Low-Wage Labor Markets and the Power of Suggestion*

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Abstract

Low-wage labor markets are traditionally viewed as competitive and the possibility of strategic behavior by employers is dismissed. However, the latter is not impossible. In this paper a possibility of collusion by low-wage employers while setting wages is investigated. Game-theoretic explanation along the lines of the Folk theorem is offered. I suggest a non-binding minimum wage could serve as a focal point that proposes a symmetric solution to an infinitely played game of wage-setting. A number of empirical techniques, including estimation of hurdle models of collusion, is used. CPS monthly data is used for the years 1995-1998, a period surrounding the last two federal minimum wage increases (in the US). Likelihood of coordination at minimum wage is evaluated, as well as its dynamics during this period.

*This is a working paper. Please feel free to contact the author if you have any questions, suggestions or criticism.

1 Introduction

An employer operating in a competitive labor market environment does not have a choice but to accept a wage dictated by the market. However, low-wage employers often set wages. Still, profit maximization suggests that a chosen wage should somewhat reflect an employee's marginal productivity. As theory shows, this is true only if a firm restricts profit maximization to a finite period, and such equilibrium collapses when infinite horizon maximization is introduced and strategic interaction among firms is allowed.

Today's economic reality calls for a manager to maximize stakeholders' value, which with reservations can be reduced to maximizing discounted stream of future profits. In this case as long as the number of employers in the market is not infinite and they manage to find a symmetric equilibrium, the marginal rule for wage determination no longer holds. An array of equilibrium wages, ranging from monopsony level wages to competitive wages, opens for employers to choose from. Rationalizing the wage choice becomes a difficult task for the manager, whose rationality is bounded, and as some recent studies in behavioral economics suggest, is a subject to a so called "framing effect".

In this paper I argue that a non-binding minimum wage may serve as a frame, or a focal point for tacit collusion by low-wage employers. Suggested by the government, non-binding minimum wage simplifies wage-setting, as it facilitates maximization of value if enough firms follow collusive path.

More frequently studied product market collusion is often viewed as undesirable since it is associated with considerable welfare losses. Labor market collusion in sectors where wages are low may not be so harmful, at least when its immediate effects are analyzed. When wages are low, firms are able to create more jobs contributing to reduction of unemployment. Consumers of low-wage industries may also benefit from low wages by paying lower prices. However, in such economies an important signaling role of wages (and prices), as first formulated by Adam Smith, is not fulfilled. Such economies may be producing and consuming more of otherwise undesired products. Furthermore, reduced purchasing power of low-wage workers increases the demand for low-priced goods. This, in turn, sends a signal to firms operating in these industries that their output is valued by consumers. Thus, if wage collusion is sustainable it may distort the outcomes not only for the affected labor market, but for the economy as a whole, reproducing the inefficient equilibria.

This paper is a first attempt to evaluate the extent of collusion facilitated by a non-binding minimum wage wag, which serves as a focal point for low-

wage employers. Estimates obtained in the paper are static, i.e. they reflect the investigated phenomenon only during the specified periods. The nature of the paper is positive: though the estimates may have policy implications, I do not formulate any policy advice.

The paper is organized as follows. In the first section I explain motivation that is behind the study supported by some stylized facts. Recent literature on minimum wages is briefly discussed. The second section of the paper contains the theory of tacit collusion and the theory of focal points with application to the labor markets. A simple game-theoretic model is constructed, which demonstrates that a tacit wage collusion is a possible equilibrium in coordination game of wage-setting. The third section explains an empirical strategy used to test the collusion hypothesis. A number of empirical techniques were employed. Namely, truncated regression and hurdle model of collusion were used to estimate its extent, and a binary choice model was used to test theory of facilitating factors. The remaining two sections discuss data, estimation procedures and results. Brief conclusion finishes the paper.

2 Motivation and Stylized Facts

2.1 Low-Wage Employment and Minimum Wage Literature

Since minimum wage laws were first introduced in the early 20th century, the minimum wage has always been a highly debated issue, both in economics and in politics. Today its relevancy has not diminished. The growing importance of low-wage sectors in the structure of the economy makes the minimum wage a more important policy tool and deserves closer consideration.

Low-wage industry is one of the key employers in the US. In 2003, about 13% of the workforce was employed in the low-wage sector (Chapman & Ettlinger, 2004). Many of them worked in services, the sector greatly expanding over the past century. In 2004, 83% of all non-agricultural jobs in the US were in services (Report, 2005)

The growing service sector has transformed an average workplace. As the service sector expands, many manufacturing jobs are lost every year. New low-paid service jobs tend to be hourly paid, non-unionized and, as a result, more likely to be affected by minimum wage legislation. From 2002 to 2005, the number of hourly paid employees increased by about three million, with two and a half million of them in service occupations (DOL statistics, 2002-2005). Thus, we can expect more workers to be affected by minimum

wage, directly or indirectly.

Minimum wage and its impact on labor market outcomes is very extensively studied in economics. A handbook chapter by Brown (1999) reviews both theoretical and empirical studies in this field. As reflected in the review, most of the recent research in the area has concentrated on the empirics, while relatively few new theoretical studies are available. The empirical studies, in turn, mainly address the employment effects of minimum wage, while re-distributive role of this policy instrument is often underplayed.

Early empirical literature on employment effects, as well more recent studies provided statistical evidence of negative employment effects of minimum wages as well, though only for certain population groups. For instance, Neumark and Wascher (1996, 2000), Burkhauser et al. (1996, 2000) report that a higher minimum wage reduces employment: a 10% increase in the minimum reduces employment of teenagers and youth anywhere in the range from 1 to 6%. During the 90s new controversial studies on the effects of minimum wages were published (Card & Krueger, 1995), which suggested that minimum wage does not necessarily negatively affect either employment or earnings. Later, Manning (2003) offered a theory of dynamic monopsony, which was able to explain the absence of negative employment effects of minimum wages.

While employment effects of minimum wages are important, its other effects should be studied as well. As Freeman (1996) points out, "most of the analyses of the minimum wage focus on its unintended employment consequences. The goal of a minimum wage is not, of course, to reduce employment, but to redistribute earnings to low paid workers".

In fact, the re-distributive role of minimum wage is a subject of this study. However, the usual question of whether minimum wage improves the position of the low-paid is substituted by a question whether a non-binding minimum wage may harm it.

In connection with re-distributive efficacy of minimum wage I would like to draw the attention to the following data patterns commonly observed in low-wage markets.

2.2 Low-Wage Labor Markets: Notable Data Patterns

Many empirical studies of low-wage markets suggest that the re-distributive role of minimum wage is rather limited. It is reflected in a number of empirical observations and research findings, which list includes a distributional spike at minimum wage, overall skewness of wage distributions and wage compression towards the lower end of the distribution, recent increases in

wage inequality.

2.2.1 Minimum Wage Spike

Many empirical studies acknowledge the existence of substantial clustering of wages around the statutory minimum wage. Brown (1999) summarizes:

> "Among those who are employed, the distribution of ln(wage) tends to look bell-shaped with occasional spikes at round-dollar amounts Often there is another spike, at the minimum wage, even when the minimum is not a round-dollar amount. Spikes at the minimum wage are stronger when the minimum wage is more binding; e.g. in wage distributions for teenagers rather than for all workers, and in years when the minimum wage has been raised rather than after several years of a constant nominal and eroding real minimum wage".

The most common explanation to the distributional spike at minimum wage is a "forced truncation": minimum wage "takes a bite" from a wage distribution, which results in some workers losing their jobs and some workers being brought up in a pay schedule up to the minimum. This explanation, however, is not theoretically supported if labor markets are assumed to be competitive since under perfect competition profit maximizing employers already pay wages equal to their marginal contribution. Thus, when minimum wage is raised all workers whose wages were below the new minimum should be displaced. If the latter is true it should translate into rather large estimates of elasticity of employment (or unemployment) with respect to minimum wage. However, such estimates are usually rather modest.

Studies cited above quote estimates of 1 to 6% reduction in teenage employment, and about 1% reduction in employment of young adults due to a 10% increase in minimum wage. Almost no study surveyed by Brown reported a significant impact of higher minimum wage on adult employment. Freeman (1996) also points out that "no study in the United States or the United Kingdom has found that increases in minimum wages reduce total unemployment with an elasticity near unity: the debate over the employment effects of the minimum is a debate of values around zero". Panel data studies that follow same workers also show that the majority of affected workers remain employed following an increase in minimum wage. For instance, Currie and Fallick (1996) use NLSY data and estimate that only 3% of youth are less likely to be employed a year after a minimum wage increase. Therefore, the explanation of the spike by "forced truncation" of perfectly competitive wage distribution does not seem to go along with the

assumption of profit maximization. Firms operating in competitive environment should not be able to keep workers whose wages are below their contribution to firm's revenue.

Some studies, as for example Meyer and Wise (1983), suggest that competitive firms may work around increased minimum wage by adjusting workers' non-wage compensation or by increasing marginal productivity with heavier work-load. Thus, such firms might still keep those workers who were previously paid below the minimum. This theory is quite powerful in explaining the spike. However, under this explanation the spike should gradually disappear as minimum wage erodes, but as Brown (1999) noticed, the spike is quite persistent from one time period to another.

Another explanation for the minimum wage spike is monopsonistic structure of the labor markets. Within the framework of static monopsony an introduction of a minimum wage higher than a monopsony wage will shift wages set by a monopsonistic employers up to the minimum, possibly creating a spike. However, it has being argued that low-wage labor markets do not constitute a monopsony, at least not in a structural static sense.

A relatively recent development in the area is the theory of dynamic monopsony (Manning, 2003), which declares that a monopsony-like equilibrium can exist in visible competitive markets due to existence of search frictions. Thus, minimum wage spike should be explainable within this framework.

Little theoretical research done in the area has benefited from dynamic models developed by Flinn (2000, 2003b, 2003a) and Flinn and Mabli (2005). The authors were able to replicate the minimum wage spike in competitive environment within a bargaining framework. In the models minimum wage constitutes a constraint in Nash-bargaining problem. Thus, the reproduction of the spike has a similar nature as in case monopsony, where minimum wage is binding constraint.

While existing explanations to the minimum wage spike are valid, collusion may still contribute to its magnitude.

2.2.2 Other Empirical Facts and Findings

Another interesting empirical phenomenon observed in the US labor market, at least during the past two decades is an increasing *wage inequality*. Minimum wages aiming at re-distribution of economic surplus does not seem to aid in closing the widening gap. Freeman (1996) notes that in the 1980-90s rising real earnings of the US and UK workers were accompanied by falling real wages of the low-paid. Statistics show that real wages of the tenth and

twentieth percentiles of workers within wage distribution were either falling or stayed at the same level since 1970s, compared to an increasing pay of the higher paid workers, as can be seen from the figure 1 below.

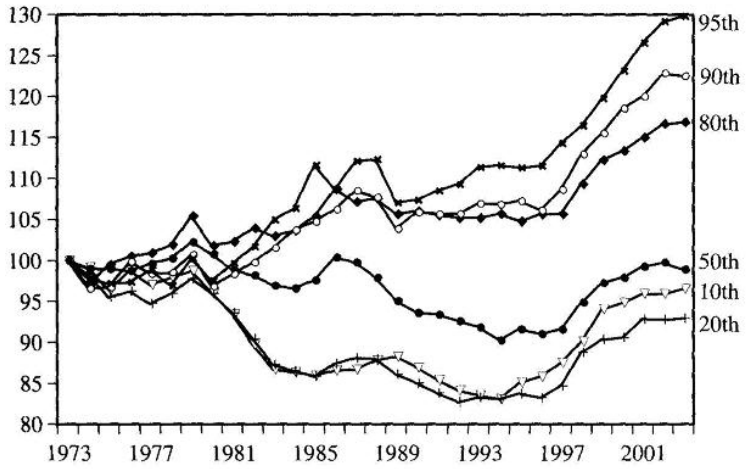

Figure 1: Real hourly wages of men by wage percentile, US, 1973-2003 (On-the Job Search & in an Equilibrium Bargaining Framework, 2005)

Originally, minimum wage laws were designed to eliminate or minimize the effect of worker exploitation, child labor and pay inequality between men and women. Thies (1991) describes minimum wage as implementation of social justice:

> " Towards the end of the 19th century, Marxists, Fabian socialists, progressives, and Catholic and pietist Christian social reformers increasingly questioned the ability of ordinary men and women to consent to contracts, or, as they would put it, to bargain. As John R. Commons and J.B. Andrews (1920, p.163) stated, "large numbers of unorganized workers are found . . . bargaining individually, employed at low wages and apparently unable to . . . improve their condition." Social justice, as determined by government, was to replace justice, as determined by consenting individuals".

Throughout the twentieth century economic conditions have improved, while the arguments in favor of minimum wage have not. The objectives of reducing exploitation and eliminating child labor have been achieved, at least in developed nations, but earnings and income inequality continues to be an issue.

Perhaps, the most popular explanation to increasing inequality is a recent surge in demand for high skill labor. This is a valid reason. However, assuming that high and low wage sectors are open and migration of workers from one to another is not constrained, we should observe some sort of "factor price equalization". In other words, if wages of workers in one sector rise there should be observed a corresponding increase in wages in another sector, if not immediately, then at some point in time.

I suggest looking at the the problem of rising inequality from a different angle: wages of the lowest paid are stagnating because they are tied to the minimum! Rising wages in high-wage sectors, effectively decrease the supply of labor in low-wage sectors, which should translate into higher overall earnings. The latter is not observed. The possible explanation to this dilemma is that low-wage labor markets may have low wages (and high uniformity of wages) because employers use existing statutory minimum as a focal point for collusion. Minimum wage, if non-binding, is used as a reference in setting wages. It reduces selection of wage offers available on the market. When reinforced by limited chances for upward mobility and search frictions, it may result in acceptance of low offers by some workers whose actual productivity maybe high.

Thus, it might contribute to a widening wage gap: depressed wages in low-wage sectors may coexist with rising wages in high-wage sectors, for which minimum wage requirement is not a relevant.

The problem of wage inequality and minimum wage was addressed in several recent studies. Among them are papers by Neumark et al. (2004), Machin et al. (2003), Teulings (2003) and some others. Uniformly, authors find that minimum wage positively affects overall wage levels. While average wages of all employed workers increase due to a higher wage floor, some low-wage workers may experience a decrease in real wages, or maybe unable to find jobs with remuneration levels corresponding to their productivity, because of potential collusion at the minimum.

Studies cited above have also pointed out problems of *wage compression* and short-lived effects of minimum wage while reducing wage inequality. For instance, Neumark et. al. (2004) when analyze responses of wages, hours and employment to changing minimum wage conclude that low-paid workers experience an initial wage gain, but combined with hours and employment total effect is negative, while high-paid workers are little affected. Machin et. al.(2003) evaluate the effects of the introduction of a national minimum wage in the UK in 1999 in a low-wage sector - the residential care homes industry. They found that the UK national minimum wage while increased the wages of homecare workers, it also caused a greater compression at the

lower end of wage distribution, and did not aid in reducing wage inequality. Study by Teulings (2003) points out that a reduction in *real* minimum wage in the US was a main cause for wider wage dispersion among the lower half of wage distribution in the US in the 1980s. He also estimates that a 10% reduction in *real* minimum wage causes wages of someone earning the previous minimum to fall by 8%.

Various minimum wage studies have cited other interesting results that may support the collusion hypothesis. Card and Krueger (1995) point out that the minimum wage spike is pronounced even if firms are not required to comply with minimum wage laws. Frequently, sub-minimum wage provisions are under-utilized. In rare instances when they are, many employers set wages below actually use the existing federal minimum wage (Card & Krueger, 1995).

Another interesting observation by Nordlund (1997) was cited in a review by ? (?):

> "... When the minimum wage is raised by statute, compliance falls, and when the purchasing power of the minimum wage is eroded by inflation, compliance increases".

In summary, evidence of increasing wage inequality and some other empirical phenomena associated with minimum wage support or, at least, does not contradict the hypothesis of employers' collusion at minimum wage.

3 Focal Points and Tacit Collusion: Theory and Empirical Implications For Low-Wage Markets

In this section I set aside the empirics and attempt to link existing theories of tacit collusion and focal points with the reality of low-wage markets. A simple game-theoretic model illustrates why collusion is possible. Then, I discuss a focal point hypothesis that explains why a non-binding minimum wage can become a stable, socially inefficient focal equilibrium.

3.1 Wage-Setting as a Coordination Game

Collusion in any market is, first of all, an outcome of a coordination game. This section briefly explains why wage determination in low-wage markets can be a result of coordination game played by employers while setting wages.

A central assumption necessary for the existence of a focal equilibria, and for the possibility of coordination, is the assumption of wage-setting. Wages that are observed in low-wage markets are in most cases determined exclusively by employers, while employees have little influence over it. Multiple factors contribute to this.

The mere existence of unemployment creates a queue of jobless who will pick up a vacancy as soon as it is available. The homogeneity of low-wage jobs that do not require extensive human capital investments makes this queue built not only from down to up, but also from up to down.

Also, because the pay is low and a replacement of an individual worker is relatively easy, it does not make sense for a firm to invest into searching, selecting or negotiating the pay with every individual worker. Thus, the wage-setting (not a bargaining) can be a rational, profit maximizing (and transaction cost minimizing) choice of employers.

Since low-wage *jobs* are also homogenous and generally no bargaining over wages is observed, an incentive for the employers to coordinate wage-setting efforts emerges. If successful, coordination will further reduce the transaction costs and, if coordinated wage is below the competitive level, it can increase profits. Even though such a comparison can be considered unethical, wage-setting in low-wage markets can be compared to price-setting by buyers of homogeneous goods in product markets. Industrial organization literature has many examples of such coordination: processed potato markets (Richards, Paterson, & Acharya, 2001), retail gasoline markets (Borenstein & Shepard, 1996), timber sales (Baldwin, Marshall, & Richard, 1997), just to name a few. Perhaps, the most relevant to this paper is the study by Knittel and Stango (2003). The authors analyzed likelihood of tacit collusion by banks issuing credit cards to consumers in the 1980s. During that period, credit cards were rather homogenous products (mainly interest rates were distinguishing among them). Both supply and demand side of the market was represented by large number of agents. Banks (as low-wage employers) had to comply with legal limits on annual percentage rates (APR) charged to the debtors. The authors demonstrated that banks successfully used these legal limits on APR's as focal points for collusion. Since the organization of credit card markets is rather similar to low-wage labor markets, I refer to this paper quite frequently.

Borrowing Crawford and Haller's (1990) definition, wage-setting game in low-wage markets can be classified as a coordination game according to the following criteria: "Are preferences of wage-setters symmetric?", "Is number of equilibria large?", "What is nature of sustainable equilibria?". We can say that low-wage employers have similar preferences over wage levels, i.e.

employers would generally prefer wages to be low and labor force abundant. In addition, low-wage employers will generally have identical beliefs about each other strategies with respect to wage-setting and they are well aware of what these strategies are. The number of possible equilibria is large, i.e. employers would generally a range of wage levels that could lead to a market equilibrium. The efficient equilibria are supportable, i.e. special incentives are necessary in order to induce coordination by employers (the next section will discuss the last two points in more detail).

3.2 Two-Firm Model of Dynamic Wage-Setting

To illustrate the idea that employers' collusion at minimum wage is an intuitive outcome of wage-setting game of coordination I use a simple two-firm model[1].

Claim: *If minimum wage is non-binding wage-setting employers will be drawn to set wages at the minimum.*

Suppose, a market consists of two identical firms i and j that operate in a perfectly competitive product market with product price p. Labor is the only production input with input requirement one unit of labor per unit of output. Workers are perfectly substitutable. Marginal revenue product of labor is assumed constant. Market labor supply is upward-sloping function of the wage $S(w)$. In this environment each firm will set wage rate equal to the product price and will earn zero profits.

