to contract out and to pursue other alternatives to fixed hourly wage relations as strategies for achieving production flexibilities in response to the nature-centered character of production in the logging sector. Specifically, I argue that variability, risk, and uncertainty associated with the 'in situ' character of logging production—that is, the intimate engagement of social and natural production—creates an incentive for firms to minimize their exposure to these risks and uncertainties while at the same time inducing rationalized production. Not only does this explain why contract logging appeals to wood-products manufacturing firms, it also explains why the largest firm in the state's forest industry—Weyerhaeuser—has pursued both contract logging and,

more recently, restructured wage relations featuring production-based incentives for unionized company loggers.

There is a considerable existing literature on contract production networks as a feature of late capitalism. Such networks—specifically their apparent resurgence—underpin notions of post-Fordist production systems and are critical to debates over the dynamics of social power in contemporary industrial relations. This literature tends to emphasize contracting as a strategy for achieving both flexible and lean production, insulating firms from unpredictable variations in market demands and circumventing the comparative rigidities of vertically integrated social structures and fixed hourly wage relations. These explanations are adequate in certain respects; subcontracting *does* act to insulate contracting firms from market risks, and may be seen to confer certain flexibilities in production relations. However, the reason why certain elements of production would be targeted for 'putting out' remains to be explained. If, following Scott (1987), this turns on internal and external economies of scope, how do firms decide what to do in house and what to accomplish via contracting? Addressing this issue requires careful consideration of specific material aspects of production processes, consistent with a 'problem-oriented' approach to industrial organization (Sayer, 1989; 1995). In the specific context of logging, this requires addressing what I refer to as 'nature-centered' production.

In what follows, I first provide some contextual information on logging in Oregon. I then review in greater depth some theoretical approaches to contract networks, wage relations, and flexibility perspectives on contemporary industrial systems. Subsequently, I turn to the ways in which nature-centered production has been theorized as an influence on the social organization of food, fiber, and raw materials sectors. In particular, I discuss nature as a source of risks, uncertainties, and rigidities, and therefore a possible influence on the incentive to contract out. I then examine the specific dynamics of social and natural production in the logging sector, with emphasis on the ways that subcontracting relations insulate firms from certain production risks and at the same time encourage more efficient production in the face of nature-centered obstacles to more direct avenues of rationalization. I argue that, although subcontracting is an attempt to achieve insulation from risk and greater flexibilities, contract relations of production in Oregon logging are not always the arms-length ideal invoked by apparently dichotomous choices to 'make' to 'buy' (Coase, 1937). Instead, numerous firms, including some of the region's largest, pursue relations of production that are decidedly more 'sticky' or enduring. This has very much to do with information economies of scale, echoing Storper's (1997) argument that untraded interdependencies in input–output relations propel agglomeration and repeat contracting in regional production networks. Here again, the question of nature is crucial, not least because specialized knowledge comes in part from contractor familiarity with a particular firm's timber holdings.

I close by discussing how information economies combined with concerted efforts by a major woodworkers union induced Weyerhaeuser to revisit and restructure wage relations with its company loggers under the company's Competitive Logging Program. Most recently, Weyerhaeuser has decided to revert entirely to company logging, abandoning contracting. This indicates an alternative strategy for achieving flexibility, but one that also reflects the ways in which nature-centered production in logging leads to expertise among employees, expertise that the company seeks to enlist through restructured wage relations. In addition, however, the Weyerhaeuser case points to the contingent ways in which economic incentives translate into production relations; solutions to the flexibility problem need not be unique. Moreover, the Weyerhaeuser case, revolving around collective bargaining with a major wood-products union, also

points to the politically contingent development of social relations in time and space. I take up this topic in greater detail elsewhere by examining the historical politics of industrial relations in Oregon logging (Prudham, 1999).

Motivation, context, and method

Production relations in the Oregon logging sector are of some interest and importance. For most of the last seventy years, the state has been the leading producer of softwood and solid wood products output in the United States. Despite dwindling supplies of 'old-growth'[1] timber and significant reductions in federal timber sale programs in the state, Oregon remains a hub for the forest products industry. In 1997 Oregon led all states in both logging employment and value added (see figure 1) (USBC, 1999). Although logging accounts for a relatively small proportion of the state's overall employment, it remains important to the state's hinterland, where the forest sector is still prominent in many small, remote communities.

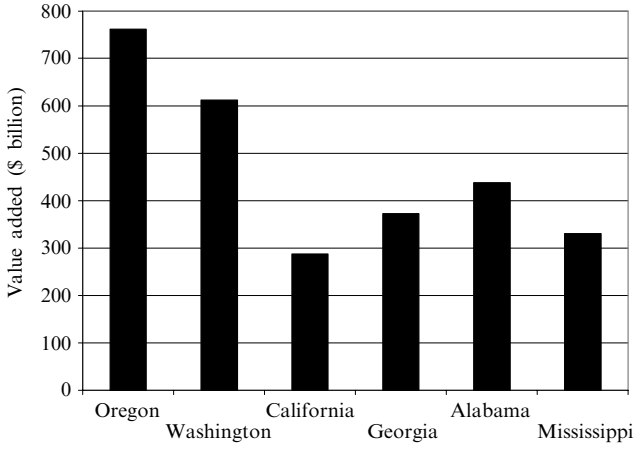

Figure 1. Value added in logging in leading states, 1997 (source: USBC, 1999).

The high profile of logging in the state makes its social organization an important concern. This is particularly the case given that there are substantial differences in wages and benefits between loggers working on company sides and those employed by gyppo outfits.[2] Moreover, extreme differences in job security and seniority protections distinguish gyppo and company sides, with rampant age discrimination among gyppos. The character of logging being what it is (difficult, arduous, and dangerous), there is a premium on both youth and skill, and workers deemed too old to work tend to be discarded by contractors. Wage and job-security differences in turn are related closely to the fact that contracting in the Oregon logging sector is virtually synonymous with the use of nonunion labor in the woods; unionized loggers are company loggers, and gyppo loggers are nonunion. In short, if you work in the Oregon logging sector, what kind of a job you have is in large measure determined by whether you work directly for a mill on a company side or for a gyppo contractor.

[1] Old-growth is defined in various ways, but typically refers to what the industry calls 'overmature' stands, characterized by a preponderance of trees in excess of 150 years old.

[2] These differences vary considerably because gyppo contractors use different pay scales. Data on average salaries between contract and company loggers are not available. However, according to the 1997 Census of Manufactures, the average hourly production wage in the Oregon logging sector was $14.75. Based on the interviews I conducted with gyppo contractors, a typical gyppo employee can expect a salary more in the $10 – 12 range.

Not only is contracting central to the social distribution of surplus in Oregon logging but, at the same time, contracting is important because it represents a strategy for firms to manage risks, uncertainties, and rigidities in production. In particular, contracts allow wood-products firms to displace the costs of dealing with these problems onto gyppo contractors and their employees. In this sense, contracts are fundamentally not a meeting of equals in exchange. Rather, they are an instrument of power used to achieve flexibility via shorter term commitments to gyppo loggers, and at the same time to pursue integration and control via specific contract terms, various asymmetries in regional market competition, and differential control of assets (Harrison, 1994; Holmes, 1986; Sayer and Walker, 1992). Thus, as Watts (1994) has argued in reference to agricultural contracts, the salience of contracting from a political standpoint is that it represents a means by which firms both subordinate subcontractors and draw them into the production sequence.