If firms compete in the labor market a firm that pays a higher wage would attract the entire market labor force, and will produce the entire market's output.

Suppose that the two firms play the wage-setting game repeatedly in periods $t = 0, 1, T$. Let $\Pi_i(w_{it}, w_{jt})$ be firm's i profit at time t. The wage it pays to its employees is w_{it} . Symmetric notations is used for firm j.

Each firm maximizes present discounted value of profits:

$$\sum_{t=1}^{T} \beta^t \Pi^i(w_{it}, w_{jt}) \tag{1}$$

At each date t firms set wages, utilizing the knowledge of histories of wage-setting, i.e. the firm has a perfect recall of the past wage-setting practices:

$$H_{it} = [(w_{i0}, w_{j0}), (w_{i1}, w_{j1}), ...(w_{iT}, w_{jT})]$$

[1]Here I closely follow Tirole (1988), with certain changes in model set-up to accommodate developments in the labor markets, namely the low-wage labor markets.

In a finitely repeated game of wage-setting this market will be drawn to a Bertrand equilibrium. Thus, in equilibrium wage rate will be equal to the perfectly competitive wage: $w_{it} = w_{jt} = p$ for $\forall t$.

Now, consider a wage-setting game when horizon is infinite ($T = +\infty$). Both firms discount their one period pay-offs by the discount rate β. In this case, the Bertrand equilibrium is also a stable solution, but it is not the only possible equilibrium.

Denote w^m a monopsony wage, which maximizes monopsony profit:

$$\Pi^m = (p - w)S(w) \tag{2}$$

Suppose, each firm follows a trigger strategy by setting the wage at monopsony level w^m if in every preceding period the rival's firm wage was w^m. By setting wages at this level, each firm earns half of the monopsony profits $\Pi^m/2$. If a firm deviates and pays a higher wage $w > w^m$ in one of the periods, in this period it receives monopsony profit Π^m, and zero profit thereafter, since its rival sets the wage equal to marginal revenue product of labor forever after the deviation from monopsony wage-setting, according to the trigger scenario.

Therefore, the trigger strategy will be an equilibrium if:

$$\frac{\Pi^m}{2}(1 + \beta + \beta^2 + ...) \geq \Pi^m, \tag{3}$$

which is equivalent to having $\beta > 1/2$. In other words, sharing the market and receiving half of monopsony profits indefinitely is more attractive to both firms than competing for workers by offering higher wages as long as the discount rate is sufficiently large. Notably, this collusive equilibrium is achievable even if no coordination between the two firms takes place.

The above example illustrates one of the staples of game theory - the folk theorem, in our case the version of folk theorem for repeated games. According to this theorem the above game may have multiple equilibria, with wage set anywhere between monopsony level wage w^m and competitive level $w = p$, as long as discount rate β is greater than $1/2$.

Paying low wages and earning equal shares of profits within the interval $[0; w^m]$ can be a sustainable strategy for both firms playing the wage-setting game. Thus, setting wages symmetrically within the interval $[w^m; p]$ can constitute a sustainable equilibrium and collusive wage-setting among employers is a possible equilibrium outcome.

It is important to note that the requirements for the discount rate become more stringent as the number of firms increase. However, the reality of low-wage markets rarely present workers with opportunity of infinitely larger

number of employers (or offers). The existence of search frictions and limited mobility of workers reduce the effective number of employers (offers) even more.

The above example of employers playing the wage-setting game continuously illustrates that paying monopsony wages as opposed to competitive wages is a rational choice for employers operating in a market indefinitely, though it requires successful coordination.

3.3 Focal Point Equilibria

Coordination in a game of wage-setting and committing to monopsony level wages is a difficult task for employers since number of equilibria is large. Tirole (1988:247) puts it elegantly:

> "The supergame theory is, in a sense, too successful in explaining tacit collusion. The large set of equilibria is an embarrassment of the riches. Somehow the firms must coordinate on a "focal equilibrium" in order for the equilibrium to remain attractive. How is this equilibrium chosen? A selection process often used in the literature makes the assumption that in a symmetric game the focal equilibrium is symmetric and the assumption that the focal equilibrium must be Pareto optimal from the viewpoint of the two firms (i.e., must yield a payoff on the frontier of attainable set of per-period profits)".

Labor markets have large number of employers that hinders the coordination, especially in low-wage markets. However, these markets contain enough possibilities for framing. They have a focal point that may serve as a coordination tool - the minimum wage, if it is below the competitive equilibrium wage. (Minimum wage is a unique coordination tool directly relevant to low-wage markets, but other markets may have other mechanisms of coordination as long as some possibilities for communication exist).

The idea of focal points was first described by Thomas Schelling in the famous book "The Strategy of Conflict"(Schelling, 1960). More recent literature on focal points includes Binmore and Samuelson (2006), Janssen (2001), Colman (1997), Crawford and Haller(1990) and some others. .

Schelling(1960:57), suggested that for parties with common interests and without opportunities for coordination it is logical to "meet" at an obvious point, which does not have to be rationally deduced but rather embedded in majority's thinking:

> "Finding the key, or rather finding *a* key - any key that is mutually recognized as the key - becomes *the* key - may depend on imagination

more than on logic; it may depend on analogy, precedent, accidental arrangement, symmetry, aesthetic or geometric configuration, casuistic reasoning, and who the parties are and what they know about each other."

Hence, solutions for coordination "puzzles" are correct if enough people think so. Schelling offers several examples of focal solutions to coordination games. The most famous one is "meeting-in-New-York" game, in which people without any indications on time and place chose to meet at the Empire State Building at noon. Another example is a "heads-and-tails" games, in which a striking 85% of players chose heads over tails, which secured them larger than average payoffs.

Another Schelling's example is a "parachutists' dilemma": two parachutists X and Y are randomly dropped into an area, known to both of them from the map (figure 2). However neither of them knows the exact location of one another. In order to be rescued (picked up by a helicopter) they have to meet each other.

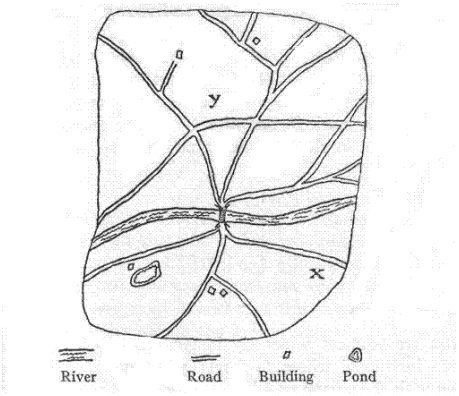

Figure 2: The Map [Schelling, 1960]

As can be seen from figure 2, the area contains several focal locations that could be used in coordination: the river, the pond, the bridge or major intersection. Which one would they chose in order to be rescued promptly? Any of the unique locations can be a meeting venue. If at first, for example, the X chose a bridge and the Y chose a pond, the two will not find each other instantly. Moreover, it may take very long time before they manage to coordinate on the venue. However, if dropped off for the second time (no knowledge of exact drop-off points is assumed) they will instantly recall

which of the unique locations was the equilibrium during the last drop-off. Thus, success in solving coordination puzzles critically depends on whether the players are allowed to do them not once but several times. By solving same coordination puzzles repetitively, players learn and become more efficient.

The "power of suggestion" is a Schelling's concept directly relevant to our discussion. It provides that if the players are interested in coordinating on some key, and are informally given some clues on what those keys could be, there is a high chance that they would use those keys. These clues can be instituted by nature as in "parachutists' dilemma" or, in a social context, by habit, custom or some formal rule. For example, in "head-tail" game (again, the experiment is described in Schelling, 1960) players much more frequently chose heads over tails due to a habitual notion of superiority. Bridge would probably be preferred over intersections by the parachutists because it is unique to the area, while it is also located in the center, i.e. more likely will minimize the traveling distance. However, the choice of the "clues" does not need to be unequivocally rationalized.

Low-wage employers play a similar coordination game. They have similar preferences towards the level of wages. Low-wage jobs are relatively homogenous. Thus, the difficult task of coordination evolves into finding *the key*, or a reference point in the range of possible wage settings, which is acceptable and will likely be chosen by many other employers. I suggest that such a focal point is the minimum wage.

3.4 Is Collusive Equilibrium Possible or Sustainable?

One might possibly ask: "how would employers, especially the myriad of low-wage employers, coordinate by playing the trigger strategy if they never get to observe actual wages set by other employers?" It is indeed possible. Friedman (1990) argues this point for a similar setting in a product market with successful price coordination by firms:

> " trigger strategy equilibria are still possible because the firms can still discern whether their rivals are sticking to the trigger strategy prices or defecting. The means for this observation is the firm's own output level. In each period, firms simultaneously select prices, following which each firm observes its own output level. If any firm defects from its trigger strategy price, other firms will find their demand and output differ from what they expected. No firm can tell which rival defected but that knowledge is not necessary for it to get the signal that it should switch to its single-period Nash equilibrium price."

Low-wage employers can either monitor its own output (if they cannot fill the vacancies at the trigger level wages output is lowered) or own employment (through unfilled vacancies and the time needed to fill a vacancy). If any employer defects, i.e. starts offering higher wages, other employers will discover it rather quickly and may decide to switch to a single-period equilibrium wage.

Porter (1983) suggested that when the prices (in our case it is wages) are not observed, firms' individual demand functions would include a random component. The presence of randomness does not, however, rules out the possibility or sustainability of collusive equilibrium. As pointed out by Porter, the presence of randomness allows brief periods of cheating by one/few number of firms without detection by others, i.e. single firm's defection is possible while the rest of the players continue to follow the "collusive" price-setting. Porter also showed that collusive price-setting is also sustainable if firms deviate and refer to competitive pricing for a finite period of time. Though, this period of reversion must be the same and should be known to all firms.

Preliminary analysis of wage distribution in low-wage sectors of US economy suggests that firms can possibly practice both. Some firms (or sectors) may defect in one or two time periods without detection by other market participants or refer to competitive wage setting for brief known periods of time with subsequent return to collusive "agreement". Appendices 1A-1D provide the table and a few graphs illustrating such behavior by two major low-wage employers: retail and food services sectors[2].

As you can see from the graphs in Appendices 1B-1C the sectors shares of wages at legal federal minimum wage are consistently moving in the same direction with few exceptions. As a rule, share of wages above minimum is increasing in retail sector in each December when retail sales are at peak for the year as can be seen in Appendix 1D. Food services sector, however, does not change its wage-setting practices during this period. In turn, the sector's employers deviate from the usual wage-setting in summer months, especially in August, when their sales are at peak for the year. It returns to the usual wage-setting practices in following months.

The wage competition for low-wage workers that could be triggered by higher wages offered by retail employers in December, or by food service employers in August does not take place. The wage-setting behavior demonstrated by retail and food services sector can be interpreted in a number of

[2]Own CPS tabulation of hourly wages and US Census data on sales were used in the appendices 1A-D

ways. It is possible that single-period defections are expected from a rival because the same "wage-setting game" had been played repetitively from year to year. In Porter's terminology firms could refer to competitive pricing for a finite time period, which is the same and known to all firms. It is also possible that the competitive trigger set by one (some) employers is not large enough to be detected and followed by other employers.

3.5 Implications of Tacit Collusion at Minimum Wage

Theory and some preliminary analysis of low-wage markets suggests that a tacit wage collusion by employers is possible. The existence of a salient focal point, the minimum wage, facilitates the collusion if minimum wage is non-binding.

Theory of tacit collusion well established in industrial organization literature formulates a set of empirical implications of collusive behavior. Following is a set of such implications with respect to tacit collusion at non-binding minimum wage.

General implications:

- If focal point facilitates the collusion, greater clustering of observations at the focal point than otherwise expected should be observed. Thus, existence of a focal point in the form of minimum wage should lead to greater clustering of wages at the minimum than at any other point in wage distribution;

- Firms operating in visibly competitive environment demonstrate high and persistent profits that are not accompanied by product quality and/or cost advantages. (Porter, 2005)

- Higher than average frequency of new entries into an industry. Larger than average rate of job creation.(Porter, 2005)

Factors facilitating collusion:

- Costs of other inputs: As costs rise, collusive "agreement" becomes easier to maintain since "cooperation is trivially easy when costs are such that a firm's noncooperative price equal the ceiling" (Knittel & Stango, 2003)..

- Number of firms on the market: Tacit collusion is more likely to take place when there are fewer firms on the market.

- Firm's size: Larger firms are expected to cooperate more often than smaller firms, since gains from "cheating" are proportionately larger than for smaller firms.

Factors hindering collusion:

- Eroding minimum wage: It is more difficult to sustain the collusion when a focal point decreases. Probability that a given firm will match a non-binding minimum wage falls as real minimum wage erodes since, again, benefits of "cheating" become larger.

- Change of minimum wage level: When minimum wage is raised it is binding for larger portion of employers. Thus, overall likelihood of collusion is smaller. Also, less collusion should be observed the longer the period since an introduction of a new minimum wage

- Collusion is more difficult to sustain in periods of high demand, due to increased incentives to deviate, as proved by Rotemberg and Saloner (1986)

In the following sections testing of selected empirical implications is performed. Appropriate measures to capture the effects of collusion at minimum wage are offered and suitable variables are suggested.

4 Empirical Strategy

Both empirical studies and existing theories of collusion at focal points supply enough evidence to hypothesize that the floor imposed by minimum wage in many cases is not binding and may facilitate wage collusion by low-wage employers using the legal minimums as communication device. In this paper I test a hypothesis whether a non-binding minimum wage serves as a focal point for tacit collusion by employers.

Before proceeding, I would like to clarify some terminology. Under "collusion", "tacit collusion", "collusion hypothesis" etc. will be denoted potentially existing wage-setting practices of low-wage employers that can lead to reduction wages at the lower end of wage distribution. Proving that a specific employer is colluding is practically impossible. This paper is an attempt to detect some general trends in the data that may indicate that tacit collusion at minimum wage is possible.

The rest of the paper is purely empirical. In this section a number of possible empirical exercises are suggested in order to test the collusion

hypothesis. One of the main empirical techniques used in industrial organizational literature is estimation of likelihood of collusion through hurdle models, originally suggested by Cragg (1971). Knittel and Stango(2003) adapted the framework to test the collusion in credit card markets. I generally will follow their method, though some data challenges posed by labor markets lead to modifications of the existing empirical techniques that will be discussed next.

Separating observationally equivalent outcomes when employers set wages at minimum can be a challenge. However, by assuming that low-wage labor markets are competitive the problem is simplified. Employers will set wages at minimum in two situations: when minimum wage is an equilibrium solution or if they follow the collusive path. To separate these to case I will proceed similarly to Knittel and Stango, who used an expanded version model for censored data by introducing an independent probability that an issuer prices at the ceiling even though it is not binding.

4.1 Basic Hurdle Model

First, let specify a wage equation in the absence of collusion. Then I amend the model by introducing the possibility of collusion. Reduced form wage equation (the 'latent wage') in the absence of the minimum wage is:

$$w_{it}^{*} = X_{it}\beta + \mu_s + \eta_t + e_{it} \tag{4}$$

where:

X_{it} - is a set of worker characteristics;
μ_s - is a set of state fixed effects;
η_t - is a set of time-period fixed effects;
and e_{it} is an individual error term, $N(o, \sigma^2)$.

If minimum wage is binding, it will censor wage distribution according to the following schedule:

$$w_{it} = \begin{cases} w_{it}^{*} & \text{if } w^{*} > M_{st} \\ M_{st} & \text{if } w^{*} \leq M_{st} \end{cases} \tag{5}$$

where:

M_{st} - is a minimum wage set in state s.

No wages will be observed if the latent wage is below existing minimum. Thus, with allowance for censoring, the likelihood function is a simple Tobit model:

$$L = \prod_{w_{it}=M_{st}} \Phi(\frac{M_{st} - X_{it}\beta - \mu_s - \eta_t}{\sigma}) \prod_{w_{it}>M_{st}} \frac{1}{\sigma}\phi(\frac{X_{it}\beta + \mu_s + \eta_t - M_{st}}{\sigma}) \tag{6}$$

In other words, the probability of $w_{it} = M_{st}$ is given by:

$$P(w_{it}) = M_{st} = P(w_{it}^*) = P(\varepsilon_{it}\varepsilon \leq (M_{st} - X_{it}\beta - \mu_s - \eta_t)) =$$

$$P(\frac{\varepsilon_{it}}{\sigma} \leq \frac{M_{st} - X_{it}\beta - \mu_s - \eta_t}{\sigma}) = \Phi(\frac{M_{st} - X_{it}\beta - \mu_s - \eta_t}{\sigma})$$

As was indicated in figure 3, there exist some sectors that are not covered by minimum wage. Per se, the uncovered sector is supposed to aid in identifying parameters of the wage distribution. In the US such uncovered sectors are rather small, I will keep it in specification for the time being.

The likelihood function becomes:

$$L = \prod_{I^{cov}=1} [\prod_{w_{it}=M_{st}} \Phi(\frac{M_{st} - X_{it}\beta - \mu_s - \eta_t}{\sigma}) \prod_{w_{it}>M_{st}} \frac{1}{\sigma}\phi(\frac{X_{it}\beta + \mu_s + \eta_t - M_{st}}{\sigma})]*$$

$$\prod_{I^{cov}=0} \frac{1}{\sigma}\phi(\frac{X_{it}\beta + \mu_s + \eta_t - M_{st}}{\sigma}) \tag{7}$$

The indicator of coverage takes values:

$$I_{it}^{cov} = \begin{cases} 1 & \text{if a worker employed in covered sector;} \\ 0 & \text{otherwise.} \end{cases}$$

In case of collusion, define an indicator that a person's employer sets the wage at non-binding focal point:

$$c_{it} = \begin{cases} 1 & \text{if an employer colludes;} \\ 0 & \text{otherwise.} \end{cases}$$

With collusion the observed wages are:

$$w_{it} = \begin{cases} w_{it}^* & \text{if } w_{it}^* > M_{st}, I_{it} = 1 \text{ and } c_{it} = 0; \\ w_{it}^* & \text{if } I_{it} = 0 \text{ and } c_{it} = 0; \\ M_{st} & \text{if } w_{it}^* = M_{st} \text{ for } \forall I_{it}; \\ M_{st} & \text{if } w_{it}^* > M_{st} \text{ and } c_{it} = 1. \end{cases}$$

Incorporating the possibility of collusion into the likelihood function gives:

$$L = \prod_{I^{cov}=1} [\prod_{w_{it}=M_{st}} [\Phi(\frac{M_{st} - X_{it}\beta - \mu_s - \eta_t}{\sigma}) + \rho\Phi(\frac{X_{it}\beta + \mu_s + \eta_t - M_{st}}{\sigma})]*$$
$$\prod_{w_{it}>M_{st}} \frac{1}{\sigma}\phi(\frac{X_{it}\beta + \mu_s + \eta_t - M_{st}}{\sigma}) * (1-\rho) \prod_{w_{it}>M_{st}} \frac{1}{\sigma}\phi(\frac{X_{it}\beta + \mu_s + \eta_t - w_{it}}{\sigma})]*$$
$$\prod_{I^{cov}=0} \frac{1}{\sigma}\phi(\frac{X_{it}\beta + \mu_s + \eta_t - w_{it}}{\sigma}) \tag{8}$$

In the above equations ρ is the conditional probability of tacit collusion in case of non-binding minimum wage in the covered sector. I.e. variable c_{it} takes values of 1 with probability ρ, and values of 0 with probability $(1-\rho)$. I assume no collusion in the uncovered sector. For wage observations identified as collusive, fitted values of wages are expected to be above the minimum wage.

Estimation of this hurdle model, which is also known as "p-Tobit" model will give us appropriate estimates of the ρ. Estimation procedures and results are discussed further in the paper.

4.2 Alternative Estimation Technique: Chain Truncation

Usually, hurdle models of collusion at price ceiling or price floor (as in our case) would include explanatory variables that might contribute to the collusion, as well as some sort of control group, or group of markets that do not have the ceilings(floors). In the labor markets the availability of such variables and of a control distribution is rather limited.

Preliminary evidence cited earlier, suggests that the tacit collusion in low-wage markets is likely to occur. However, using public access labor market data (as in this study we'll use CPS outgoing rotation groups data), which does not have employer level data on costs and income, does not allow to claim with a hundred percent certainty that the detected activity is, indeed, collusion.

Another factor that complicates the empirical work is the absence of the control group, or more generally, a control wage distribution in labor markets that do not have minimum wages. Using data from countries without minimum wage laws (for instance, Switzerland or Denmark) will not be very credible either, since different countries might not only have distinctive labor

market institutions, but also quite different economic environments. Also, even though some countries might not have minimum wage laws, but they still might be indirectly referring to wage-setting practices of their neighboring countries, or countries with similar development levels. By the same token, using data from the sectors not covered by minimum wage laws might not be possible either. For instance, agricultural workers in the US are exempt from the minimum wage laws. However, the industry is very different from the rest of the economy. At the same time they agricultural employers draw their supply of workers from the same pool of applicants, and may reference the existing minimum wage laws without even realizing it.

Another problem in detecting collusion in low-wage markets stems from the spread of potentially collusive observation over a range of wages. A close analysis of wage histograms showed that a spiking around the minimum wage goes beyond a minimum wage only. In other words, wage observations immediately adjacent to the minimum were likely affected by collusion as well. There can be named a few reasons for the spread of this spike, ranging from traveling costs to costs of living etc. Thus, in 1995-1996 when the federal minimum wage was set at $4.25 a considerable spiking was observed up to a wage of $6. After a two-step increase in minimum wage to $4.75 in October 1996 and to $5.15 in September 1997, the upper cut of the spike moved up to roughly $7. (See Appendix 2 for exemplary histograms).

The existence of such spread corrupts the accuracy of collusion estimates obtained through p-Tobit estimation described above. The maximum likelihood function in the model will repeatedly compare wage observations at the minimum or below to the distribution of wages above the minimum. Thus, if wage observations above the minimum are affected by collusion as well, the estimates of the ‘rho‘ will be incorrect, particularly, they will be biased downwards.

To work around these issues a technique that allows both to predict the extent of collusion, and to re-create a so-called "control group" (or a "quasi-control group") was developed. The technique is based on a visual analysis of wage distribution around the minimum wage that will provide a cut-off point, after which no correlation is assumed between wages and collusive wages. The cut-off points were set at the level of $6.01 for the period of 1995 up to August 1996, and $7.01 thereafter. Such choice of cutoff points is justified by the fact that the remaining part of the distribution still represents a large enough set of wages to correctly identify the parameters of wage equation. At the same time, the range of wages up to these cut-off points shows the largest spiking in the entire distribution.

After establishing these points, I separate wages below them and run

truncated regression using the remaining wages. Then I use estimated wage equation to predict would-be wages of workers that are currently paid immediately below the cut-off points. For example, in 1995 when the cut-off point was \$6.01, workers whose current wage was exactly \$6 should have been paid more if the same pay schedule was applied to them in 11% of cases, with 95% confidence interval applied to obtain lower limit values. Then, wages of workers whose fitted wages should have been higher then observed were substituted for predictions in the set of wages used in regression. As a rule, a 10 cent interval to predict the fitted values was applied. Thus, a truncated regression on wages staring at \$5.90 is estimated next with fitted values replacing actual wages for the subset of workers in the interval \$5.90-6. The next truncated regression is performed for the wages set at \$5.80 and higher and so on until the minimum wage is reached. To be more exact, the chain truncation is conducted up to the wage level of \$4.21 for the periods when federal minimum wage is \$4.25, \$4.71 when minimum wage is \$4.75 and \$5.11 when minimum wage is \$5.15. The wage distributions (actually, estimated kernel densities) obtained through such chain truncation are compared against the originals in Appendix 3. The results of truncation as indicating average shares of potentially collusive wages are reported in the "Results" section of the paper.

4.3 "Is it Collusion?": Probit Model

Chain truncation technique will provide an indicator of whether a particular wage observation within a specified interval is potentially collusive. Next, I estimate a probit model that allows to investigate contribution of different factors to the degree of collusion found in low-wage markets.

$$c_{it} = Z_{it}\gamma + \lambda_s + \kappa_t + \nu_{it} \tag{9}$$

where:

Z_{it} - is a set of worker and job characteristics;
λ_s - is a set of state fixed effects;
κ_t - is a set of year fixed effects;
and ν_{it} is an error term, $N(o, \sigma^2)$.

The choice of explanatory variables Z_{it} included in the regression is suggested by the theory of collusion that was discussed earlier.

One of the predictions of the theory was that the collusion is more difficult to sustain when real minimum wage erodes. This can be interpreted as

that the signaling role of minimum wage as being instrumental to collusion weakens the longer the period of time has been since the change in minimum wage laws, or the longer the time period prior to a next increase. At the same time, the lengthier the period since an increase, eroding real minimum wage increases the short-term gains from deviating from a collusive "agreement".

Also, there might be a curve for employers to learn about each other wage setting practices. In other words, we can anticipate an increase in collusion the longer the time period since the minimum wage change. Those three effects, the "signaling", the "learning" and the "incentive-to-deviate" effects that work simultaneously but often in different directions, can be captured by inclusion of time-period variables related to changes in minimum wage laws. Thus, the first subset of the Z's includes time-period variables associated with minimum wage increases.

For each state and every month was created a discrete variable indicating the number of months since the minimum wage was either raised. If a state adopted a minimum wage higher than existing federal minimum wage, the higher minimum wage "takes over". For instance, Massachusetts in January of 1996 adopted a minimum wage of $4.75. Subsequently, in October of 1996 the minimum wage of $4.75 was enacted at the federal level. In this case, say, in December of 1996 the variable of interest - "months since last minimum wage re-enactment" would be eleven months, not two months as for the states without own minimum wages. The relationship between time elapsed since latest minimum wage change and probability of collusion is likely to be non-linear. Thus, create a set of binary variables by grouping the above variable: 0 to 1 months, 2 to 6 months, 7 to 12 month and more than 12 months.

A similar variable was created for the number of months prior to an adoption of new minimum wage. The grouping into binary choice variables is done according to the schedule: 1 month prior, 2 to 6 months, 7 to 12 months and more than 12 months.

Another implication of collusive wage-setting was that as costs of other inputs rise. This again is another implication of the "incentive" effect: in case of higher cost of other inputs the incentive to collude is strengthen, in case of lower cost - the incentives to deviate strengthen. Thus, collusion by low-wage employers is more likely to occur if other inputs, such as of high-wage (skilled) labor, capital etc. In order to proxy for price of other inputs I chose average wages of workers with bachelor's degree within a specific age category for every state. Such choice was limited by the nature of the data - CPS does not contain any information about the costs of comparable

inputs. Ten age groups were formed: 15 to 24 years old, 25 to 29 years old, 30 to 39 years old, and so on until the last age group 65 years and older. Wage information of hourly as well as non-hourly workers was utilized.

State unemployment rate is included in a set of Z's as a proxy for the demand conditions. As Rotemberg and Saloner (1986) suggested, the likelihood of collusion decreases during the periods of high demand. We can apply this to labor markets as well: the higher the demand for labor, which translates into the low unemployment rate, the lower the probability of collusion.

And finally, a proxy for the number of firms in the labor market is entering the set of Z's. The theory predicts that the smaller the number of firms on the market, the easier it is for them to coordinate their wage-setting practices directly or indirectly (through learning the market outcomes). A suggested proxy is an indicator if a worker lives in central city.

Thus, our empirical strategy will include:

- Estimation of likelihood of collusion through chain truncation;
- Estimation of collusion at minimum wage by T-tobit MLE;
- Testing whether empirical implications of collusion hold and consistent with the theory of facilitating factors through estimating a binary choice model.

5 Data

Data used in the paper is CPS "merged outgoing rotation groups" (MORG) that represent extracts of earnings related variables from the US Current Population Survey, the government monthly household survey of employment and labor markets. Variables included in MORG extracts reflect workers' earnings, industry, occupation, education, and unionization, as well as some background variables: age, sex, race, ethnicity, geographic location, etc.

Four years of CPS were used in the estimations, 1995 through 1998, since years 1996 and 1997 were the last years for the federal minimum wage increases in the US. Such choice was motivated by the goal of observing dynamics of collusion that surrounds the minimum wage hikes. In the future I plan to extend the analysis to include more recent data.

Hourly employee data is used only. Two reasons for doing so can be given. First, it should serve the goal of minimizing the measurement error

due to calculations without actual knowledge of hours worked for full time employees. Second, hourly employees is a category of workers to be more likely affected by minimum wages, since the "frame" of the minimum wage is more relevant for firms employing hourly workers.

Minor data cleaning was performed. Workers who simultaneously satisfied following conditions were excluded: indicated as full-time labor force but reported no hours, weekly wage less than $100, wages less than legal minimum.

Additional variables, crucial to the analysis of facilitating factors, were added to the data set. The first and the foremost, minimum wage variables were added. US Department of Labor data on minimum wages were used, as well as annual surveys of state labor legislature published in Monthly Labor Review annually (prepared usually by R.Nelson). Surveys published from 1991 to 2005 were used. These data was also used to create variables indicating the lengths of time periods elapsed since re-enactment of new minimum wage laws, as well as for time periods prior to new laws. State unemployment rates by month, as published by US DOL, were also used in analysis. Census data on retail sales cited earlier did not enter the regressions.

6 Estimation and Results

6.1 Chain Truncation

6.1.1 Histograms and Choice of Truncation Limits

I start quantitative assessment of the likelihood of collusion with visual examination of wage histograms for each month in our data set. Appendix 2 has exemplary histograms for April of each year. April is chosen as a relatively neutral month that usually does not exhibit any major surges in demand for either output of low-wage sectors or in aggregate demand and supply for the economy as a whole.

As expected, histograms show rather extensive clustering of wages at the lower end of the distribution. The tallest bar in each histogram, except for 1998, is the cluster of wages equal to $5. Rather large frequencies are recorded for many low values of wages. This, as was stated in section 4, complicates estimation of the hurdle model since wage observations do not simply pile at the minimum but spread over a certain interval. The borders of such interval can be somewhat established.

In this paper I first use a "visual" approach to determining the extent of such intervals. I fully understand that it might not be precise, but in

the absence of other instruments this approach offers some solution. The red line on the histograms denotes the upper limit of the intervals, which is equal to $6 or $7, which I refer to as the upper cut-off points.

Therefore, an assumption that wage observations above the cut-off points are not contaminated by collusive wage-setting is made. Of course, it can be argued that some observations are still correlated with collusive arrangements, and it will be true in some of the cases. For example, some observations as high as $8 or $9 may be related to collusive wage-setting. However, choosing a higher cut-off point will bias predicted wages for workers below the cut-off point that chain truncation will produce. Simply stated, would you trust the predicted wages of workers currently earning an hourly wage of $4.50 that was obtained by using earnings function estimated by using data for workers earning $9 or more?

Though the choice of the cut-off points is somewhat arbitrary, it is a necessary compromise between the accuracy of wage predictions for the lower end of wage distribution and the accuracy of estimates of the likelihood of wage collusion.

The choice of cut-off points and minimum wage levels divide our data into three large groups. The first group contains observations from 1995 to August 1996 (cut-off point $6, federal minimum wage $4.25), the second group - from September 1996 to August 1997(cut-off point $7, federal minimum wage $4.75), and the third group - from September 1997 to December 1998 (cut-off point $7, federal minimum wage $5.15).

6.1.2 Truncated Regressions: Preliminary Estimates of Extent of Collusion

After establishing the cut-off points I proceed to estimation of truncated regressions. As was explained in section 4, consecutive truncation of the wage distribution where most of the spiking occurs let us infer as to what degree an existing wage floor affects the wages of the lowest-paid. Control variables used in both truncation regressions and in p-Tobit are listed in Appendix 4.

Detailed analysis of wages at the lower end of the distribution (within specified intervals) shows that large clustering of observations occurs at round-dollar amounts. But such clustering at, say $5 or $6, does not necessary mean that large portions of observations can be classified as potentially collusive. For instance, in May 1996 (see Appendix 11 for an illustration) the largest shares of wages that can be regarded as collusive are found at the intervals immediately below the round amounts. Within the intervals

$5.91-5.99 and $4.81-4.90, up to 50% of employees would have to be paid higher wages if the same earnings schedule was applied to establish their predicted wages as to workers whose wages are immediately above $5.99 and $4.90 respectively. However, the number of observations in these intervals is small.

Though the degree of potential collusion is lower for workers paid round dollar amounts, the overall impact in terms of lost payments is larger. Tables in Appendix 5A provide information of how many observations are located at the intervals containing round dollar amounts and at around current minimum wage, as well as weighted estimates of shares of these observations that can be classified as potentially collusive. Figures in Appendix 5B graphically depict changes in these estimates.

As can be seen from the tables, the number of wage observations at chosen intervals somewhat decreases as time passes by, but the extent of potential collusion is relatively stable. For example, in 1995-1996 the estimates for workers currently paid $6 fluctuate at around 10.6%, the estimates for workers currently paid in $4.91-$5 range fluctuate at around 12.7%. In 1996-1997, the year of a minimum wage increase from $4.25 to $4.75, the estimates for workers currently paid $7 fluctuate at around 7.1% (new cut-off point), estimates for workers currently paid in $5.91-$6 range fluctuate at around 11.74%. The estimates for workers currently paid in $4.91-$5 range fluctuate at around 14.1%, a substantial increase from the previous year. In 1997-1998, the year of a minimum wage increase from $4.75 to $5.15, the shares of potentially collusive wages for workers currently paid $7 fluctuate at around 7.3% (a slight increase), estimates for workers currently paid in $5.91-$6 range fluctuate at around 9.9%, which is a substantial drop from the previous year.

Figures in Appendix 5B also show that the pattern of estimated shares at specified round dollar amounts is somewhat repetitive in 1995-1996, a period of no prior changes in minimum wage legislation. The pattern for the lower pay interval also seems to repeat itself in the pattern for higher pay intervals but at later months. In other words, under eroding real but stable nominal minimum wage the potentially collusive wage-setting simply shifts up. During the next three years, 1996-1998, the repetitive pattern of collusive shares seems to fade away. I suggest that a changing minimum wage level disrupts the existing pay practices, which contributes to the decreasing collusive shares and, perhaps, forces employers to set wages according to the marginal rule in more instances than before.

Average weighted shares of potentially collusive wages immediately above existing minimum wage and below the specified cut-off points are estimated

based on chain truncated regression results and are shown in the table in Appendix 6A. The average share of potentially collusive wages estimated at 10.8%. Average estimated difference between the actual and potential wages is about $9.21[3]. The first two graphs in Appendix 6B illustrate monthly dynamics in these estimates. Gaps in the graphs denote the change in minimum wage levels. Clearly, there is an upward trend in the difference between predicted and actual wages for workers in the lower end of wage distribution. The estimates of collusive shares steadily rise prior to minimum wage hikes and abruptly drop following the hikes.

The third graph in Appendix 6B compares collusive shares by month in four study years. Monthly comparison reveals an interesting pattern. In 1995 and 1998 estimates of the collusive shares are similar from month to month, though they are generally higher in 1995 than in 1998. Recall, that 1995 and 1998 are the years of changes to the federal minimum wage. In 1996 and 1997, some months show increases in collusive shares relatively to the previous year. In 1996 the collusive shares increased in almost all months except April (prior to the hike in minimum wage), October and November(the months of the hike and the following month). In 1997, the estimates of collusive shares were lower than in 1996 in all months except for June. At this level of analysis we can infer that the collusion tends to generally diminish when minimum wage is raised, with exception for a few months that precede the raise.

Similar estimates are reported for a subset of observations within the interval "minimum wage -to- cut-off point" for the lowest 1100 actually surveyed hourly employees, to make the results more comparable. Please refer to Appendix 6C for the estimates. For this subset of data an average share of potentially collusive wages is slightly higher, around 11.0%. Average estimated difference between the actual and potential wages is smaller, $9.15. Probability of collusion is overall smaller towards the end of the period following the two consecutive increases in the federal minimum wage, but a clear upward trend is detected in each of the three periods. The first graph in Appendix 6D contrasts the estimates for all hourly workers within the specified intervals and for the lowest 1100. Interestingly, the estimates of collusive shares for the lowest 1100 are larger than ones for the compared group prior to the minimum wage increase of October 1996. After the shifts in minimum wage levels, these estimates are generally higher for the lowest 1100.

[3]The estimated difference between fitted and actual wages does not take into account confidence interval.

The largest estimates of collusion were obtained for a subset of workers, whose wages are currently below the statutory minimum. Appendix 6E displays monthly estimates. Average share of potential collusion for this subset of workers is 28.7%, with the maximum reaching 48.5% in August 1996, a month prior to the first of two minimum wage increases. Percentage of potentially collusive wages below the minimum is relatively low prior to minimum wage increase in 1996 and it spikes up immediately after the increase, and again spikes up before the increase of 1997.

Estimates of collusion for a subset of workers whose wages are within the plus/minus five-cent interval of current minimum wage are relatively stable and average to about 9.6%. Absolute number of wage observations potentially affected by collusion falls after a new minimum wage is introduced.

Percentage of potentially collusive wages below the minimum is relatively low prior to minimum wage increase in 1996. It spikes up immediately after minimum wage level was raised, and spikes again before the increase of 1997. As number of wage observations potentially affected by collusion below the minimum increases upon changes in minimum wage, it is relatively stable for workers who are paid exactly the minimum. For this subset of workers it is even slightly decreases. But the overall number of affected wages tend to rise before the hikes and gradually fall thereafter, which is consistent with predictions (Appendix 6G).

6.1.3 Kernel Densities

The chain truncation technique was intended not only to provide first approximations of the extent of collusion at the lower end of wage distributions, but also to supply wage observations for a "quasi-control" group used in estimation of the hurdle models. Appendix 3 provides graphs with kernel density estimations of original wage distributions and modified wage distributions that were obtained through chain truncation.

In Appendix 3A original and modified densities for the Aprils of each year are contrasted against each other. All four graphs demonstrate large clustering of observations immediately above the minimum wage. The original density lines at the lower end of the distribution (but above minimum wage) lie over the modified density lines, as expected. The difference constitutes potentially collusive wage observations, identified through the chain truncation. Modified densities show where these observations would otherwise locate: in all cases modified density lines lie above the original density lines after the two cross at some value around $10.

One can also observe that the shapes of the densities differ in each year.

In 1995 the "hump" corresponding to the mean values of wages is rather weakly outlined. It becomes much more pronounced in 1996, even more so in 1997 and 1998. From the perspective of collusion theory, the defacto merge of the "hump" with the rest of the distribution in 1995 can be interpreted as evidence of tighter relationship between the higher wage observations and lower "collusive" wages. In 1995 employers supposedly had more time since the last minimum wage increase in order to learn each other wage-setting practices. The adoption of new minimum wage laws in 96-97 may have acted as a disruption to the established practices and forced the employers to compete for most productive workers. This resulted in more "fair" wage distribution, i.e. wage distribution more reflective of workers' marginal productivity which transformed the shape of the distribution resulting in a more "normal" shape in 1996-1998.