Despite the salience of contract logging, information directly indicating the number of gyppo logging sides versus company sides in Oregon is not available. This is in large measures a result of establishment-based reporting in the Census of Manufactures which does not differentiate between the two types of firm organization. However, data compiled by the Associated Oregon Loggers (AOL—a group representing gyppos) in conjunction with census data and interviews I conducted with key industry observers and participants all indicate that company crews now account for no more than 10–15% of the industry, or between 800 and 1200 employees statewide.[3] The remaining 7000 to 8000 workers work for gyppo outfits.

To supplement the scant existing information on gyppo production in Oregon, I conducted field research during 1997. I spent approximately six months in the Eugene–Springfield area of central-western Oregon, as part of a larger project on restructuring of the Oregon forest industry (Prudham, 1999). The Eugene–Springfield area is centrally located within the state, and is a major hub for the state's forest industry. In particular, Eugene–Springfield is home to numerous commodity-manufacturing facilities, a concentration of gyppo logging firms, and numerous individuals with knowledge of the industry. Moreover, it is close to extensive private and public timberlands with active logging operations.

In the study, I conducted in excess of 150 interviews overall, including about twenty-five pertaining directly to production relations in the logging sector. My method involved semistructured interviews with key informants. Interview subjects represented a breadth of individuals with expert knowledge of the logging sector in Oregon, including: gyppo logging contractors; company loggers; forest company management; government officials; academics; industry lobbyists and industry group representatives; consultants; and union representatives and staff. I supplemented these interviews with analysis of historical and contemporary documents pertaining to the Northwest logging sector, and census data.

[3] This estimate is based on conversations with several people, including an interview conducted with a union representative on 2 September 1997 with a follow-up on 28 October 1998 and an interview conducted on 25 September 1997, also with a union representative. It is also based on inferences drawn from the Census of Manufactures, and information provided by the AOL. According to the most recent AOL estimates, there are about 840 active independent logging contractors in Oregon. The 1997 Census of Manufactures reports 1130 logging establishments in the state. This would indicate that on the order of one quarter to one third of the logging establishments are company logging establishments. However, the census allows for firms to be counted more than once if they have multiple establishments, and the AOL survey indicates that the average logging contractor maintains 1.8 logging sides.

To make or buy

A central preoccupation of research on the character of late capitalism concerns on apparent transition from 'Fordism' to 'post-Fordism' in patterns of both capital accumulation and social regulation (for example, see Amin, 1994; Harvey, 1989; Piore and Sabel, 1984). In this context, one of the foundations behind the notion of post-Fordist production systems is the idea that recent decades have seen an increasing emphasis on achieving *flexibility* in production systems. This is a broad term referring to a myriad of ways that mass-production systems typical of Fordism and propelled by large-scale economies in manufacturing are giving way to, inter alia, batch-oriented production systems, just-in-time delivery, and rapid adaptation to changing domestic and international markets.

Varying interpretations of what flexible production or specialization may mean and over what historical period it has emerged persist (for example, Amin, 1994; Gertler, 1988; Sayer, 1989). Yet, employment relations are critical. Contractor networks have emerged as a focus in studies of dynamic industrial districts (for example, see Saxenian, 1994; Scott, 1987; 1988a; Storper, 1997), and contracts are considered to be one of the central instruments that firms (large and small) have employed in search of both enhanced flexibility and so-called lean production (Harrison, 1994). Sayer and Walker (1992), for example, identify subcontracting between lead capitalist firms and subordinate networks of contract parts and labor suppliers as an integral part of what they refer to more broadly as the 'new social economy'.

Many explanations of subcontracting have been offered. For example, subcontracting has been linked to the development of 'leaner' production systems, that is, stripped-down production processes that capitalize on a firm's core strengths, while putting out for other activities (Norcliffe and Bates, 1997). Transactions cost theory has been widely used to explain which activities are contracted out and which are not, based on neoclassical ideas of cost minimization, and ultimately, on Coase's (1937) well-known opposition of vertical integration (make) and market transactions (buy) as alternative firm strategies. In particular, transactions costs have been invoked to address internal and external economies of scope (Scott, 1987; for a recent example, see Ó hUallachàin and Wasserman, 1999). At the same time, the proliferation of contracting has been tied to possibilities opened by new information technologies, allowing better just-in-time coordination of supply chains over increasingly far-flung production networks (Castells, 1996; Piore and Sabel, 1984).

Yet, the choice to make or buy is not seen as purely a technical one. Rather, contract production is also discussed as an increasingly prevalent strategy for firms to remain competitive in the face of fragmentation and volatility in domestic and international markets, and to capture the expertise and creativity of smaller, more independent, and specialized producers (Hayter, 2000; Hayter and Barnes, 1997). In this context, some emphasis has been placed on the ways in which risks of various kinds, including the risks of market fluctuations, are displaced by contractors from larger firms to smaller, quasi-independent suppliers of parts and services (Harrison, 1994; Holmes, 1986).

In this context, the efficiency of specific regional contracting systems has been theorized in terms of capturing knowledge economies within dense networks of localized competing contracting firms and their contract suppliers. Repeat contracting and negotiated prices among parent firms and contract producers who gain familiarity with one another is a noted aspect of the geography of flexible production networks in the context of numerous manufacturing districts. Storper (1997) discusses these as local networks of input–output relations based on so-called 'untraded interdependencies'.

Specialized contractors familiar with the needs of contracting firms compete in markets that occupy a space between pure, open competition and vertical integration or formal partnerships. One of the main reasons for some degree of continuity and loyalty in these regional systems of contracting stems from the development of knowledge economies and trust. Knowledge economies vis-à-vis specific production processes develop through repeat contracting between firms. Such knowledge can improve quality, while also simplifying negotiations and reducing transactions costs. At the same time, repeat contracting builds trust, central to efficient markets (Bowles and Gintis, 1993).

One of the additional features of many subcontracting systems and certainly one germane to the Oregon logging sector is that such systems often circumvent collective bargaining agreements with unionized employees. In this sense, discussions of the ways in which contracting helps to deal with particular technologies, risks, and uncertainties must also address the ways in which contracting is central to the social distribution of surplus. This raises the issue of who bears the costs of flexibilities, a question not only of efficiency, but also of social power and control (for example, Harrison, 1994; Holmes, 1986; Hudson, 1989; Walker, 1995). However, circumventing the apparent 'rigidities' of collective bargaining agreements should not be seen as an entirely distinct rationale for the pursuit of flexible solutions. Rather, this strategy may be understood in part as instrumental to the pursuit of flexibility encouraged by an assortment of changing economic and technological conditions (Norcliffe and Bates, 1997). Moreover, once the issue of politics has been broached, it becomes important not to reify contracting as the only game in town, to the exclusion of other ways of achieving greater flexibilities. For example, restructured industrial relations such as team-based production techniques may achieve some flexibility goals within vertically integrated wage structures (Sabel, 1995).