Another group of kernel densities is displayed in Appendix 3B. The figures show original and modified wage distributions in the month immediately before a minimum wage change and the month of the change. A close look at the histograms reveals that the peak of the distributions is located at the lower density values in both years in the month following the introduction of the new minimum wage, while the spikes at the minimums are higher.

6.2 Probit Model

Next step in the estimation is to determine whether the extent of collision, or the probability of wage observations identified as potentially collusive, does in fact depend on factors explaining sustainability of collusion. The choice of variables used as proxies for factors facilitating/hindering collusion was discussed in section 4 of the paper.

Wage observations within the "collusive interval" and that were identified as potentially collusive by chain truncation were used as regressands for probit model. Among the regressors are following variables: set of binary variables indicating the length of the period since/prior to introduction of new minimum wage levels, wages of college graduates within same age group as a proxy for cost of other inputs, state unemployment rates as indicating demand conditions in the local labor markets, a binary variable "central city" as a proxy for number of employers in the relevant labor market. Other regressors, such as level of minimum wage, state dummies, year dummies were successively added to the basic model, which produced four different specifications.

In order to have greater variability in all variables, including levels of minimum wages, I use two larger pooled cross-section data sets comprised

of a) MORG data for 1995 plus MORG data for 1997; b) MORG data for 1996 plus MORG data for 1998. The choice of such pooling is explained by the data collection process of the CPS: "If you append records from the next year you will get repeated observations on the same individual, and you would want to worry about your standard errors"[4]

Results of probit regressions are reported in Appendix 7. Coefficients on "time-since" variables are positive and significant for the time period elapsed since the introduction of a minimum wage up to 12 months in specifications 1 and 2 for both pooled sets. Compared to the month of actual change of the minimum wage, likelihood of collusion increases as time passes, which supports the "learning effect" explanation of a new minimum wage as a new focal point. Coefficients on the variable indicating 13 and more months since the change in the minimum are also positive and significant, but smaller than the coefficient for the variable "7-to-12-month-since". Again, this holds true only for specifications 1 and 2.

Thus, the coefficients for "time-since" variables indicate that the likelihood of collusion is still increasing after 12 months from the introduction of the new minimum wage, but at a decreasing rate. This would be true if deviations from collusive "agreement" by employers become more frequent since the incentives to deviate are stronger as minimum wage erodes. The "incentive effect" combined with the "learning effect", produces a new, lower level of collusion after 13 or more months. The graph illustrating the change in the coefficients for variables "time-since" is presented in the figure in Appendix 7B.

Another group of time related variables indicate how the probability of collusion is affected if there is an expected change in minimum wage in the future. In the US, the congress starts the discussion of changes to federal minimum wage usually about one year in advance. So, the definite knowledge of the coming change becomes public one or so years in advance. That is when the signaling role of minimum wage starts working, which contributes to greater collusion. Though political composition of the Congress is important too, even if no changes in minimum wage are currently announced. However, I do not use have a variable controlling for such composition in this paper.

The coefficients of the "time-until" variables are negative and significant when contrasted to the month before changes to minimum wage are made in the first pooled set (1995-1997). However, for 1996-1998 same coefficients become smaller and insignificant. Perhaps, it can be attributed to

[4]As explained in CPS MORG documentation: http://www.nber.org/data/morg.html

smaller number of months in "time-until" variables. Overall, the probability of collusion is higher one or two months prior to the changes, and lower the longer this period. The first graph in Appendix 7B provides an approximation of the change in these coefficients. This reiterates the results of chain truncation shown above, and p-Tobit results to be shown next: employers rather abruptly start to increase collusion only one or two months before changes to the minimum wage are made. In other words, they try to take the advantage of lower input price, only immediately before a higher price takes over. This effect seems to dominate all other effects of minimum wage during the outlined period. Thus, the likelihood of collusion depends both on how much time has elapsed since the introduction of the new minimum wage laws, and on how much time prior to the changes is available.

The next variable of interest entered in the probit model was wages of college graduates, as a proxy for cost of other inputs. As anticipated, the coefficients on this variable are positive and significant for all specifications in both sets of data. The higher wages of skilled workers raise likelihood of collusion: a $10 increase in average pay of a college graduate of the same age group increases the likelihood of collusion by about %5.8-5.9. Obtained estimates support theoretical predication that profit-maximizing employers will be more likely to collude the higher the costs of other inputs.

A state's unemployment rate as an indicator of demand conditions also supports the collusion hypothesis along the lines of predictions of Rotemberg and Saloner (1986): during the periods of high demand the collusion is less likely to occur. Coefficients on this variable are positive and significant in the first two specifications of the probit model for both sets of data. Though, the estimates are somewhat lower for the set 1996-1998, a period of favorable economic conditions and relatively frequent changes to minimum wage in the past. The overall conclusion is that when a labor market is tight, collusion is less likely.

Results on the "central city" dummy are rather puzzling. I expected to see a negative relationship between the probability of collusion and the fact that a worker lives in a central city, which was chosen as a proxy for number of employers in local labor market. Large cities usually provide more job opportunities, which should trigger competition among employers. At the same time, large American cities tend to be populated by low-income minorities which tend to have lower earnings.

The coefficients on the variable are negative and insignificant for 1995-1997 data, but become positive and significant for 1996-1998 data. A possible explanation to such results, apart from demographic composition of the cities' residents, is that in central cities not only are more jobs available

but also collusion is more likely since close location of employers improves opportunities for coordination. In other words, employers' learning of each other wage-setting practices occurs faster. Positive and significant estimates for 1996-1998 may also indicate that more frequent minimum wage changes enhances the signaling power of minimum wage, which when combined with faster learning contributes to the collusion as opposed to lessening it.

To finish discussion of probit model estimates, I look at the coefficients on minimum wage variable. Coefficients on this variable are negative and generally significant, which means that the higher the level of minimum wage lowers the likelihood of collusion. This is consistent with prior discussion: only non-binding minimum wage may serve as a focal point for tacit collusion. High minimum wage levels more likely to be binding, which by definition can not contribute to tacit collusion.

In summary, the results of the probit models provide strong evidence in support of hypothesis of existing tacit collusion facilitated by the minimum wage.

6.3 P-Tobit Model

A final empirical exercise undertaken in this paper is estimation of hurdle models of collusion, namely of p-Tobit models, specified in section 4.

Recall that a p-Tobit model specification assumes censoring of the wage distribution at certain points. This class of models allows identification of observations currently located at the censoring bound, which otherwise should locate above the bound.

The fact that collusion induced by non-binding minimum wages has a spreading effect on nearby observations, censoring distribution at minimum wage would underestimate the probability of collusion. Furthermore, widespread non-compliance with minimum wage laws complicates the matter too. Thus, I was forced to make some choices with regards to where to censor wage distributions and what should be a "model" distribution, to which to contrast a distribution with suspected collusion.

To deal with the second problem I use the results of chain truncation described above. To deal with the first problem I suggest censoring of the wage distribution initially at existing minimum wage, then estimate the ρ as a share of observations currently located at or below the minimum that should be located above the minimum. Another censoring point is the 10th percentile of wage distribution. Interpretation of the ρ in this case is similar: it represents the share of observations currently located at or below the 10th percentile' that should otherwise locate above this level.

To prepare data for the estimations of hurdle models I perform the following. First, I randomly assign observations to two groups. The first group, which I've earlier referred to as quasi-control group, will contain wages that are the combination of actual and fitted wages obtained through chain truncation. The second group of observations will be censored at either the minimum wage or at the 10th percentile. For observations above the censoring point fitted wage values from chain truncation (combined with actual values) will be assigned. Wage histograms in Appendix 8 give an idea how the two groups of data generally looked like. This procedure is crucial to estimation, since the availability of the quasi-control group allows to obtain a better "guess" for the underlying standard deviation of the error term, which in the absence of the quasi-control will be significantly larger.

Quarterly estimates of probability of collusion are presented in Appendix 9 for censoring at the minimum wage, and in Appendix 10 for censoring at the 10th percentile. Earnings equations contained same regressors as in case of truncation, refer to Appendix 4 for the list.

STATA's[5] maximum likelihood module ("`ml`") was used in estimations. Codes by Moffat (2005), as well as the article by McDowell (2003) were instrumental in writing the codes. Since STATA has certain restrictions for options used with `ml` command, two alternative estimations were done in order to get a range of results. First, regressions with robust standard errors were estimated, but no survey weights were applied[6]. Second, regular weighted maximum likelihood models were estimated, however standard errors were not robust. Both models were estimated separately for all hourly employees, as well as for subsets of hourly employees in the states that did not have state level minimum wage laws, i.e. had to comply with the federal minimum wage legislation.

As a rule, starting values for heteroscedasticity corrected regressions were set at the level provided from simple OLS models. Obtained coefficients were then used as starting values for the following estimation of weighted MLE. Generally, converge of maximum likelihood function for heteroscedasticity corrected regressions was achieved somewhat faster than for the weighted MLE, and convergence for the whole data sets was achieved faster than for the subsets.

As table in Appendix 9A shows, an average estimate for the share of potentially collusive wages at or below minimum wage range from 2.32% to

[5]STATA is statistical software supplied by Stata Corporation: www.stata.com

[6]Stata's `ml` module does not allow simultaneous use of "robust" option and "svy" option.

2.41% for all hourly employees, and from 2.43% to 2.51% for hourly employees in states with federal minimum wage levels, depending on specification. Generally, estimates of the ρ are significant at 5% level. Less significant results were obtained for first quarters in 1996, 1997, 1998 and the third quarter of 1995.

The difference in estimates for "all hourly workers" and "hourly workers in the states with federal minimums" is rather small but persistent. The exception presents the period between two minimum wage increases, from October 1996 to September 1997, when likelihood of collusion was higher in "federal wage" states. Generally higher estimates for the aggregate data may imply that more frequent adjustment of minimum wages in the states with own minimum wage laws impedes the learning of wage-setting practices by employers, as well as it "refreshes the signal" sent by minimum wage laws.

Estimates of the ρ obtained in p-Tobit regressions suggest that number of potentially collusive wages tend to decrease immediately after introduction of new minimum wage levels, which imply that more workers are paid accordingly to their marginal productivity. However, soon after the introduction of new minimum wages, shares of potentially collusive wages begin a steady climb despite of the eroding real minimum. This just reiterates the results of chain truncation, as well as conclusions from estimating probit models. Graph illustrating dynamics of the indicator is presented in Appendix 9B.

As the table in Appendix 10A shows, an average estimate of the share of potentially collusive wages at or below the 10th percentile range from 3.46% to 3.60% for all hourly employees, and from 3.10% to 3.32% for hourly employees in the states with federal minimum wage levels. These estimates are higher and generally more significant than the ones from the model with censoring at minimum wage: most of the estimated ρ's are significant at 1% level.

Appendix 10B illustrates the development of the estimated parameter in time. As can be seen from the graph, likelihood of collusion is steadily rising prior to the 1996 increase in the federal minimum wage, it abruptly drops during the "intermission" of 1996-1997, drops even more following the September 1997 increase before it starts the next climb.

Another result from the 10th percentile censoring p-Tobit model, which support the collusion hypothesis, is in reduction in wages of workers at the 10th percentile that takes place after increases in federal minimums in both 1996 and 1997. Wages of workers at the 10th percentile otherwise show small, but consistent growth. Though, this drop in wages is short-lived.

In summary, the results of the hurdle models provide modest, but sta-

tistically significant evidence in support of collusion hypothesis that could be facilitated by non-binding minimum wages.

7 Conclusions

This paper was a first attempt to explain some interesting empirical puzzles found in low-wage labor markets that are subject to minimum wage laws. The most visible is perhaps the minimum wage spike puzzle, which can not be explained within the neoclassical competitive markets framework or the framework of structural monopsony. Dynamic monopsony models, which allow existence of monopsony-like equilibrium are potentially able to explain the spike, however existing models were not able to replicate it. The paper offered an alternative explanation to the puzzle within the theory of tacit collusion and focal point equilibria.

The research question posed in the paper was different from the questions most frequently addressed in minimum wage literature. Employment effects of minimum wage were not the main focus of the study, while wage effects of minimum wage on the set of low-paid workers were considered. Thus, I attempted to quantify the extent of collusion potentially existing due to a focal point suggested by existing minimum wage.

Even though the scope of the research was limited by the time period of 1995-1998 as well as by quality of the data availabe, I was able to obtain consistent and significant estimates for parameters that can potentially reflect wage collusion induced by non-binding minimum wage. Thus, the results of chain truncation show with 95% confidence that on average 28% of wage observations currently located below the minimum can be affected by collusion, and about 10-11% of wages currently slightly above the minimum can be affected.

The results of hurdle models show that about 2.3-2.5% of workers currently earning minimum wage or below ($4.25-$5.15 in the estimation sample), and 3.1-3.6% of workers currently at the 10th percentile in wage distribution ($5.30-$6. in the estimation sample) should be earning more, i.e. they are wages can also be potentially affected[7].

These estimates, however, are likely to represent the lower boundary of collusion since the choice of cut-off points was somewhat arbitrary, and the assumption of no correlation between wages below and above these cut-off points was crucial. If such correlation is present and goes beyond the chosen

[7]The reader should keep in mind that results of truncation and hurdle models cannot be directly compared, as their estimations were based on rather different assumptions.

cut-off points, the collusion estimates are likely to be higher. The author also fully the weakness of the so-called visual approach to establishing the cutoff points and intends to develop a more formal procedure for doing this.

Within the context of the posed research question, minimum wage is found to have contradictory effects on wages of the low-paid. Serving as a focal point for tacit collusion, non-binding minimum wage reduces wage levels of the lowest paid. However, the increasing minimum wage tends to ease the extent of collusion, though temporarily. Generally, most empirical implications of tacit collusion formulated in IO literature were found to hold when considered within the context of low-wage labor markets.

In summary, non-binding minimum wage that serves as a focal point for tacit collusion by low-wage employers may contribute to establishing monopsony-like equilibrium along with existing search frictions. If used as a collusion tool, non-binding minimum wage may reduce the range of wage offers available on the market, thus reducing the expected benefits of job search and inducing workers to accept wages lower than the competitive markets would otherwise offer.

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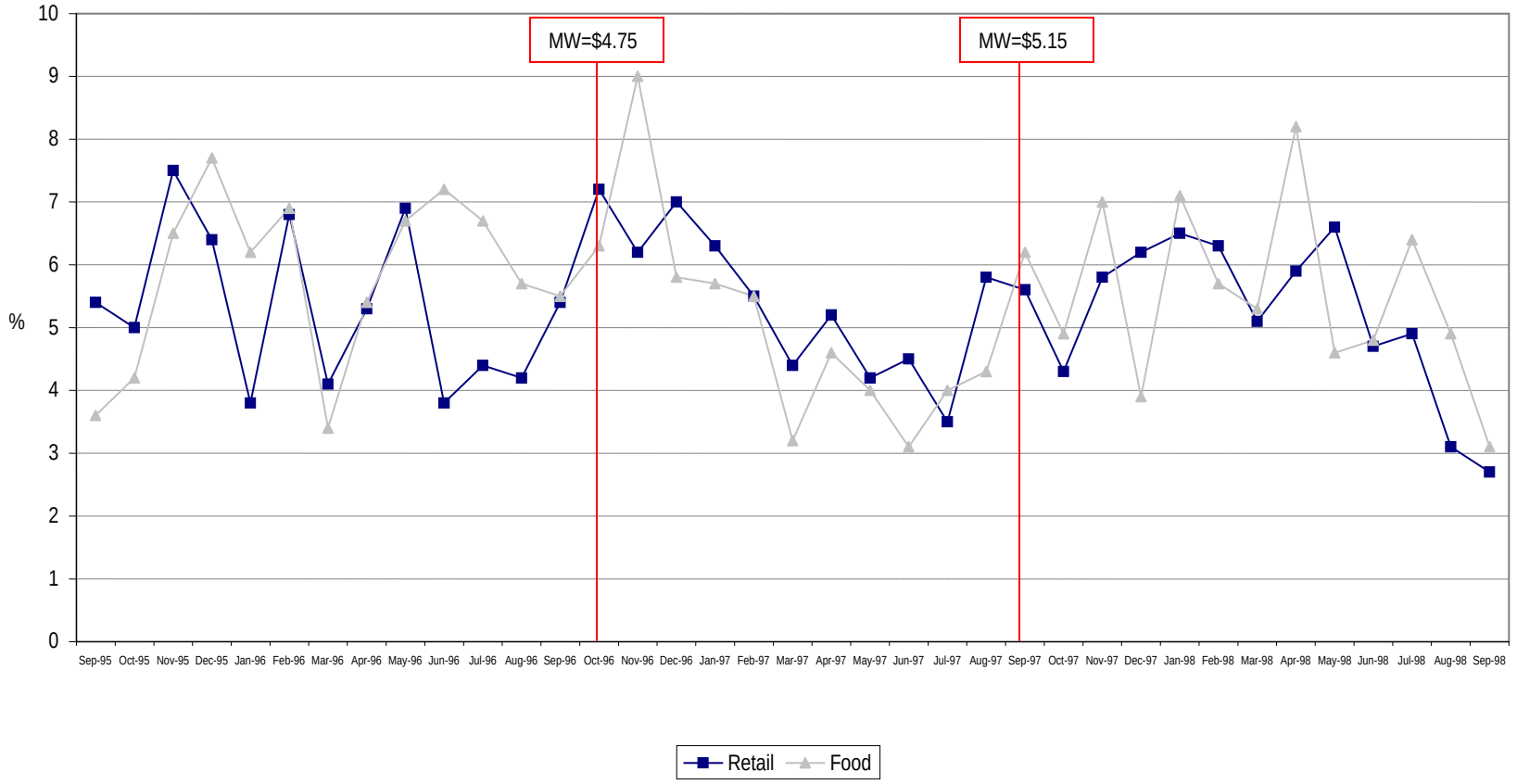
Appendix

Appendix 1A

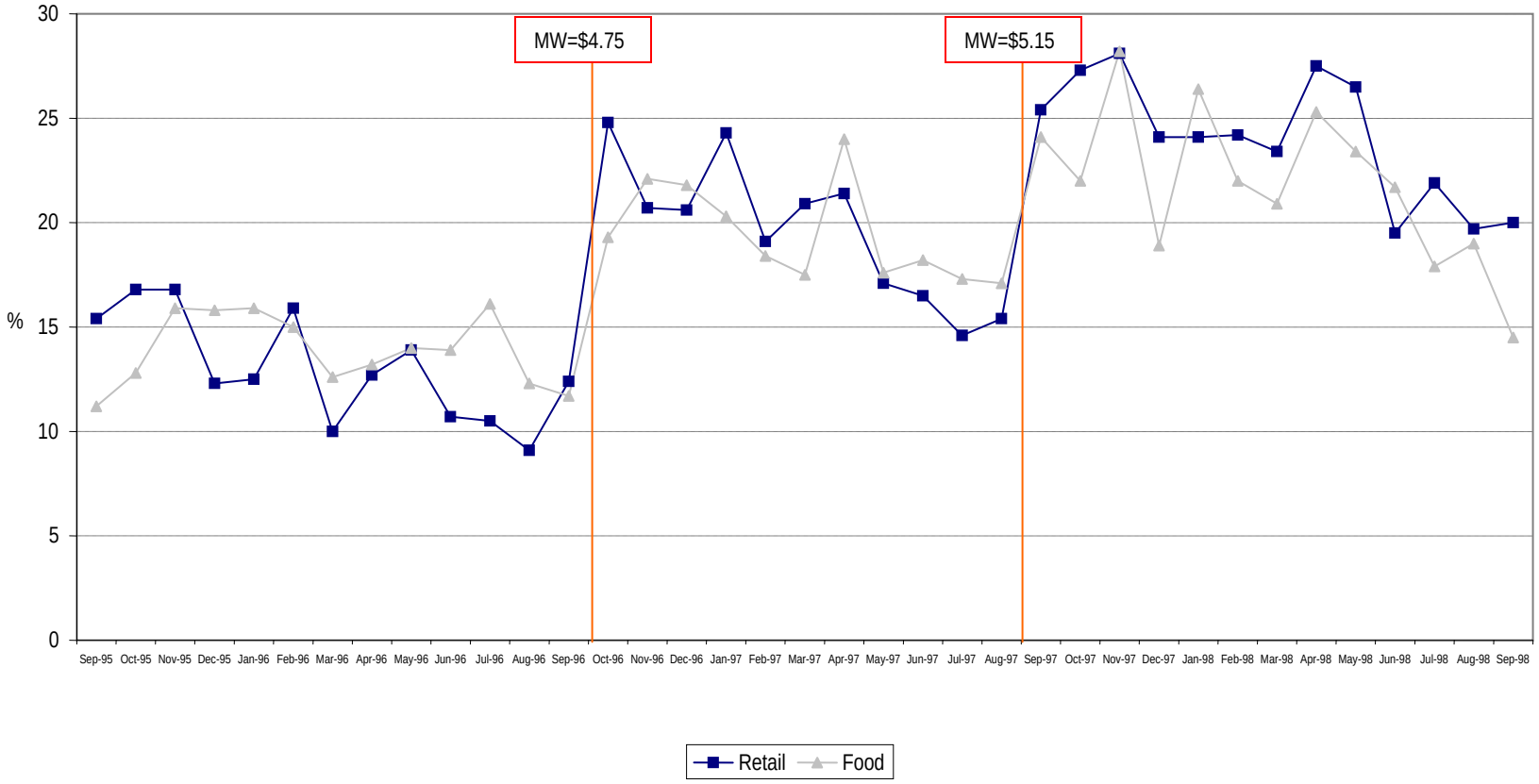
Percentage of Employees at Current Minimum Wage and Sales
Retail Trade and Food Services

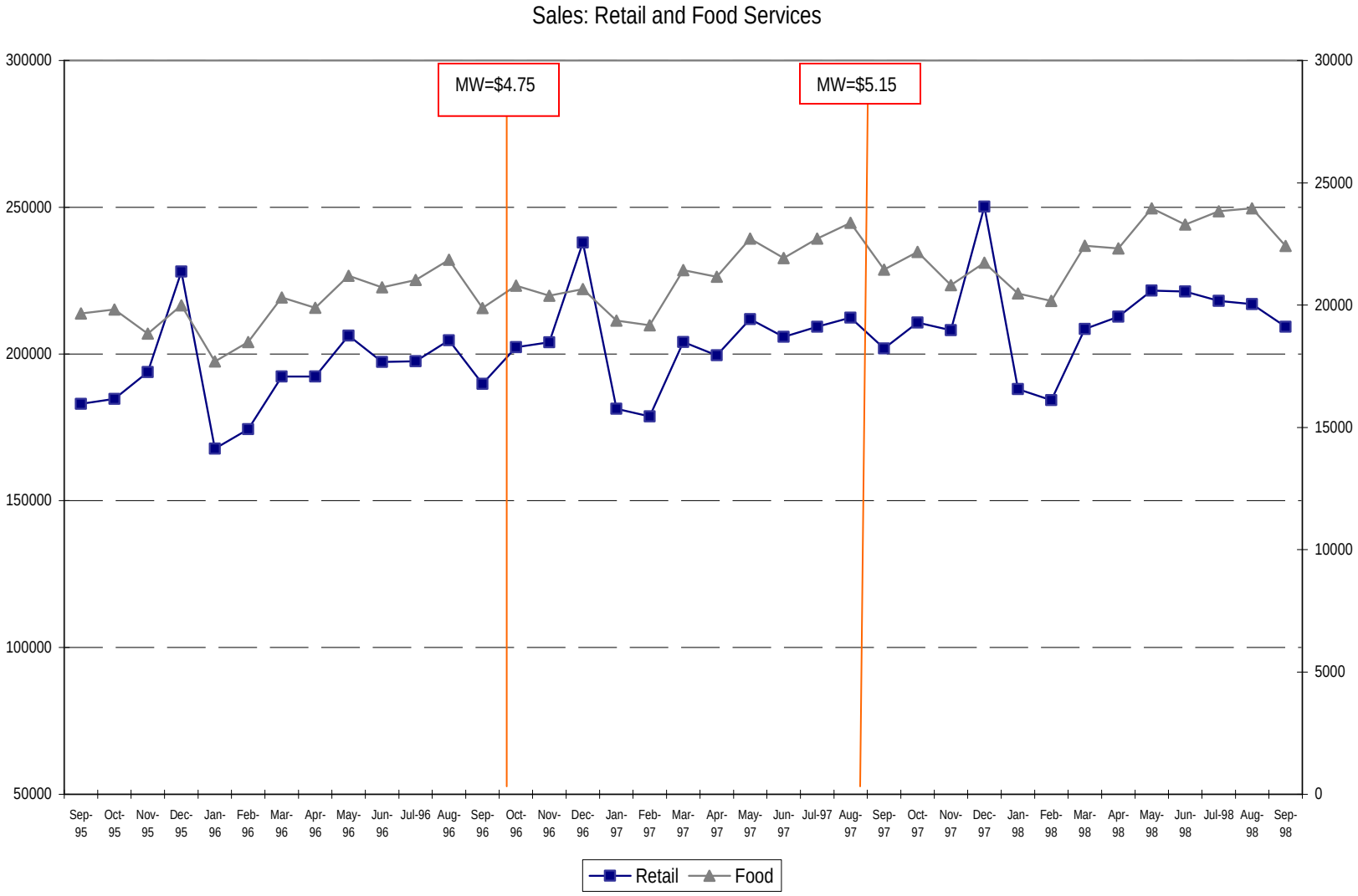
		Percentage of Wage Observations at Current Minimum Wage		Percentage of Wage Observations at +/- 10% of Minimum Wage		Sales (thousands of US doll.)	
		Sales, Retail and Personal Services	Food Services	Sales, Retail and Personal Services	Food Services	Sales, Retail and Personal Services	Food Services
MW=4.25	Sep-95	5.4	3.6	15.4	11.2	182975	19654
	Oct-95	5	4.2	16.8	12.8	184696	19822
	Nov-95	7.5	6.5	16.8	15.9	193822	18836
	Dec-95	6.4	7.7	12.3	15.8	228098	19990
	Jan-96	3.8	6.2	12.5	15.9	167738	17693
	Feb-96	6.8	6.9	15.9	15	174358	18491
	Mar-96	4.1	3.4	10	12.6	192296	20316
	Apr-96	5.3	5.4	12.7	13.2	192336	19888
	May-96	6.9	6.7	13.9	14	206266	21200
	Jun-96	3.8	7.2	10.7	13.9	197291	20724
	Jul-96	4.4	6.7	10.5	16.1	197572	21025
	Aug-96	4.2	5.7	9.1	12.3	204703	21848
	Sep-96	5.4	5.5	12.4	11.7	189808	19879
MW=4.75	Oct-96	7.2	6.3	24.8	19.3	202343	20792
	Nov-96	6.2	9	20.7	22.1	204005	20385
	Dec-96	7	5.8	20.6	21.8	237949	20655
	Jan-97	6.3	5.7	24.3	20.3	181374	19365
	Feb-97	5.5	5.5	19.1	18.4	178736	19177
	Mar-97	4.4	3.2	20.9	17.5	204054	21434
	Apr-97	5.2	4.6	21.4	24	199532	21162
	May-97	4.2	4	17.1	17.6	211859	22724
	Jun-97	4.5	3.1	16.5	18.2	205861	21924
	Jul-97	3.5	4	14.6	17.3	209263	22722
	Aug-97	5.8	4.3	15.4	17.1	212399	23360
MW=5.15	Sep-97	5.6	6.2	25.4	24.1	201893	21447
	Oct-97	4.3	4.9	27.3	22	210701	22173
	Nov-97	5.8	7	28.1	28.2	208133	20817
	Dec-97	6.2	3.9	24.1	18.9	250198	21735
	Jan-98	6.5	7.1	24.1	26.4	188012	20477
	Feb-98	6.3	5.7	24.2	22	184275	20167
	Mar-98	5.1	5.3	23.4	20.9	208491	22422
	Apr-98	5.9	8.2	27.5	25.3	212745	22321
	May-98	6.6	4.6	26.5	23.4	221629	23962
	Jun-98	4.7	4.8	19.5	21.7	221317	23290
	Jul-98	4.9	6.4	21.9	17.9	218109	23837
	Aug-98	3.1	4.9	19.7	19	216988	23953
	Sep-98	2.7	3.1	20	14.5	209272	22414

Percentage of Wage Observations at Current Minimum Wage:
Hourly Paid Employees, Monthly CPS

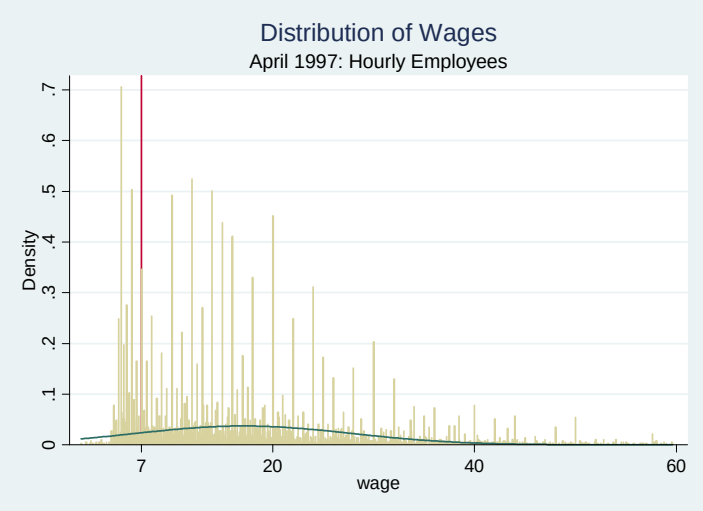


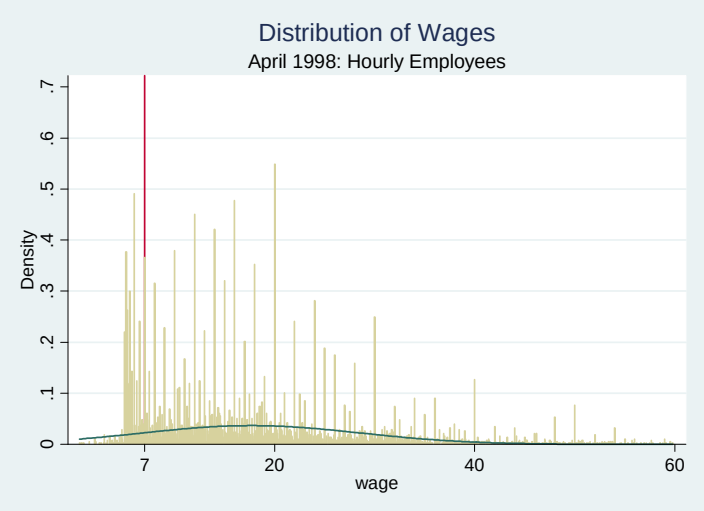
Percentage of Wage Observations at +/- 10% of Current Minimum Wage:
Hourly Paid Employees, Monthly CPS

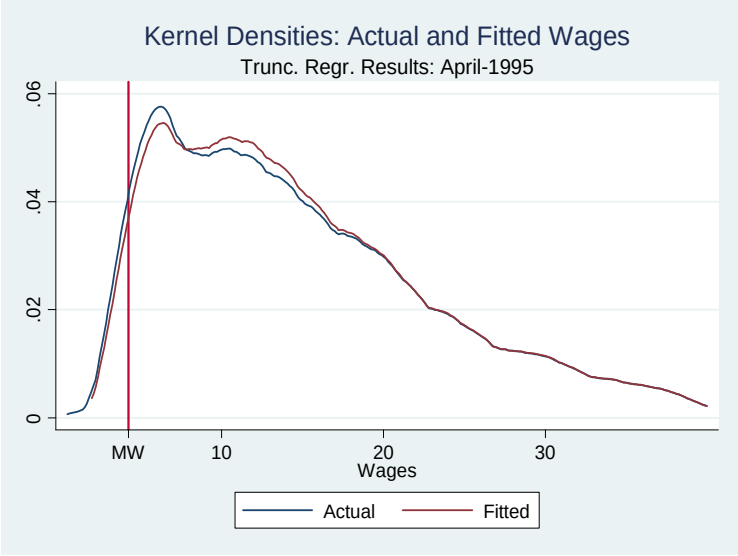


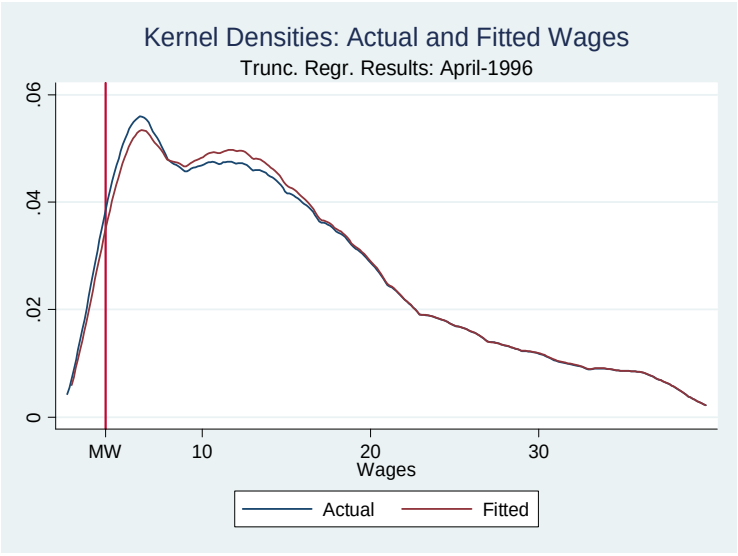

Sales: Retail and Food Services
MW=$4.75
MW=$5.15
300000
250000
200000
150000
100000
50000
30000
25000
20000
15000
10000
5000
0
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
Sep-97
Oct-97
Nov-97
Dec-97
Jan-98
Feb-98
Mar-98
Apr-98
May-98
Jun-98
Jul-98
Aug-98
Sep-98
Retail
Food

Wage distributions and cut-off points for chain truncation






Kernel Densities: Actual and Fitted Wages
Trunc. Regr. Results: April-1995
0
.02
.04
.06
MW
10
20
30
Wages
Actual
Fitted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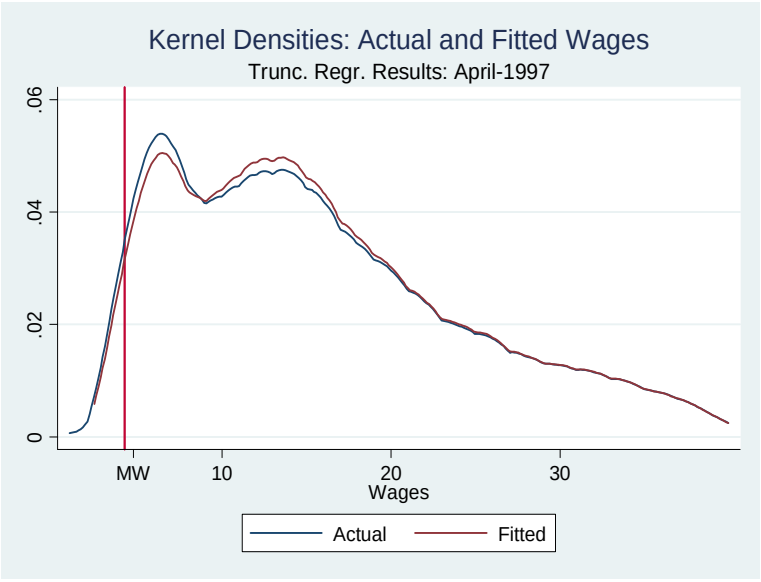
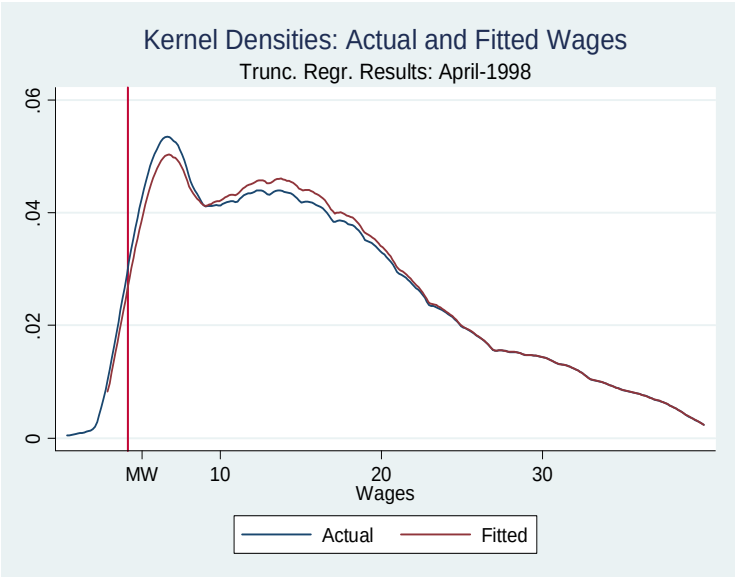
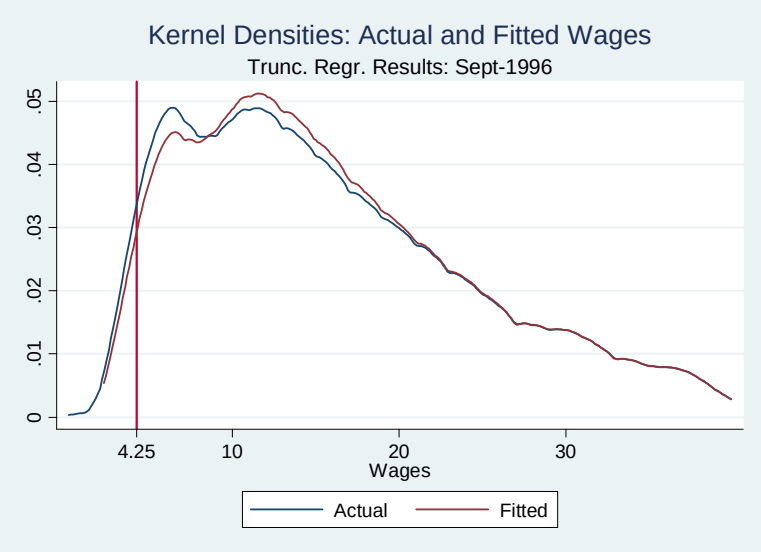
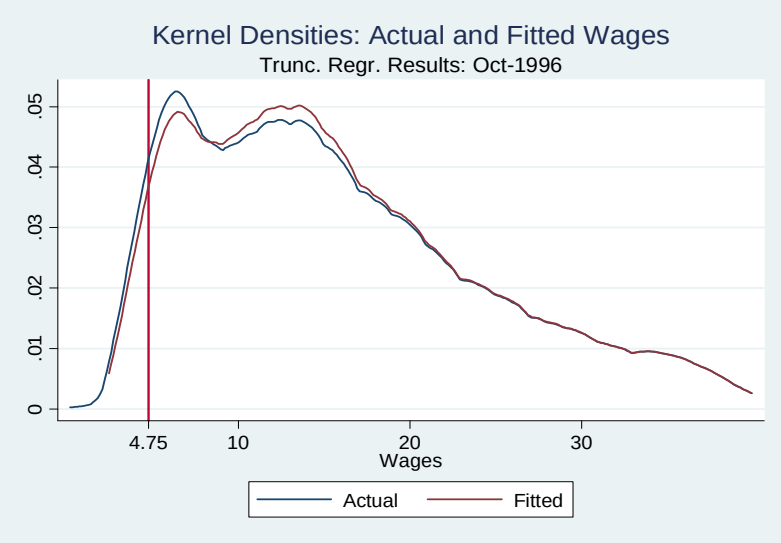
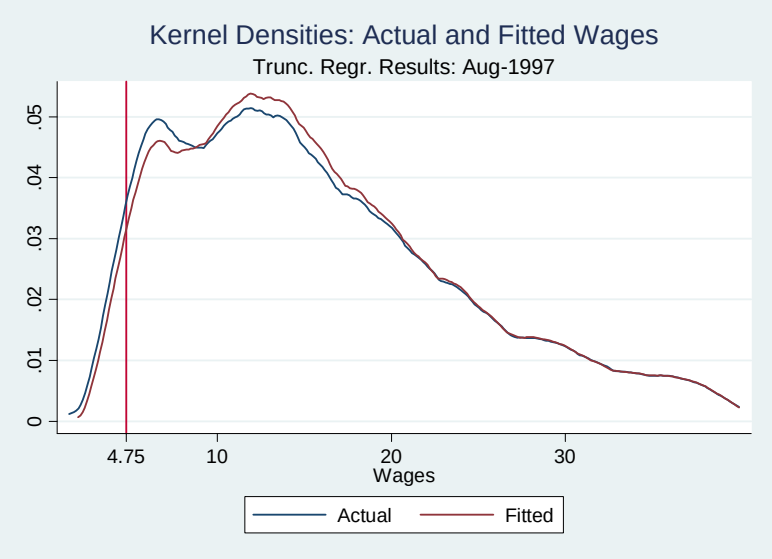
Trunc. Regr. Results: April-1996
0
.02
.04
.06
MW
10
20
30
Wages
Actual
Fitted