The flexibility literature offers important insights about the comparative efficiencies of contracting, repeat contractor networks, and various and more flexible forms of integrated wage relations. Two related problems emerge, however, in trying to understand the pursuit of flexibility in Oregon logging. First, the literature generally does not provide an adequate explanation as to why particular activities would be subject to pressures for restructuring and contract production. For example, Scott (1987, page 220) notes, "... scope effects (i.e. internal and external economies of scope) are ultimately defined by transactions costs, which in turn have both institutional and technical foundations". Yet, what are these foundations, and how is it that particular activities come to be isolated for potential outsourcing? How is it that some labor processes are designated lean, and others 'lard'?

Second, very little work has examined the development of flexible production in natural resource industries and, in particular, the role that nature-based production might have in encouraging the pursuit of flexible production via nontraditional employment relations (although see Boyd and Watts, 1997). Moreover, very little work has been done applying the notions of Fordism or post-Fordism to the forest industry. Although Graham and St. Martin (1989) examine restructuring in the global solid-wood-products industry, they focus largely on the dynamics of changing resource availability, regional specialization, and product differentiation. There has been some research on industrial restructuring and the pursuit of various forms of flexible production in the Canadian forest products sector (see Barnes and Hayter, 1992; 1994; Hayter and Barnes, 1997; Holmes, 1997; Norcliffe and Bates, 1997). Yet, little has been written about logging or nature per se. Although Hayter (2000) discusses changing resource and regulatory dynamics as important influences on the British Columbia forest industry, he does not explore links or tensions between the emergence of post-Fordist production systems and the influence of resource depletion and environmental

politics. Norcliffe and Bates (1997) specifically discuss subcontracting of wood-cutting operations in the drive to achieve lean production at a Newfoundland newsprint mill during the late 1980s and early 1990s. But their emphasis is on the broad architecture of lean manufacturing at the mill. They do mention changing environmental regulations and far-flung labor deployment as factors in the designation of logging as a peripheral (noncore) labor process, but they do not dwell on the issue.

Nature-based production and social relations

Because there is a general (if misguided) perception that natural resource industries are the hallmark of economic backwardness (Walker, 2001), it should come as no surprise that research on the new social economy would generally overlook such sectors. Yet there is a strong basis for the argument that nature-based production activities involve certain variabilities, risks, and uncertainties that encourage firms to seek flexibility in production relations, including subcontracting. One of the important themes within contemporary social theory and nature revolves around the difference that nature makes, that is, how nature works as a "material entity and actor in history" (Castree, 1995, page 25; see also Benton, 1989).[4] In reference to nature-based production, considerable emphasis has been placed on both the uneven social production and reproduction of nature *and* the problematic ways in which natural inputs are appropriated into the circuits of capital accumulation (for example, see Bridge, 2000; O'Connor, 1988; Smith, 1984).

In particular, numerous observers have argued that close reliance on natural systems within 'natural resource' or nature-based industries helps shape the organization of production in these sectors (for example, Barham and Coomes, 1994; Bunker, 1989; for discussion, see Boyd et al, 2001). This is a particularly strong and established theme in agrarian political economy. For example, Mann (1990) has specifically argued that agriculture's nature-centered character presents obstacles to the penetration of agricultural capital. Drawing on Marx and on Kautsky (1988), Mann calls for an agrarian political economy that emphasizes "how various natural features of certain branches of agriculture can serve as impediments to the efficient use of advanced technology and wage labor" (page 3). One example of such mechanisms is provided by seasonal fluctuations and delays in animal and crop maturation, time schedules that confront both the continuous deployment of capital and labor and the transformation of production processes (see also Goodman and Redclift, 1991). In particular, Mann points to the difference between production time and labor time, arguing that crop cycles extend production time, and create unevenness in the demand for wage labor. This produces an incentive for agrarian capital to achieve flexibility in production relations by exploiting contract and household labor, and by passing on the risk of production variabilities through contracts and piece wages. In short, agriculture's nature-centered character provides a rationale for production relations with what Mann refers to as "a much different complexion than that found in industry proper" (1990, page 39).

Agriculture's extensive geography has also been identified as a constraining influence. Goodman et al (1987) refer to this problem as the constraint of land as space, arguing that it is one of the structural peculiarities of agriculture helping to shape the trajectory of social and technological change. Land-based production implies variable conditions under which labor and machinery are deployed. It also gives rise to an extensive geography. Kautsky himself (1988) in fact argued that this extensive geography

[4] This is a broad project. See, inter alia, Altvater (1993), Castree (1997), Castree and Braun (1998), Cronon (1983; 1991; 1992), FitzSimmons (1989), Goldblatt (1996), Harvey (1996), Redclift and Benton (1994), and Smith (1984).

produced an inherent constraint to the development of scale economies in agriculture by blocking the dramatic centralization of production characteristic of emerging factory facilities. He noted further that such extensive geographies of production create obstacles to effective labor supervision, and thus coercive rationalization.

Although the development of this line of inquiry is strong in agrarian political economy, similar thinking may be applied to a range of nature-based industries, particularly with respect to the ways that social relations coaelsce. Benton (1989) has argued that agricultural labor processes are examples of what he refers to more generally as 'ecoregulatory' activities. He identifies four central features of such activities: (1) labor is applied to optimizing conditions of transformation, that is, organic processes, which are relatively impervious to intentional modification; (2) labor is primarily aimed at sustaining, regulating, and reproducing, rather than transforming, those conditions and processes; (3) the organic character of production shapes the temporal and spatial distribution of social production; and (4) certain natural conditions of production (for example, water, sunlight) act both as conditions of production and as the subjects of labor (Boyd et al, 2001).

My argument here is that the pursuit of more flexible production relations in Oregon logging provides a specific example of feature (3) of Benton's typology of ecoregulation. In particular, the 'difference' that nature makes lies in breaking down the regularities typical of factory-production regimes via a number of decisive disruptions. These disruptions act not to block or prevent capital accumulation per se, but as has also been described in relation to agriculture, to shape and constrain industrial development—including production relations—in important ways (Goodman et al, 1987). Thus, natural 'obstacles' become the vehicles or organizing principles around which firm strategies and organizations coalesce (Boyd et al, 2001; Henderson, 1998). The contract in particular can be understood as a key instrument or building block by which capital has imposed discipline and subordinated labor in the context of highly specific "biological and geographic peculiarities" (Watts, 1994, page 71), achieving in the process a form of flexibility in production. In short, Oregon logging provides an example of how production subcontracting and other nontraditional employment relations reflect responses to the challenges of nature-centered production.

Social and natural production in logging

The nature-centered character of logging generates a number of risks and uncertainties by challenging the continuous deployment of machinery and labor, rationalization of the labor process, and prediction and regulation of production costs and returns. Specifically, logging presents three basic kinds of ecoregulation: (1) extensive geographies; (2) frequent relocations and landscape heterogeneity; and (3) variable weather. All of these confront the continuous deployment of labor, undermine labor supervision, and impede the predictability and rationalization of production. They also contribute specifically to extraordinarily high accident rates in the industry, which themselves act as obstacles to more rational production.