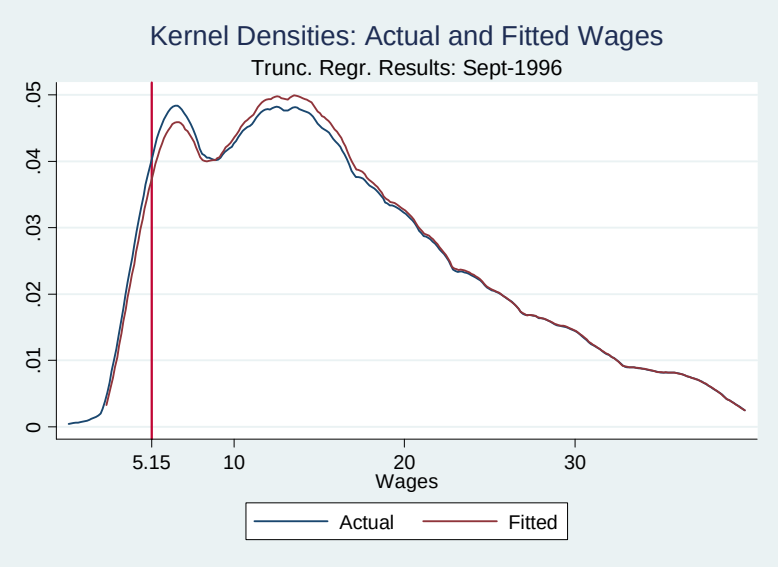

Kernel Densities: Actual and Fitted Wages
Trunc. Regr. Results: April-1997
0
.02
.04
.06
MW
10
20
30
Wages
Actual
Fitted


Kernel Densities: Actual and Fitted Wages
Trunc. Regr. Results: April-1998
0
.02
.04
.06
MW
10
20
30
Wages
Actual
Fitted


Kernel Densities: Actual and Fitted Wages
Trunc. Regr. Results: Sept-1996
0
.01
.02
.03
.04
.05
4.25
10
20
30
Wages
Actual
Fitted


Kernel Densities: Actual and Fitted Wages
Trunc. Regr. Results: Oct-1996
0
.01
.02
.03
.04
.05
4.75
10
20
30
Wages
Actual
Fitted


Kernel Densities: Actual and Fitted Wages
Trunc. Regr. Results: Aug-1997
0
.01
.02
.03
.04
.05
4.75
10
20
30
Wages
Actual
Fitted

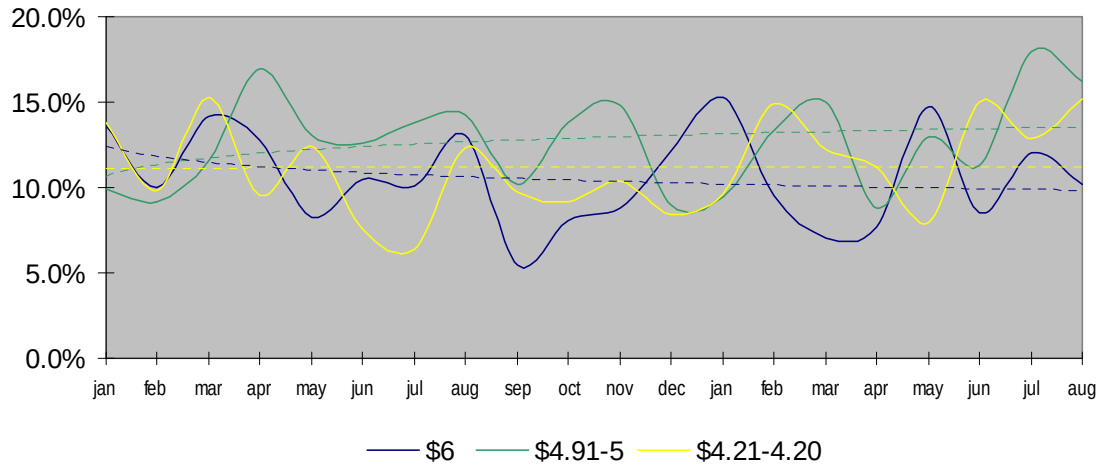

Kernel Densities: Actual and Fitted Wages
Trunc. Regr. Results: Sept-1996
0
.01
.02
.03
.04
.05
5.15
10
20
30
Wages
Actual
Fitted

Appendix 4

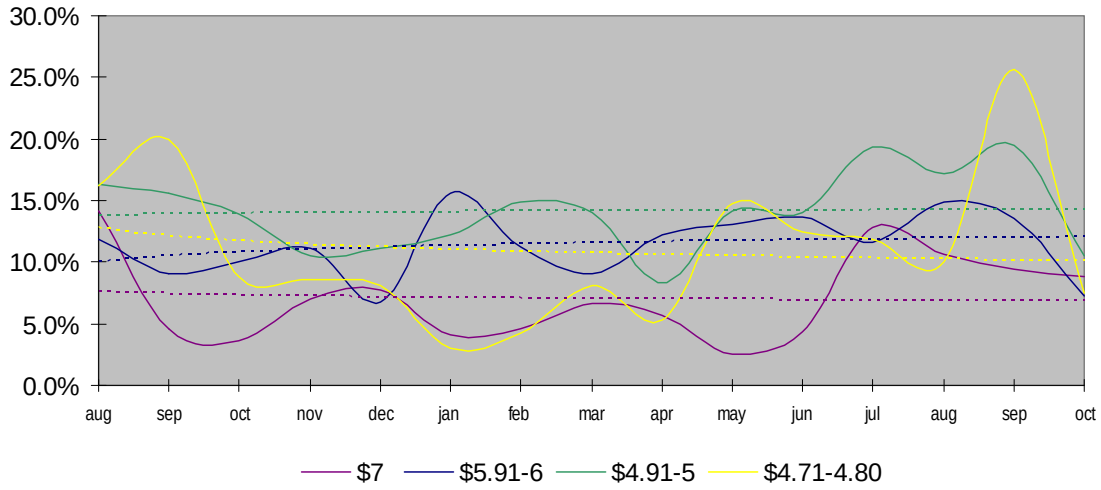
List of Regressors Used in Earnings Equation

Demographic variables	Age Age squared Male Married, spouse present Black Hispanic Foreign born Not a citizen
Educational groups	Less than 8th grade High school grades completed, no diploma High school graduate[1] Some college Associate's degree Bachelors degree Master's degree Professional degree Doctorate degree
Time allocation	Part-time labor force Enrolled in school
Cost-of-living and local labor market conditions	Metropolitan area State dummies
Industries	Agriculture, forestry, fishing and hunting Mining Construction Manufacturing Transportation Communications Utilities and sanitary services Wholesale trade Retail Finance, insurance and real estate Private households Business, repair, auto personal services Entertainment and recreation services Hospitals and other medical services Educational, social other professional services Forestry and fisheries Public administration (Armed forces excluded)
Occupation group	Executive, administrative and managerial Professional specialty Technicians and related support Sales Administrative support, inc. clerical Private household Protective service Service occ., except protective and household Precisionn production, craft and repair Machine operators, assemblers and inspectors Transportation and material moving Handlers, equip. cleaners, helpers, laborers Farming, forestry and fishing occ. (Armed forces excluded)
Other work related variables	Union member / covered by union contract

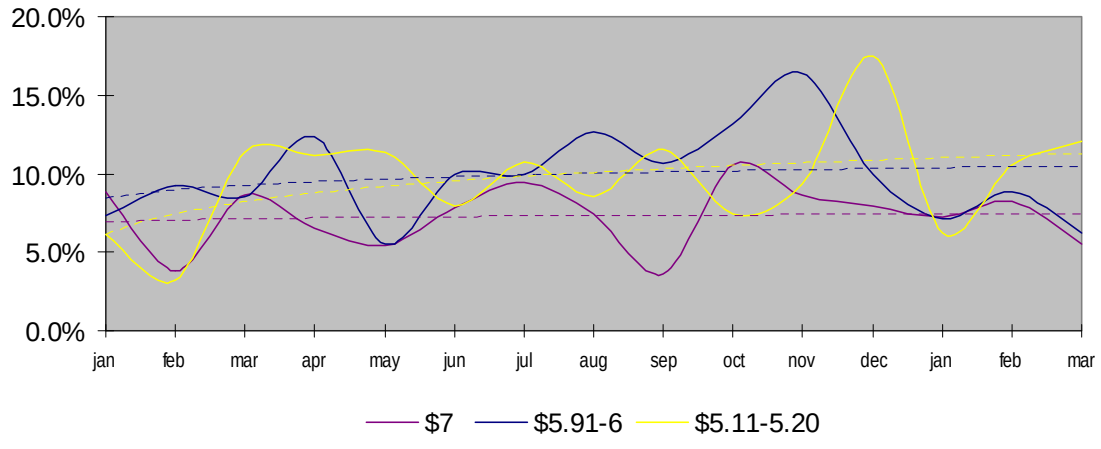
Shares of Potentially Collusive Wages at Selected Intervals, Jan 1995-Aug 1996



Shares of Potentially Collusive Wages at Selected Intervals, Aug 1996-Oct 1997



Shares of Potentially Collusive Wages at Selected Intervals, Oct 1997-Dec 1998



Shares of Potentially Collusive Wages at Selected Intervals, Jan 1995-Aug 1996

		$6		$4.91-5.00		$4.21-4.20		lowest to $4.21	
	Total obs.(lowest-$6)	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights
jan	1680	222	13.6%	343	9.9%	183	13.8%	191	53.1%
feb	1574	182	10.0%	328	9.2%	153	9.8%	188	45.9%
mar	1640	191	14.2%	335	11.6%	134	15.3%	200	65.0%
apr	1687	182	12.8%	356	16.9%	140	9.5%	199	58.1%
may	1442	204	8.2%	270	13.1%	135	12.4%	177	59.8%
jun	1483	181	10.5%	309	12.6%	139	7.6%	164	62.0%
jul	1525	192	10.1%	301	13.8%	153	6.4%	169	63.0%
aug	1550	178	13.1%	347	14.3%	147	12.3%	165	56.9%
sep	1481	203	5.5%	299	10.2%	140	9.7%	170	62.9%
oct	1450	174	8.1%	291	13.8%	117	9.2%	174	66.7%
nov	1544	191	8.8%	326	14.8%	159	10.4%	161	65.1%
dec	1544	214	12.1%	305	9.0%	143	8.4%	161	64.9%
jan	1101	177	15.3%	296	9.4%	107	9.6%	159	62.7%
feb	1322	181	9.5%	275	13.3%	133	14.9%	164	56.7%
mar	1296	162	7.0%	263	15.0%	120	12.2%	145	66.1%
apr	1356	181	7.7%	304	8.8%	127	11.2%	120	63.2%
may	1351	176	14.7%	272	13.0%	104	8.0%	147	74.5%
jun	1272	166	8.5%	265	11.3%	122	15.0%	147	63.8%
jul	1251	160	12.0%	261	18.0%	141	12.9%	138	68.9%
aug	1282	166	10.2%	259	16.2%	111	15.2%	141	70.1%

Shares of Potentially Collusive Wages at Selected Intervals, Aug 1996-Oct 1997

		$7		$5.91-6		$4.91-5.00		$4.71-4.80		lowest to 4.70	
	Total obs.(lowest to $7)	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights
aug	1636	101	14.1%	179	11.8%	259	16.3%	38	16.2%	370	37.4%
sep	1598	120	4.6%	172	9.1%	266	15.6%	48	20.0%	350	32.3%
oct	1609	137	3.6%	183	10.0%	271	13.9%	143	8.8%	240	52.2%
nov	1713	134	7.0%	175	11.1%	288	10.5%	171	8.6%	239	38.5%
dec	1789	112	7.8%	221	6.8%	318	11.1%	152	8.1%	273	40.2%
jan	1693	132	4.1%	188	15.6%	313	12.2%	121	3.0%	204	42.4%
feb	1747	152	4.6%	188	11.3%	280	14.9%	127	4.2%	242	45.7%
mar	1615	119	6.6%	156	9.1%	301	14.0%	120	8.1%	221	41.1%
apr	1653	127	5.7%	196	12.2%	296	8.3%	92	5.3%	224	46.6%
may	1623	123	2.5%	209	13.1%	248	14.2%	115	14.7%	201	49.7%
jun	1622	123	4.3%	202	13.7%	283	14.0%	106	12.5%	225	54.5%
jul	1645	127	12.8%	218	11.6%	256	19.3%	101	11.8%	222	57.5%
aug	1499	119	10.6%	188	14.9%	226	17.2%	107	10.1%	179	57.9%
sep	1470	149	9.4%	187	13.5%	158	19.5%	20	25.6%	149	60.4%
oct	1563	124	8.8%	241	7.3%	141	10.5%	15	7.5%	145	68.1%

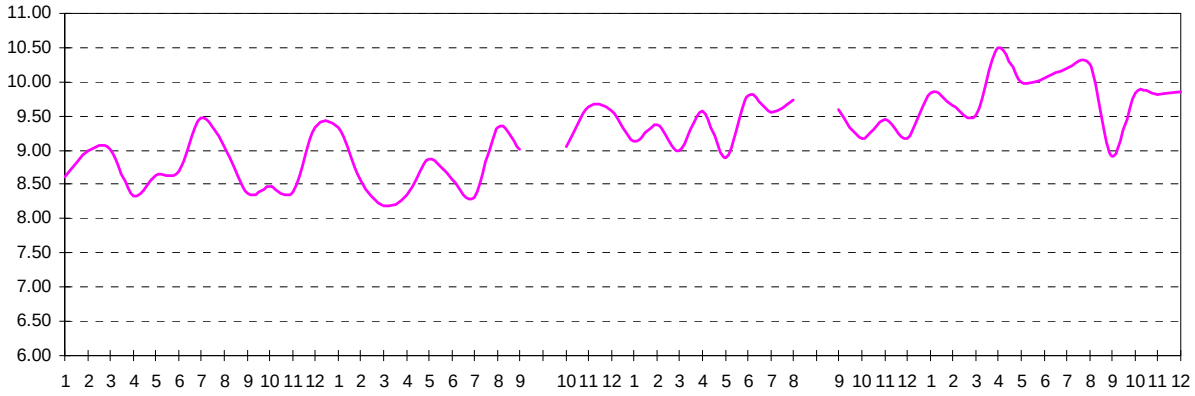
Shares of Potentially Collusive Wages at Selected Intervals, Oct 1997-Dec 1998

		$7		$5.91-6		5.11-5.20		lowest to 5.10	
	Total obs.(lowest to $7)	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights	Obs.	Coll, lower CI, survey weights
oct	1563	124	8.8%	241	7.3%	142	6.1%	313	39.1%
nov	1743	152	3.8%	240	9.2%	151	3.2%	358	32.8%
dec	1573	160	8.6%	208	8.5%	139	11.4%	329	39.7%
jan	1567	126	6.5%	207	12.4%	167	11.2%	277	46.1%
feb	1600	150	5.4%	251	5.5%	154	11.4%	310	48.4%
mar	1568	133	7.8%	233	9.9%	128	7.9%	311	48.4%
apr	1558	140	9.4%	196	10.0%	143	10.8%	267	43.7%
may	1554	143	7.4%	209	12.7%	131	8.5%	250	40.8%
jun	1461	140	3.6%	201	10.7%	122	11.6%	242	54.7%
jul	1489	160	10.6%	214	13.2%	108	7.4%	225	49.5%
aug	1378	149	8.6%	197	16.4%	103	9.3%	216	48.0%
sep	1787	193	7.9%	279	9.9%	117	17.5%	246	48.0%
oct	1490	138	7.2%	243	7.1%	94	6.2%	218	44.9%
nov	1520	155	8.2%	245	8.8%	75	10.6%	241	52.2%
dec	1486	156	5.5%	229	6.2%	90	12.1%	239	50.5%

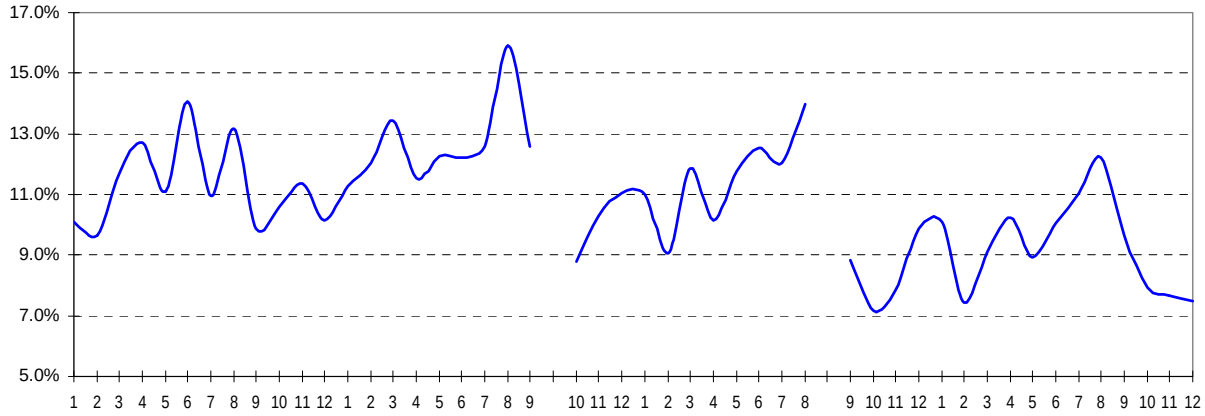
Shares of Potentially Collusive Wages at Minimum Wage and Immediately Above, Chain Truncation Results, All Hourly Employees