Extensive geographies of production

Without question, the increasing prevalence of integrated logging machinery (for example, feller-bunchers) is reshaping logging operations (MacDonald and Clow, 1999). This fits into a longer term process of technological and social reorganization in logging over the last century (see Prouty, 1988; Rajala, 1998; Williams, 1989). Nevertheless, most logging systems in use in the Pacific Northwest, including commonly used 'high lead' systems, involve an extensive geography of labor deployment that

makes coordination difficult.[5] In the woods, workers are typically deployed over a wide area and are constantly on the move. In a heterogeneous forest environment, particularly in the uneven topography of the Oregon Douglas-fir region, this makes supervision and the imposition of labor discipline extremely difficult. The most extreme example of this is provided by the workers who actually fell the trees ('cutters'). Because of logistical issues and the dangers involved, cutters typically work separately from the rest of the logging crew, often cutting as much as a month ahead. This creates obvious coordination and supervision problems, and many gyppos actually subcontract cutting to independent contract cutters.

Yet, even at the landing site, coordination and control are hard to achieve. Workers must gather or 'yard' downed logs to a central area in order to prepare them and load them for shipping. Once the logs have been gathered, they need to be cleaned up and cut ('bucked') into specific lengths, depending on the requirements of different mills. The logs also need to be sorted and graded according to log quality in relation to the specifications of different kinds of mills (for example, sawmills versus veneer mills) and the prevailing market demand for different kinds of log (sawlogs and 'peelers', respectively). Finally, the sorted logs need to be loaded onto trucks for transport out of the woods. These tasks all require the combination of speed and skill on the part of workers, and a high degree of coordination. Yet, at the same time, the different jobs on site must be executed in a maze of downed logs, scrub brush, uneven terrain, and noisy equipment.

On-site coordination of the various tasks is difficult to achieve from processing facilities because logging sites are typically far removed from the mills. In fact, as wood-processing efficiencies have improved and as scale economies in mills have escalated, transportation costs have declined, making it possible for mills to source timber from greater and greater distances (Mead, 1966; Mead et al, 1983; Prudham, 1999; Williams, 1989). For example, one mill in Eugene has hauled logs from as far away as Sacramento, California, a distance of over 450 miles. Although such distances are not typical, the average spatial separation between logging sites and mills has certainly increased over time, making coordination more and more of a challenge.

Inconstant geographies

This problem is compounded by the need for frequent relocation. Commercial tree species in the Northwest have extremely long rotation or maturation ages. For example, Douglas-fir, the region's staple tree, takes about sixty to eighty years to reach commercial maturity in western Oregon (Lettman, 1988). This means that the disparity between production time and labor time dwarfs the seasonal problem in agriculture, with significant geographic implications. That is, although logging parallels agriculture's land-based deployment of labor with attendant problems for monitoring and control, logging operations also present the challenge of relocating on a regular and frequent basis in order to renew timber supplies.

At the same time, not only does frequent relocation exacerbate the labor-control problem, it is accompanied by wide variations in conditions from one logging site to another. In the uneven terrain of the Pacific Northwest, such variations are numerous. Local timber stands vary widely, for instance, in the density of tree growth (measured either in stems per acre or in total volume per acre). One example of this is given by

[5] There is still a significant difference between logging technologies used in the Pacific Northwest, and those used in other parts of the world. Specifically, advanced mechanized logging equipment (for example, feller-bunchers) is much more prevalent in other regions (MacDonald and Clow, 1999). Such machines are not designed to handle the size of timber in Douglas-fir forests of the Northwest, nor to negotiate the steep slopes characteristic of the Coast and Cascade ranges.

the variation in timber densities on public and private lands in Oregon (see figure 2), a product of different harvest and management histories. However, species composition also varies considerably, as does the quality of the timber. Even fluctuations in the average size of the trees (diameter and height) matters, because the costs of using machinery to handle logs is generally insensitive to log size (within the range of the machine's capabilities), yet large trees yield a higher relative and absolute volume of merchantable wood from each log (see figure 3). Moreover, each logging site has its own particular logistical challenges (for example, steep slopes, unstable ground) which can be greatly compounded by increasingly stringent environmental standards.[6] All of these variations are unpredictable sources of ecoregulation affecting the rate of production, fluctuations that can be quite difficult to assess ex ante. They thus undermine what Scott (1998) refers to as the 'legibility' of nature, a key to systematic rationalization in nature-based industries.

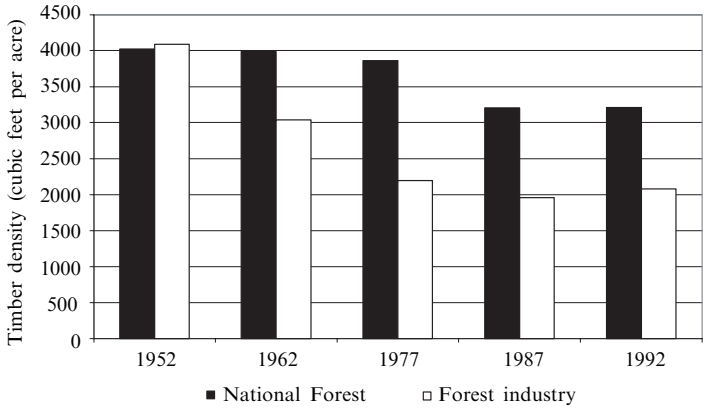

Figure 2. Density of softwood timber, Oregon 1952 – 92 (source: Powell et al, 1993).

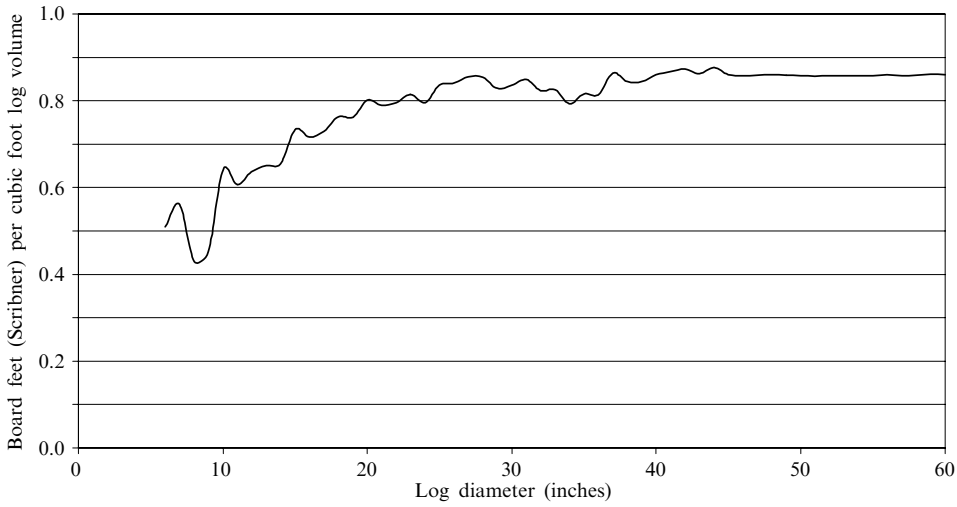

Figure 3. Merchantable volume versus log diameter, 20-foot log standard (source: based on data from the USFS *National Forest Log Scaling Handbook*).

[6] My description and analysis of the labor process in logging was assisted by site visits, and interviews with numerous loggers and industry officials.

Variable weather

Although extensive geographies, frequent relocations, and local site variability all present certain challenges to labor monitoring and control and the predictability and rationalization of rates of production, variable weather creates further problems. In the Pacific Northwest, the weather is at its worst and most unpredictable in winter, with wet, cold, wind, and snow making logging very difficult. In contemporary logging, increasing mechanization has facilitated and also motivated more consistent production. Yet, poor and unpredictable weather, particularly at high elevations, continues both to depress and to render unpredictable the amount of actual production time in the sector, as well as playing havoc with daily rates of output. As one logger noted:

> "One of the things you are concerned about is the wind. If there is timber around, whether in a partial cut or if there is timber where you are logging, and the wind is coming, that is probably one of the most unsafe areas you can be in. If there is a lot of wind, don't go. You go out there, look around, and crank up the crummy and go home" (interview, 17 December 1997, Oregon logger).[7]

The implications of weather delays include daily and seasonal fluctuations in production, and reduced total labor time in the sector. Loggers work fewer days and fewer hours on an annual basis than do their counterparts in other industries, including other wood-products sectors. On a national basis (see figure 4) logging employees worked an average of about 190 fewer hours per year per worker between 1977 and 1992 than sawmill employees, and just over 300 fewer hours per year than softwood plywood mill employees. This translates into just under 5 fewer weeks, and just over 7 fewer weeks, respectively (based on a 40-hour work week). In Oregon in 1992 loggers worked an average of 1878 hours per employee, compared with 2116 for sawmill workers, and 2181 hours for softwood plywood mill workers. The difference translates into the equivalent of between 5 and 6 weeks of work at 40 hours per week.[8]

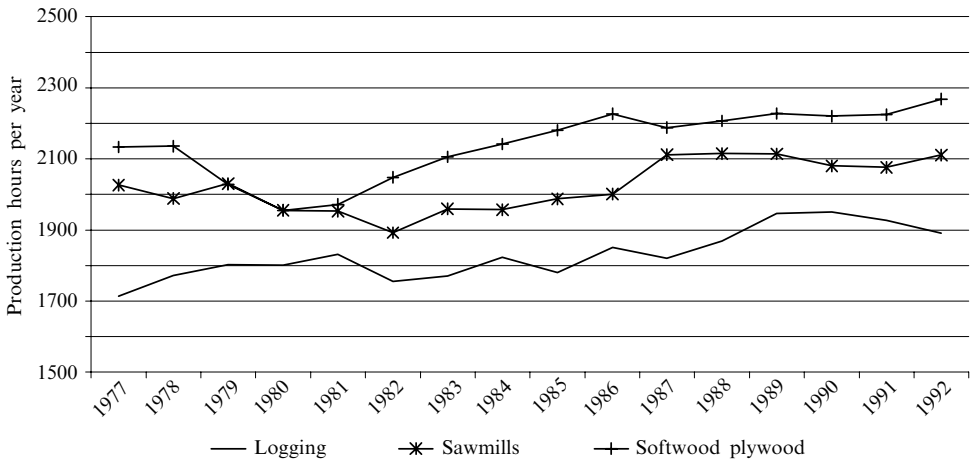

Figure 4. Annual hours of production for workers in logging, sawmills, and softwood plywood mills, 1977 – 92 (source: USBC, 1995).

[7] A 'crummy' is a logger's term for the vehicle, usually a van or truck, used to transport workers to and from the job site.

[8] These comparisons are based on data for Standard Industrial Classification 2411 (logging), 2421 (sawmills and planing mills) and 2436 (softwood veneer and plywood). Data taken from USBC (1995).

Ecoregulation and industrial accidents

Fluctuating rates of productivity from site to site, and depressed labor time in logging all indicate variabilities and uncertainties related to logging's nature-centered character. But no single measure more clearly (and gruesomely) reflects variability and uncertainty in logging than accident rates. High mortality and morbidity rates have long been associated with the logging sector, as noted by Somers and Somers (1954) in their seminal volume on occupational hazards and the rise of workers' compensation (see also Jensen, 1945; Prouty, 1988). Today, logging remains the most dangerous manufacturing occupation, and is arguably the most dangerous of all industries. According to 1995 occupational health and safety data (table 1), loggers rank behind only commercial fishers and sailors in the frequency with which they are killed on the job (see also Sygnatur, 1998). Other occupations with a reputation for hazard—including structural metal work, law enforcement, and farming—do not compare in terms of the risk of death at work. In fact, besides seafaring occupations, only commercial airline pilots and miners can be considered to be in the same range of mortality risk. In Oregon in 1996, the logging sector accounted for 15% of the state's occupational fatalities (9 out of 54); yet loggers make up less than 1.5% of the state's total employment.

Logging's human toll cannot be attributed to any particular technology or logging system (see Rajala, 1998). Instead, the danger of logging is primarily a result of the inherent variability and unpredictability of the work itself; evidence from around the United States and from other countries indicates that in logging the main source of danger is actually the timber (Egan and Alerich, 1998; Slappendel et al, 1993). Fully 70% of the fatal accidents in logging nationwide from 1992 to 1997 resulted from workers being struck by trees or logs (Sygnatur, 1998). Moreover, an estimated one quarter of all logging injuries take place during the actual felling of trees.

Though horrific in their own right, such accidents also carry costs in terms of production slowdowns, lost labor, wages, health care, and even lawsuits stemming from injury causing accidents. There have been recent instances, for example, in which injured workers have sued logging employers alleging unsafe working conditions in violation of existing safety standards (Egan and Alerich, 1998). Because of the high rate of accidents and injury in the industry, the costs of accidents are significant. Thus, because accidents impact the variability and predictability of production, they comprise one source of risks and costs that are socially distributed in part via production relations, including contracts.

Table 1. US occupational death rates by selected occupations, 1995 (source: USBLS, 1995).

Occupation	Fatalities per 100 000 employed	Relative standard error (%)
Sailors and deckhands	115	20.6
Fishers	104	15.6
Timber cutting and logging	*101*	*10.6*
Airplane pilots and navigators	97	9.8
Mining machine operators	78	17.5
Structural metal workers	64	13.6
Farm workers, including supervisors	30	3.6
Police and detectives, including supervisors	17	3.2

Production contracts in Oregon logging

As a response to logging's nature-centered character, contracts help wood-products firms achieve three things. First, contracts help offset onto gyppos the risk of uncertain and discontinuous production generated by extensive and variable geographies. Second, contracts place the onus on contractors (through the explicit or implicit threat of market bidding) to achieve more continuous throughput and enhanced productivity—that is, to *rationalize* production—in the face of such variabilities and uncertainties. Third, contracts encourage the development of expert, experiential knowledge among contractors about how costs fluctuate across different sites, and the reflection of such knowledge in contract bidding. Although specialized knowledge can and does develop among company wage employees, firms may be unable to develop or control such knowledge themselves because conventional hourly production costs do not accurately reveal the costs of variations from site to site, and direct monitoring is difficult and expensive in the woods. Thus, contract bidding can act as a way of capturing expert ex ante estimates of variations in production costs.