	Month	Number of collusive obs., weighted	Linearised St.Error	Total number of obs., weighted	Linearised St.Error	"2"/"4"	Avg. deviation between actual and fitted wage, $	Linearised St.Error
	"1"	"2"	"3"	"4"	"5"	"6"	"7"	"8"
1995	1	1022.4	107.0187	9440.3	299.5	10.1%	8.60	0.299
(4.21-6)	2	918.8	108.6	9515.6	321.3	9.7%	8.98	0.349
	3	1067.2	106.5	9154.1	298.9	11.7%	9.01	0.280
	4	1239.3	117.2	9758.5	316.3	12.7%	8.32	0.278
	5	977.9	106.5	8826.1	307.4	11.1%	8.63	0.342
	6	1255.1	116.9	8913.9	303.1	14.1%	8.69	0.229
	7	951.0	103.8	8692.5	291.4	10.9%	9.47	0.313
	8	1172.0	114.2	8916.0	296.3	13.1%	9.05	0.281
	9	858.6	112.4	8688.7	295.9	9.9%	8.37	0.295
	10	954.9	104.0	9007.1	311.0	10.6%	8.48	0.339
	11	1077.6	114.0	9482.0	312.4	11.4%	8.40	0.334
	12	977.3	111.1	9621.7	320.8	10.2%	9.34	0.380
1996	1	1048.6	107.6	9302.2	324.0	11.3%	9.34	0.351
(4.21-6)	2	1050.0	119.6	8710.7	311.6	12.1%	8.57	0.332
	3	1162.7	120.5	8667.7	308.0	13.4%	8.18	0.268
	4	1069.3	120.5	9282.6	320.5	11.5%	8.35	0.354
	5	1121.1	122.3	9153.2	317.5	12.2%	8.87	0.463
	6	1031.8	109.1	8444.4	300.7	12.2%	8.57	0.302
	7	1063.6	113.6	8468.3	303.8	12.6%	8.30	0.254
(4.71-7)	8	1542.2	140.9	9686.7	329.7	15.9%	9.33	0.239
	9	1176.2	111.8	9359.2	317.3	12.6%	9.01	0.259
	10	939.1	97.0	10686.9	343.0	8.8%	9.04	0.305
	11	1085.4	115.4	10570.1	336.2	10.3%	9.64	0.383
	12	1228.0	125.6	11138.8	343.8	11.0%	9.58	0.355
1997	1	1253.2	118.7	11373.7	352.3	11.0%	9.14	0.239
	2	1009.2	103.1	11123.1	345.1	9.1%	9.37	0.351
	3	1255.3	122.6	10605.9	341.6	11.8%	9.00	0.280
	4	1107.9	109.4	10938.3	350.2	10.1%	9.58	0.373
	5	1264.6	116.0	10756.8	339.0	11.8%	8.89	0.262
	6	1292.3	117.7	10302.9	332.8	12.5%	9.80	0.326
	7	1315.0	115.8	10935.3	345.9	12.0%	9.55	0.306
	8	1417.8	125.1	10154.5	335.0	14.0%	9.74	0.283
	9	907.2	97.7	10290.4	337.4	8.8%	9.59	0.346
(5.11-7)	10	681.0	83.6	9507.4	322.4	7.2%	9.18	0.301
	11	764.3	87.7	9759.1	320.4	7.8%	9.46	0.297
	12	951.8	105.2	9636.2	327.9	9.9%	9.18	0.348
1998	1	1018.8	109.5	10104.1	338.9	10.1%	9.84	0.356
(5.11-7)	2	756.2	93.1	10179.5	337.9	7.4%	9.65	0.329
	3	857.0	96.5	9426.2	319.0	9.1%	9.51	0.491
	4	995.5	104.2	9721.1	330.4	10.2%	10.49	0.322
	5	906.1	101.7	10128.2	338.6	8.9%	9.99	0.335
	6	915.8	102.9	9127.1	318.8	10.0%	10.05	0.473
	7	1064.0	109.1	9641.3	326.8	11.0%	10.20	0.309
	8	1126.4	111.0	9234.6	328.9	12.2%	10.25	0.289
	9	1165.6	119.4	12056.9	373.7	9.7%	8.91	0.245
	10	747.3	87.7	9428.9	318.3	7.9%	9.83	0.342
	11	713.4	86.4	9286.7	313.6	7.7%	9.82	0.335
	12	740.2	94.7	9866.6	334.0	7.5%	9.86	0.604
Average						10.8%	9.21	

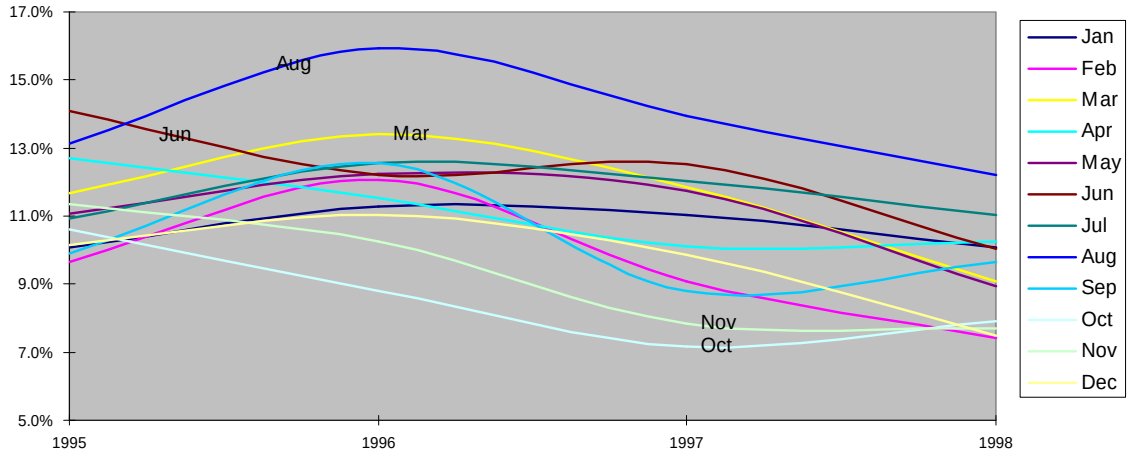
Average Wage Difference Between Fitted and Actual Wages,
Observations at MW and Immediately Above (Hourly Employees) 1995-1998, $



Shares of Potentially Collusive Wages at Minimum Wage and Immediately Above:
Hourly Employees, 1995-1998



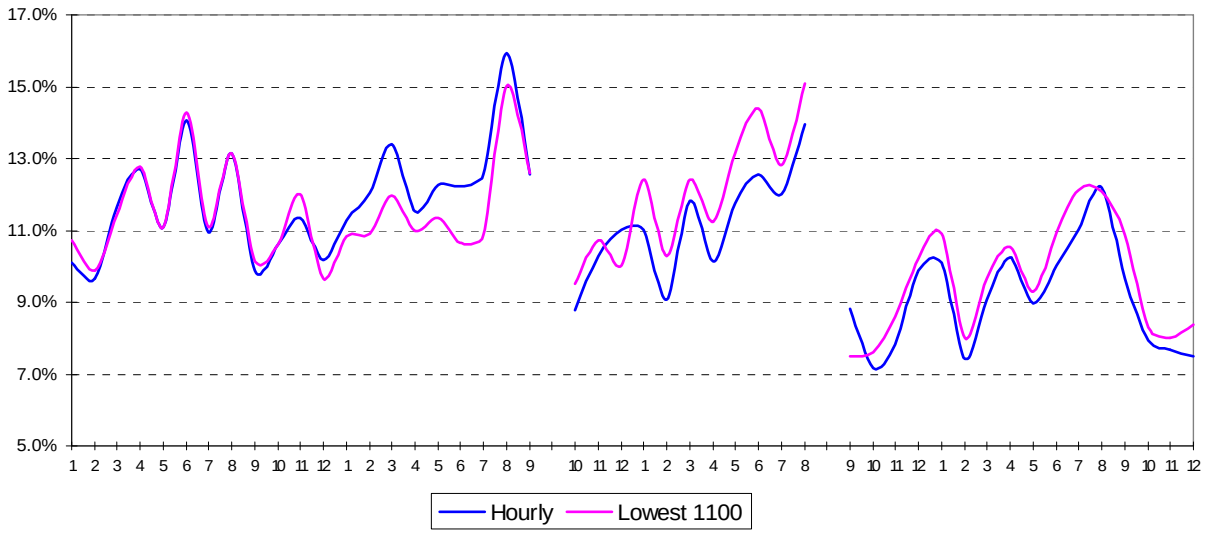
Number of Potentially Collusive Shares by Month:
Hourly Employees, 1995-1998



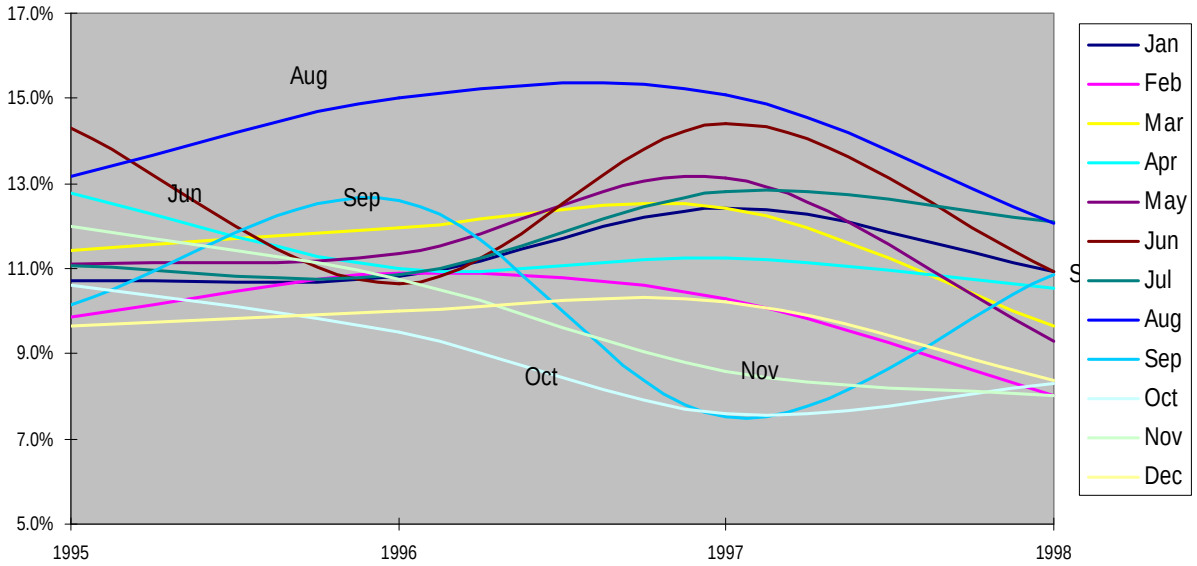
Shares of Potentially Collusive Wages at Minimum Wage and Immediately Above, Chain Truncation Results, 1100 Lowest (Hourly Employees)

	Month	Number of collusive obs., weighted	Linearised St.Error	Total # of obs , weighted	Linearised St.Error	"2"/"4"	Avg. deviation	Linearised St.Error
	"1"	"2"	"3"	"4"	"5"	"6"	"7"	"8"
1995	1	866.6	98.3	8085.0	264.5	10.7%	8.35	0.33
	2	859.6	105.8	8715.0	292.8	9.9%	8.91	0.36
	3	945.2	100.2	8285.4	269.1	11.4%	8.94	0.31
	4	1097.5	109.3	8586.2	281.48	12.8%	8.25	0.31
	5	977.9	106.0	8807.6	292.25	11.1%	8.63	0.34
	6	1240.5	115.6	8683.4	285.08	14.3%	8.71	0.23
	7	937.8	102.5	8467.5	274.63	11.1%	9.39	0.31
	8	1102.8	110.8	8380.9	273.78	13.2%	9.01	0.29
	9	858.6	112.1	8471.6	278.16	10.1%	8.37	0.30
	10	936.6	101.9	8815.9	292.94	10.6%	8.47	0.35
	11	1026.6	110.5	8550.6	281.77	12.0%	8.39	0.35
	12	851.7	101.3	8816.1	291.51	9.7%	9.35	0.42
1996	1	1048.6	106.9	9675.4	311.24	10.8%	9.34	0.35
	2	1050.0	119.0	9626.2	309.44	10.9%	8.57	0.33
	3	1162.7	119.8	9711.9	305.75	12.0%	8.18	0.27
	4	1069.3	119.9	9732.9	308.00	11.0%	8.35	0.35
	5	1121.1	121.6	9870.7	310.96	11.4%	8.87	0.46
	6	1031.8	108.5	9697.9	304.53	10.6%	8.57	0.30
	7	1063.6	113.0	9789.0	308.80	10.9%	8.30	0.25
	8	1512.9	136.3	10072.7	318.87	15.0%	8.97	0.24
	9	1222.0	113.9	9713.5	308.77	12.6%	8.71	0.28
	10	895.7	94.5	9431.6	305.01	9.5%	9.03	0.32
	11	971.8	109.5	9050.8	295.11	10.7%	9.46	0.42
	12	932.8	108.1	9315.3	298.24	10.0%	9.03	0.37
1997	1	1179.5	124.2	9509.0	303.62	12.4%	9.03	0.26
	2	952.8	105.5	9275.3	298.83	10.3%	8.98	0.34
	3	1212.2	119.7	9757.1	309.29	12.4%	8.90	0.28
	4	1087.2	118.3	9677.1	311.00	11.2%	9.41	0.39
	5	1234.8	118.7	9397.6	299.72	13.1%	8.76	0.27
	6	1375.6	132.4	9551.9	303.42	14.4%	9.79	0.33
	7	1271.2	120.1	9918.4	312.62	12.8%	9.22	0.30
	8	1476.4	136.4	9791.0	311.06	15.1%	9.70	0.29
	9	728.6	90.9	9699.1	310.0	7.5%	10.09	0.42
	10	727.0	91.7	9577.9	305.9	7.6%	9.18	0.30
	11	794.5	96.0	9251.9	295.8	8.6%	9.36	0.29
	12	1005.1	114.2	9826.5	312.9	10.2%	9.18	0.35
1998	1	1065.3	116.5	9757.4	314.1	10.9%	9.79	0.36
	2	787.5	101.7	9816.5	313.9	8.0%	9.65	0.34
	3	921.2	107.8	9546.5	303.1	9.6%	9.51	0.49
	4	1002.1	105.3	9516.0	308.4	10.5%	10.51	0.32
	5	903.1	105.1	9733.8	312.2	9.3%	10.04	0.36
	6	1056.3	121.9	9665.7	309.8	10.9%	10.05	0.47
	7	1169.9	121.2	9655.7	309.6	12.1%	10.20	0.31
	8	1210.2	120.4	10024.8	323.8	12.1%	10.25	0.29
	9	1079.8	122.5	9948.1	322.9	10.9%	8.60	0.25
	10	773.9	95.2	9309.9	299.1	8.3%	9.87	0.36
	11	747.6	91.8	9313.3	297.2	8.0%	9.82	0.34
	12	820.9	108.1	9791.3	314.6	8.4%	9.86	0.61
Average		49366.4		449664.8		11.0%	9.15	

Shares of Potentially Collusive Wage Observations Immidiately Above Minimum Wage:
Hourly Employees 1995-1998



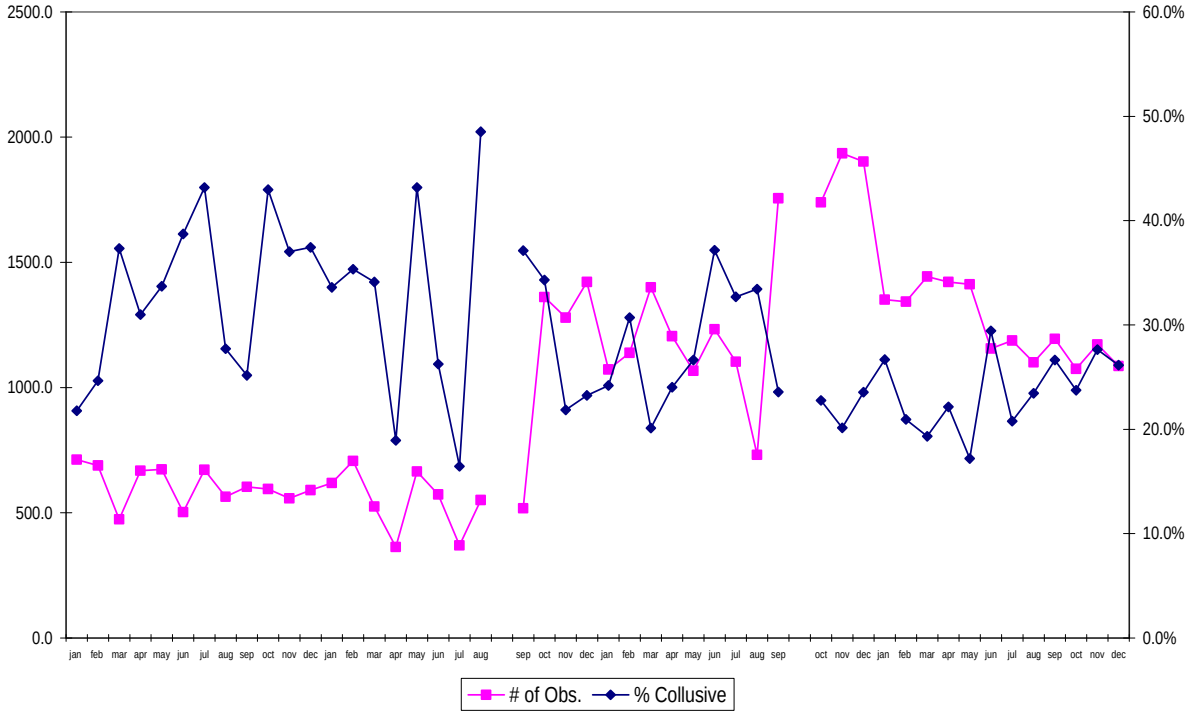
Number of Potentially Collusive Shares by Month:
Lowest 1100 Hourly Employees, 1995-1998