However, the apparent contradiction of contract bidding to capture expertise is that at least some of the expert knowledge loggers develop is firm specific, driven by geographic and technological factors in the contracting firm's commodity-manufacturing facilities, and by the specific characteristics of the firm's lands. This can give rise to firm-specific information economies of scale in logging. Thus, two distinct patterns of subcontracting have emerged in Oregon. The first is relatively open bidding, involving more arms-length relations between contracting firms and gyppo logging outfits. This strategy has the advantage of using market competition to rationalize production, and to act as a surrogate for expert knowledge by forcing contractors to bid against one another. The second strategy involves repeat contracting between contracting firms and gyppos, featuring much greater familiarity and continuity than the more open market strategy. This has the advantage of allowing gyppos to build up specialized expertise that is specific to the contracting firm's production and land portfolios. Not surprisingly, firms opting for the second strategy tend to be larger, horizontally and vertically integrated firms. For these firms, the complexity of their operations generates greater demand for highly specialized expertise.

Risk and rationalization

In Oregon, gyppo loggers work on the basis of production subcontracts. The typical arrangement is one in which a gyppo is retained to log timber that is owned by the mill, or has been purchased through a separate transaction. There are very few gyppos who buy timber sales directly, though this practice was once more common (for example, see Gibbons, 1918). Gyppos in turn employ wage laborers who work together on one or more logging sides operated by the gyppo. Workers are predominantly paid on an hourly basis. The contracts stipulate production levels at given locations for fixed prices per volume and grade, and are usually (but not always) negotiated between gyppos and the contracting firm.

What these contracts give to the mill is insulation from risk, and an associated flexibility in their relationship to logging operations. Management of risk is one of the most commonly identified reasons in the flexibility literature for explaining why firms pursue subcontracting in many industries, because (a) dense contracting networks can pool and reduce aggregate risk (Scott, 1987), and (b) large firms can displace risk onto smaller and more vulnerable subcontractors. Typically, the source of these risks is rapidly changing or fragmented market demands (Scott, 1988b; Storper, 1997). However, in this case, I argue that the risks involved are not market risks, but *endemic production risks* related to the unpredictability of production costs in logging.

In a regime where the rate of output is so highly uncertain and uneven, production contracts make sense for firms because they allow them to peg their costs only to the timber they receive, displacing the risks (that is, costs) of uncertain production schedules onto the contractors. By setting the costs prior to logging a site, the firm places a ceiling on production costs, and is therefore able to insulate itself from the risks of production slowdowns and cost overruns. With employees paid at fixed hourly rates, this risk is displaced onto the gyppo. In this risk-price regime, contracts also place the burden squarely onto the contractor to impose labor discipline and rationalize production under conditions that impede employee monitoring and make the assessment of production logistics difficult and unpredictable.

Not only do contracts insulate firms from the risk of cost overruns due to site variation, but they are also asymmetric with respect to the risks (costs) of accidents. Contracts allow gyppo firms to displace accident costs and restructure risks in several ways. The first of these pertains to insurance costs for workers. Workers' compensation legislation has generally been structured to socialize these costs through standard payroll deductions. Because these deductions are in principal indifferent to contract versus vertically integrated social relations, as long as contractors pass their costs to firms, the distribution of these costs should be indifferent to company and gyppo logging. Yet, industry compliance with the requirement that all employees be covered by insurance is not uniform. Despite the availability of pooled insurance among gyppos, insurance costs are still very high. In response, a considerable number of contractors opt for cash wages paid 'under the table' for some or all of their employees.[9] This can act to reinforce contracting if gyppo loggers use savings from this practice to suppress contract bid rates.

Second, accidents drive up insurance rates. By contracting for logging, firms displace the risk of escalating insurance premium hikes by linking the higher rates to the contractor rather than to the mill. When a contractor's rates increase because of accidents, wood-products firms can avoid having to pay for these costs by shifting to a contractor with lower rates. In this way, mills lower their exposure to the potential costs of accidents.

Third, the use of production contracts preserves an incentive among loggers to 'get out the cut' in the face of strong incentives to reduce the rate of accidents. That is, insurance premiums tied to accident rates combined with fixed wages or salaries creates an incentive in company crews to increase safety even at the expense of production. By contrast, use of contractors allows firms to have it both ways. Gyppos face a cost–price squeeze, because they pay insurance rates that rise in proportion to the number of accidents, but they pay wages on a strict hourly basis, and receive contract prices that are fixed to volume alone. If the gyppos push the workers too hard, they will save on wages and receive higher profits from volume-based contracts, but exacerbate the risk of accidents, and thus production delays and higher insurance premiums on subsequent jobs.

Information economies

Contracting out for logging also takes advantage of information economies generated by market competition among gyppo contractors. That is, production contracts have the advantage over conventional, integrated wage relations of allowing firms to capture expert knowledge among loggers through contract bidding. Variation in the rate of production owing to topographic variation and changes in forest types (age, species, timber density, etc) can be translated into more or less accurate ex ante assessments by

[9] Interview conducted 30 June 1997 with a gyppo logger. This was echoed by an academic researcher whose expertise is Oregon logging, and by several other loggers.

knowledgeable, experienced loggers. This type of knowledge and information (that is, conception) is very difficult for the vertically integrated firm to capture, even with careful accounting for the rates of production and costs within each division of the firm. This is because conventional fixed wage and salary employees do not bid for jobs based on their specialized knowledge, nor is there any indication when the job is done of how actual costs and potential costs compare because of wide variation in local conditions. By contrast, competitive contract prices reflect expert assessments of the costs of logging a site and the value of the timber. The point here most emphatically is not that mills are unable to measure the costs of their company logging operations. They clearly do so. They also know the value of the timber coming from each site, and can therefore perform detailed ex post calculations of profit rates for each site, and for that matter, for each logging side. But, translating this knowledge into ex ante assessments of logging costs is impeded by natural variability from site to site. In turn, this impedes prediction of how the costs of logging each site will vary, which in turn impedes systematic rationalization of on-site production.

Of course, contractors do not report actual costs to the mills either. However, they do bid for contracts in markets that place downward pressure on logging prices. Mills may therefore rely on market competition as a check on inflated logging prices, and as an indirect way of capturing an expert logger's ability to 'read nature' as a form of information or knowledge. The combination of this expertise with the incentive to apply expert knowledge to improving on-site efficiencies propels a drive for contract relations in Oregon logging.

The practice of contracting: nontraded interdependencies and repeat contracting

Although production contracts help mills offset various risks and uncertainties, induce rationalization, and capture expertise through contract bid markets, the expert knowledge contractors develop can to some degree be highly specialized to the mix of lands and manufacturing facilities held by particular integrated forest products companies. This leads to information economies of scale between contractors and larger companies. Precisely because of these information economies, many contract relations between wood-commodity firms and gyppo contractors do not conform to an 'ideal type' of arm's-length transaction, that is, open bidding with the contract awarded strictly according to price. Instead, numerous firms practice repeat contracting.

A significant number of Oregon firms do indeed simply announce jobs and accept the lowest credible bid (for example, Seneca Forest Products in Eugene). Yet numerous prominent firms do not. Instead, some firms work with a set group of contractors to whom they offer jobs and accept the lowest bid (for example, Roseboro Forest Products in Eugene, and Roseburg Forest Products of Roseburg).[10] This strategy maintains competitive relations among a subset of gyppos, but also encourages familiarity between the parent firm and the contractors, encouraging the developing of information economies of scale in their interactions. Other firms retain gyppo loggers on an annual basis, and maintain an implicit understanding with contractors that relationships will be renewed (given sufficient work) in the absence of any truly competitive bidding. In these cases, it is very common for job prices to be negotiated between the wood-products firm and the gyppo(s). Although such practices deviate from an ideal typical open and blind bidding process, they do so in ways that further reflect attempts to manage information economies in the logging industry that have much to do with its nature-centered character.

[10] Interviews conducted 10 and 11 July 1997 with mill management, and echoed by gyppos.

In logging, knowledge of a wood-product firm's particular needs combined with the degree of trust that accumulates through past performance creates a niche for gyppos with experience working with particular firms. One logger summed up why Willamette Industries—one of the firms with the largest land base in the state—typically works with a small group of contractors with the following anecdote:

> "[Williamette has] a loyal commitment. It is good for them. Like this year, they were complaining that their cutting costs were too much. So they got some cutting contractors and they got a cheap rate, so that they could use the leverage on the few cutters they already contracted with. You know 'we can get it done for this rate'. Well it kind of backfired on them. They ended up with the best job that was available this year and got a cheap rate. Well, they've got special ways that they want their job done. And it turns out that the contractor didn't have enough people to do it, so he hired people and he got lower quality people, people that weren't familiar with the lengths and what they wanted [in terms of] diameters and grades, and they'd send somebody for a couple of days and then somebody else for a few days. So it is a major headache. And [Williamette's] quality control guy has got to keep going back and he's not getting what they want, and here's the best job and the best timber and it's getting butchered out there. You know, it wasn't worth [it]" (interview with a gyppo logger in Springfield).

A specific aspect of specialized knowledge stems from the interaction between variation in the forest and the ways that each wood-products firm chooses to deal with such variation. The issue here is that logs vary in quality from site to site, but also at a given site. Yet, specific knowledge can be accumulated about a particular firm's lands (for example, tree age, species composition, spacing, location, etc), as well as how the firm wants the lands managed. Compounding geographic variation in the wood, each wood-products company has its own particular way of sorting and processing logs according to its mix of production facilities in the area as well as the relative strength of the parent firm's margins in its nearby mills. That is, not only does the geographic distribution of each firm's plants vary, but some firms profit more from plywood than lumber, others the reverse, etc. Different kinds of logs (species, size, wood density, prevalence of knots and other flaws), are generally suitable to different kinds of processing, yet such decisions are to some extent a function of a particular company's mills, specialization, and market position. The specialized knowledge required to sort logs to suit the company develops among employees through extended employment with a firm, and gyppos who contract repeatedly with the same company. But manufacturing firms cannot expect the same of gyppos if they are retained through truly arm's-length market transactions.

By practising repeat contracting with known gyppos, in some cases over periods in excess of fifteen to twenty years, firms can help to create and capture specialized knowledge among contractors, while at the same time maintaining the added flexibility of contracting over wage employment. The merits of this approach to contracting are particularly apparent to large, horizontally and vertically integrated firms seeking to capture economies of scope in log processing. These firms require the most complex and firm-specific information to be assessed by their logging crews. Thus it is telling that the region's two largest and most diversified firms—Weyerhaeuser and Willamette Industries—have been particularly prone to repeat contracting. These firms have the largest landholdings among private forest companies in Oregon, and also operate a diverse set of wood-processing facilities in the state. For them, repeat contracting in their gyppo logging operations makes sense because the information economies of scale in doing so are much greater than for smaller firms, with little or no land of their own, and with only one or two mills to supply.

To contract or not to contract: Weyerhaeuser's competitive logging program

Although contract logging is a strategy for achieving flexible production relations motivated in response to logging's nature-centered character, contract logging is not a unique solution to the flexibility dilemma. Indeed, perhaps the best demonstration of the way that ecoregulation in logging creates impediments to information-based rationalization of the labor process under conventional hourly wage relations is provided by Weyerhaeuser's Competitive Logging Program (CLP). Under this program, the company opted to experiment with restructured wage relations in addition to contracting as a strategy for rationalizing its logging operations. The results provide a direct indication of how much trouble firms have controlling production costs in logging under fixed hourly wage relations, but also substantiate that there is more than one institutional 'solution' in the pursuit of production flexibilities.

One of the problems with both fixed hourly wage relations and contracting in the logging sector is that both present obstacles to firms *directly* monitoring and rationalizing production costs in logging. By utilizing production contracts, firms can induce market competition as a surrogate for rationalizing production, but they cannot directly monitor how the prices they are paying for contracts correspond to production costs. Instead, firms depend on the competitiveness of the contracting market to keep logging costs under control. Yet, if contractors make substantial profits on a particular contract, the firm has no way of knowing unless the contractor makes his books available to the firm (unlikely). If the local market for contractors is not competitive, the firm faces the risk of inflated contract prices. Firms that pursue more open, competitive bidding processes need not worry as much about inflated logging prices. But firms that prefer repeat contracting with a small set of gyppos exacerbate the risk of inflated contract prices. Because of this, some of the larger firms consciously manipulate contractor markets in order to make sure that, as one logger put it, there is "always one more local gyppo than they need to do all the logging".[11] However, this requires the exercise of considerable market power and manipulation. On the other hand, fixed hourly wage relations do not allow for direct monitoring and rationalization for the reasons already discussed. Firms can certainly account for their production costs and returns from a given site after it has been logged, but they do not know how closely their costs conform to how cheaply the job could have been done. Thus, wood-processing firms seem caught between intersecting dilemmas.

The Weyerhaeuser Company recognized and directly confronted these trade-offs by instituting a system of competitive bidding among contractors *and* between contractors and company logging sides. In so doing, the firm restructured its wage relations in logging, and thereby challenged an industry-wide perception that contracting is always cheaper than company logging.

Weyerhaeuser's attempt to confront and directly monitor the costs of logging dates to the Northwest wood-products industry's labor dispute of 1986 (Widenor, 1991; 1995). Using weak commodity markets and the collapse of an industry-wide agreement on wages and benefits to press for concessions in collective bargaining. Weyerhaeuser successfully negotiated a $4 per hour wage reduction with its employees and initiated the CLP. Under this program, the company began to set target prices for logging in each of its areas. These prices were offered both to gyppos and to company sides on the basis of Weyerhaeuser's estimate of what it should cost to log a site. Company crews were challenged to beat gyppo rates in the same area, and to demonstrate that they could compete with the gyppo sides. Existing union contracts fixed the proportion of cutting done by company sides, but the company threatened to replace company sides

[11] Interview with a gyppo logger in Cottage Grove; echoed in several interviews.

with more gyppos in the longer term if the gyppos consistently outperformed the company loggers.

The key incentive in the system lay in restructured compensation packages to company employees. In addition to their hourly wages, company loggers were encouraged to beat the targets with performance incentives guaranteeing them any savings generated. This induced rationalization undertaken by the company loggers, and at the same time allowed the firm to compare its internal 'bids' or estimates with actual performance. What Weyerhaeuser found was that the company sides routinely beat the targets, often by substantial amounts.

Although the company was not saving money on individual contracts, Weyerhaeuser put in place a system that allowed it to better monitor, predict, and ultimately depress its production costs. Lowering production costs took place via expert-based rationalization among company sides. Although employees received the immediate benefits of beating targets, in the long run the company used the information generated to lower costs by improving management's capacity to estimate production costs ex ante. At the same time, the firm created more competitive pressures on its network of contractors, critical since the initially 'inflated' targets were a direct indication of gyppo profit margins. That is, bonuses pointed to contractors whose profits were at least equal to the bonuses, and likely higher.[12] Weyerhaeuser then used information generated by the CLP to improve its estimates and to ratchet down contract prices set in subsequent years.

As the CLP progressed, company crews began to generate smaller and smaller bonuses, while Weyerhaeuser earned a reputation among Oregon gyppo loggers as a company whose contracts offer little hope of generating a profit. Said one Weyerhaeuser logging employee with knowledge of the program:

> "I don't believe when [Weyerhaeuser] went into this that they realized that their [target] prices were that bad. This is how they found out. The first clue was when the crews were making these fantastic bonuses ... I am sure that they figured it out that if they were paying the crews these big bonuses, they were paying the gyppos too .... I think the company is getting what they want out of this. I am sure that they realize that they have gotten their logging costs down on both company and gyppo sides" (interview with a gyppo logger in Cottage Grove).

Indeed, the program made Weyerhaeuser sufficiently comfortable with its ability to suppress logging costs that the company signed an agreement in 1997 with the International Association of Machinists and Aerospace Workers (IAM – AW, Woodworkers Department) that will phase out gyppo logging altogether.[13] Given the prevalence of contracting in the Oregon logging sector, and the fact that Weyerhaeuser is the dominant firm in western North America,[14] this is an extremely significant development. Critically, the agreement is predicated on the company's continued use of performance incentives to induce productivity improvements.

In considering the significance of Weyerhaeuser's CLP, two issues stand out. First, the program demonstrates that there is more than one solution to the flexibility imperative induced by ecoregulation in logging, and that the particular solution sought depends on the specifics of a firm's operations, as well as on its relationship with workers. Second, and related to this last issue, the agreement between Weyerhaeuser and the IAM – AW points to the politically contingent character of industrial relations

[12] Higher because wage and benefit rates for gyppo loggers are typically lower than for company loggers.

[13] Interview with a union organizer.

[14] Weyerhaeuser owns approximately 2 million acres of land in the Douglas-fir region of Oregon and Washington alone (Weyerhaeuser Company, 1999).

(Herod, 1995; 2001). I have focused on ecoregulation as the motivating factor behind contract logging, and, in the case of Weyerhaeuser, restructured wage relations. Yet logging has always been nature based. The obvious question becomes why would contract logging be more prevalent now than in the past? The answer to this question, as I argue elsewhere (Prudham, 1999), turns on the broader politics of work in the forest industry, and in particular, the ebb and flow of organized labor's efforts to restrict the extent of nonunion, contract logging operations in the Northwest. I do not have the space to include this facet of the story of contract logging here, and have chosen to focus on the efficiencies of contracting, not its politics. But I stress that ecoregulation can only explain why firms would want to seek greater flexibility, including via production contracts. It cannot explain how this flexibility is pursued.

Conclusion

I have emphasized the role that nature-centered production plays in inducing Oregon wood-products firms to pursue flexible production relations in logging, including contracting out to independent gyppo loggers and, in the case of Weyerhaeuser, pursuing restructured wage relations. To do so, I have drawn on two disparate literatures. First, analyses of the emergence of post-Fordist flexible production systems within industrial geography offer compelling clues to the development and character of contractor networks in logging. In particular, this literature points to the ways firms have sought alternatives to fixed hourly wages and (frequently) rigid collective bargaining agreements under the influence of such factors as fragmenting and volatile markets and new production technologies. The literature also provides clues as to the dynamics of regional contracting networks and repeat contracting based on input – output relations of nontraded interdependencies, including information economies of scale.

However, although the flexibility literature highlights alternatives to fixed hourly wage relations in vertically integrated organizational structures, there remain ambiguities in sorting out why particular activities are targeted for flexibility-oriented restructuring, including contracting out. Moreover, the flexible production literature has not included much analysis of nature-based industries such as forest-products manufacture (with a few noted exceptions), and none that has explicitly examined how the flexibility imperative may revolve around what Benton (1989) calls ecoregulation. Thus, I also draw on agrarian political economy, and the ecoregulation of industrial labor processes, in arguing that logging presents certain challenges to capitalist firms. These include: coordination problems based on extensive and inconstant geographic deployments; variable and unpredictable landscape conditions and raw material quality; and uncertainties in production schedules and costs related to weather and high accident rates. In the face of these challenges, contract production (along with more incentive-based wage relations) offers certain advantages by insulating firms from risks while at the same time encouraging the rationalization of production. What this analysis suggests is that the flexible production school is not wrong, but is inadequate to explain fully the social organization of logging in Oregon.

One caveat remains. By invoking the flexibility literature, I do not mean to suggest that contract logging is a post-Fordist phenomenon. As debates about the so-called second industrial divide have indicated, although flexible production systems of various kinds have become a focus in the literature, there is as yet little agreement on how historically novel such systems are, nor on whether or not post-Fordism is coherent as an historical era of accumulation spanning multiple industries and regions (Amin, 1994; Brenner and Glick, 1991; Piore and Sabel, 1984; Walker, 1995). In this context, the claim that Oregon logging was *ever* Fordist in its organization would be a difficult one to sustain. As Page (1996) discusses in his skepticism about a post-Fordist

agriculture, this 'difference' may also be related to the question of nature (see also Goodman and Watts, 1994). Sayer's (1989) critique of 'normal' capitalisms in studies of industrial organization remains germane in this context, as does Barnes's (1996) compelling case for contextualism in economic geography. In my view, the dynamics of contract logging in Oregon support the need for careful, contextual research on industrial formations that pays attention to geographic variation, including the biophysical environment, as an influence on regional industrial systems.

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