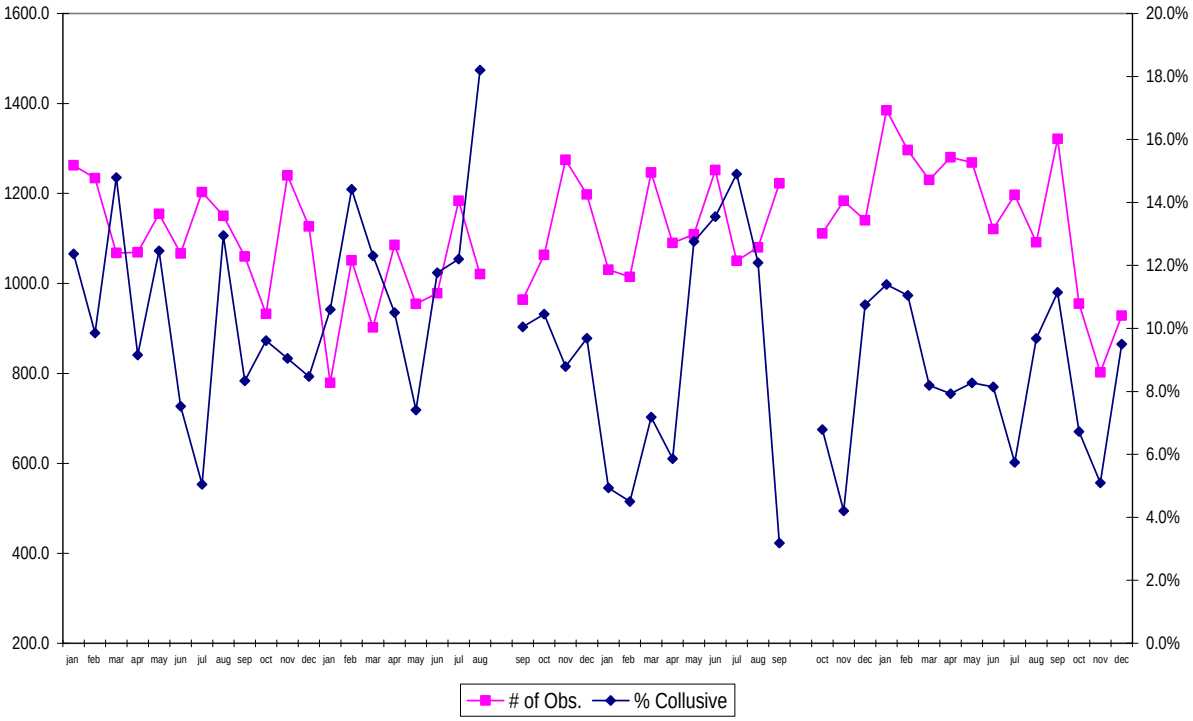
Shares of Potentially Collusive Wages Below and at Minimum Wage,
Chain Truncation Results for Hourly Employees

		Below MW (MW-$0.05)			At MW (MW+/- $0.05)		
		Obs.	Coll. obs.	% Collusive	Obs.	Coll. obs.	% Collusive
1995	jan	712.2	155.1	21.8%	1262.5	156.1	12.4%
	feb	688.6	169.8	24.7%	1234.0	121.6	9.9%
	mar	473.6	176.8	37.3%	1067.6	158.0	14.8%
	apr	667.9	207.0	31.0%	1069.0	97.9	9.2%
	may	673.4	226.9	33.7%	1154.8	143.9	12.5%
	jun	502.2	194.5	38.7%	1066.7	80.3	7.5%
	jul	671.9	290.1	43.2%	1203.1	60.7	5.0%
	aug	563.4	156.2	27.7%	1150.5	149.0	13.0%
	sep	603.0	151.8	25.2%	1060.1	88.4	8.3%
	oct	594.5	255.5	43.0%	932.4	89.7	9.6%
	nov	557.3	206.4	37.0%	1240.2	112.2	9.0%
	dec	590.4	221.0	37.4%	1126.8	95.5	8.5%
1996	jan	619.2	208.1	33.6%	779.0	82.6	10.6%
	feb	707.1	249.9	35.3%	1051.2	151.6	14.4%
	mar	525.0	179.2	34.1%	902.4	111.0	12.3%
	apr	363.5	68.9	18.9%	1085.5	114.0	10.5%
	may	664.7	286.9	43.2%	954.8	70.7	7.4%
	jun	572.8	150.3	26.2%	978.4	115.1	11.8%
	jul	369.1	60.7	16.5%	1184.0	144.5	12.2%
	aug	550.7	267.2	48.5%	1021.0	185.9	18.2%
	sep	518.1	192.3	37.1%	963.9	96.9	10.1%
	oct	1361.1	466.9	34.3%	1063.4	111.2	10.5%
	nov	1279.7	279.7	21.9%	1274.7	112.1	8.8%
	dec	1421.7	330.4	23.2%	1197.8	116.0	9.7%
1997	Jan	1072.3	259.5	24.2%	1030.5	50.9	4.9%
	Feb	1138.5	349.5	30.7%	1014.7	45.7	4.5%
	mar	1400.3	281.7	20.1%	1246.8	89.5	7.2%
	apr	1205.1	289.6	24.0%	1090.2	63.9	5.9%
	may	1067.1	284.4	26.6%	1109.1	141.5	12.8%
	Jun	1232.9	458.4	37.2%	1251.9	169.6	13.5%
	Jul	1103.4	360.7	32.7%	1050.6	156.5	14.9%
	aug	730.9	244.4	33.4%	1080.5	130.6	12.1%
	sep	1756.2	414.1	23.6%	1222.3	38.9	3.2%
	Oct	1739.8	396.3	22.8%	1111.1	75.5	6.8%
	nov	1935.6	389.8	20.1%	1184.0	49.8	4.2%
	dec	1902.8	448.2	23.6%	1140.1	122.6	10.8%
1998	Jan	1351.1	360.4	26.7%	1384.8	157.8	11.4%
	Feb	1343.2	281.4	21.0%	1296.5	143.3	11.1%
	mar	1443.2	278.9	19.3%	1230.1	100.7	8.2%
	apr	1421.5	314.7	22.1%	1280.7	101.5	7.9%
	may	1412.1	242.8	17.2%	1268.7	105.0	8.3%
	Jun	1155.5	340.2	29.4%	1121.0	91.3	8.1%
	jul	1187.5	246.7	20.8%	1196.7	68.8	5.7%
	aug	1100.4	258.0	23.5%	1091.3	105.6	9.7%
	sep	1195.1	318.3	26.6%	1321.7	147.3	11.1%
	oct	1074.9	255.2	23.7%	954.9	64.2	6.7%
	nov	1171.9	323.8	27.6%	802.5	40.9	5.1%
	dec	1085.6	283.9	26.2%	928.3	88.2	9.5%

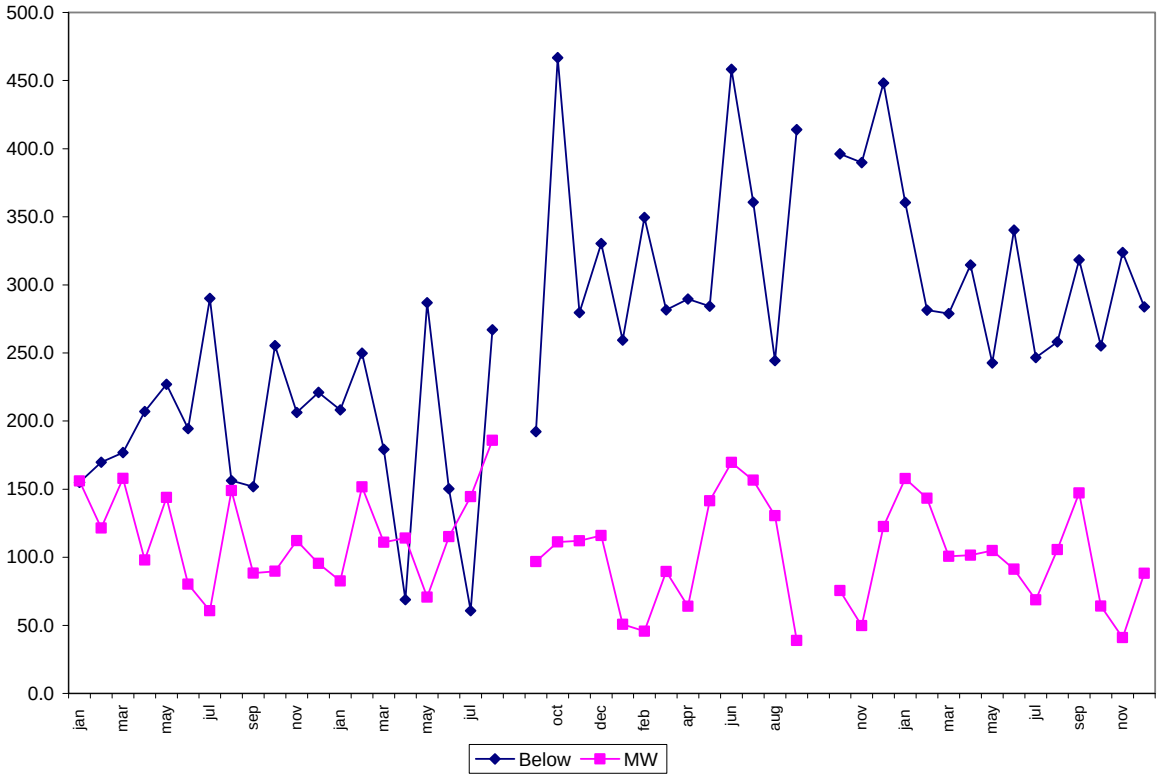
Shares of Potentially Collusive Wages Below MW (-0.05)
Hourly Employees, 1995-1998



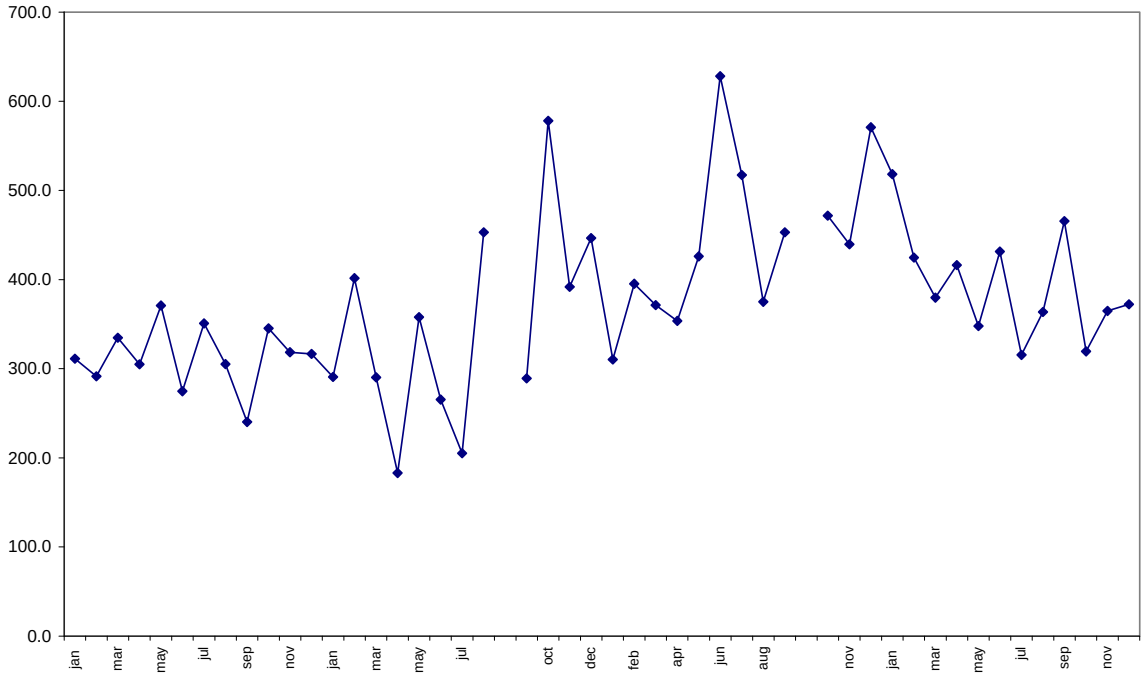
Shares of Potentially Collusive Wages at MW (+/-0.05)
Hourly Employees, 1995-1998



Number of Wages Potentially Affected by Collusion at MW and Below
Hourly Employees, 1995-1998



Total Number of Wages Potentially Affected by Collusion at MW and Below,
Hourly Employees 1995-1998



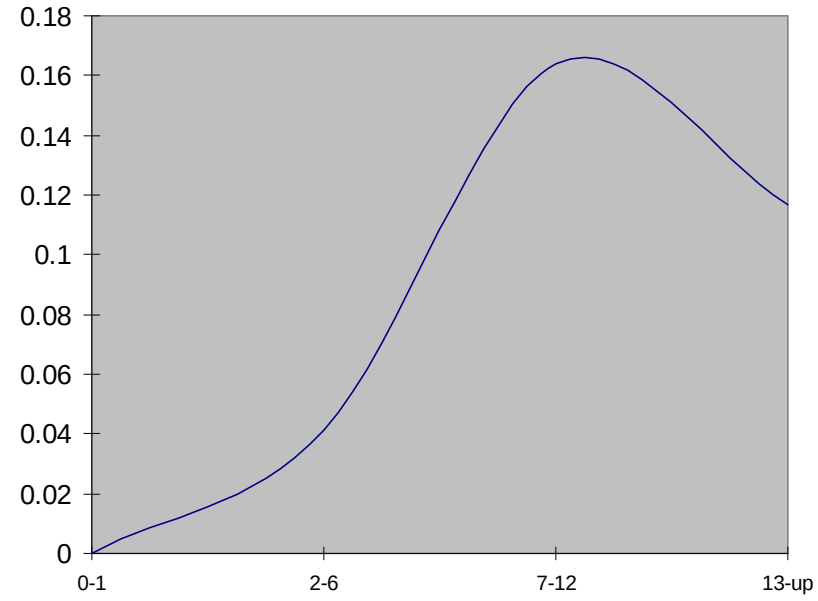
Probit estimates

Appendix 7A

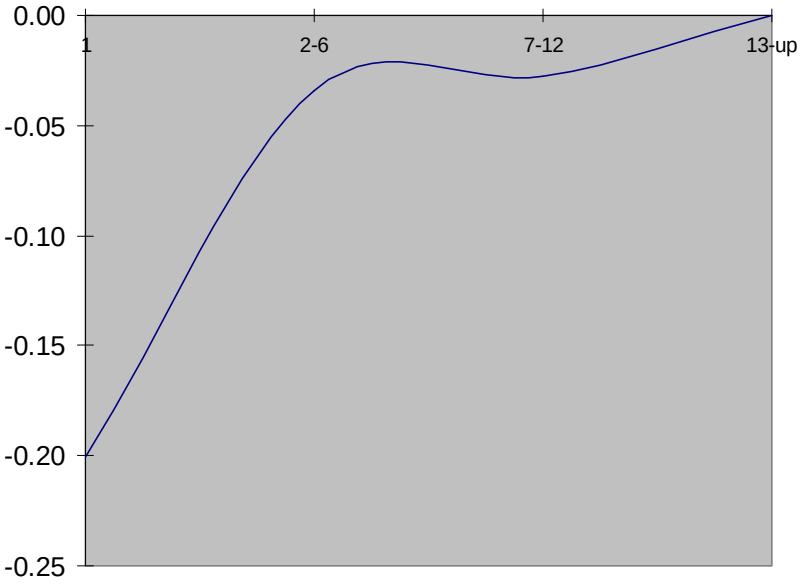
1995-1997	Model 1 Probit Est.	Model 1 Marg. Effects	Model 2 Probit Est.	Model 2 Marg. Effects	Model 3 Probit Est.	Model 3 Marg. Effects	Model 4 Probit Est.	Model 4 Marg. Effects	Variable Avg.
Months since last MW: 2 to 6	0.0716*	0.0138	0.0588	0.0113	0.0469	0.0089	0.0542	0.0103	0.244
	(0.074)		(0.154)		(0.294)		(0.238)		
Months since last MW: 7 to 12	0.1974***	0.0404	0.1785***	0.0362	0.1465***	0.0291	0.1520***	0.0303	0.149
	(0.000)		(0.000)		(0.002)		(0.002)		
Months since last MW: 13 up	0.1571***	0.0295	0.1064**	0.0200	0.0003	0.0001	-0.0188	-0.0035	0.497
	(0.000)		(0.051)		(0.997)		(0.810)		
Months until next MW: 2 to 6	-0.0521	-0.0096	-0.0550	-0.0102	-0.0590	-0.0108	-0.0569	-0.0104	0.224
	(0.190)		(0.166)		(0.138)		(0.155)		
Months until next MW: 7 to 12	-0.1101**	-0.0062	-0.1141**	-0.0206	-0.1077**	-0.0193	-0.1121**	-0.0201	0.204
	(0.019)		(0.015)		(0.022)		(0.018)		
Months until next MW: 13 up	-0.0906**	-0.0170	-0.0858**	-0.0161	-0.0683	-0.0127	-0.0782*	-0.0146	0.483
	(0.037)		(0.049)		(0.122)		(0.092)		
Wages of college graduates	0.0343***	0.0064	0.0343***	0.0064	0.0347***	0.0065	0.0347***	0.0065	25.458
	(0.000)		(0.000)		(0.000)		(0.000)		
State unemployment rate	0.0553***	0.0140	0.0557***	0.0105	0.0205	0.0038	0.0211	0.0039	5.084
	(0.000)		(0.000)		(0.208)		(0.193)		
Central city	-0.0284	-0.0053	-0.0259	-0.0048	-0.0127	-0.0024	-0.0125	-0.0023	0.170
	(0.257)		(0.301)		(0.626)		(0.631)		
Minimum wage			-0.063	-0.012	-0.211***	-0.0390	-0.179**	-0.033	4.625
	-	-	(0.158)		(0.003)		(0.033)		
State dummies included	No		No		Yes		Yes		
		-							
Year 95 dummy	No	-	No	-	No	-	0.051	0.010	0.483
							(0.484)		
Constant	-2.422***		-2.102***		-0.927		-1.091***		
	(0.000)		(0.000)		(0.027)		(0.022)		
N	31031		31031		31031		31031		
Obs.P		0.1212		0.1212		0.1212			
Pred. P (at x-bar)		0.10999		0.10999		0.10999			
Pseudo R square	0.0525		0.0526		0.0569		0.0569		
1996-1998	Model 1		Model 2		Model 3		Model 4		
Months since last MW: 2 to 6	0.0411	0.0076	0.0086	0.0016	0.0128	0.0023	0.0487	0.0090	0.193
	(0.365)		(0.855)		(0.790)		(0.320)		
Months since last MW: 7 to 12	0.1637***	0.0314	0.1066**	0.0201	0.1058**	0.0198	0.1475***	0.0280	0.244
	(0.001)		(0.035)		(0.043)		(0.006)		
Months since last MW: 13 up	0.1170***	0.0215	0.0341	0.0062	0.0015	0.0003	0.0343	0.0062	0.465
	(0.003)		(0.470)		(0.997)		(0.507)		
Months until next MW: 2 to 6	-0.0277	-0.0050	-0.0387	-0.0069	-0.0383	-0.0068	-0.0428	-0.0076	0.190
	(0.510)		(0.359)		(0.366)		(0.313)		
Months until next MW: 7 to 12	-0.0344	-0.0062	-0.0359	-0.0064	-0.0394	-0.0070	-0.0507	-0.0090	0.197
	(0.390)		(0.370)		(0.342)		(0.224)		
Months until next MW: 13 up	-0.2009***	-0.0369	-0.0717	-0.0131	-0.0633	-0.0115	0.0627	0.0113	0.516
	(0.000)		(0.210)		(0.352)		(0.439)		
Wages of college graduates	0.0350***	0.0064	0.0352***	0.0064	0.0359***	0.0065	0.0361***	0.0065	26.254
	(0.000)		(0.000)		(0.000)		(0.000)		
State unemployment rate	0.0374***	0.0068	0.0388***	0.0071	0.0378**	0.0068	0.0305*	0.0055	4.801
	(0.000)		(0.000)		(0.027)		(0.078)		
Central city	0.0423*	0.0078	0.0481**	0.0089	0.0466*	0.0086	0.0454*	0.0084	0.200
	(0.079)		(0.047)		(0.066)		(0.073)		
MW	-	-	-0.183***	-0.0334	-0.242***	-0.0437	-0.168**	-0.0305	4.839
			(0.001)		(0.001)		(0.035)		
State dummies included	No	-	No		Yes		Yes		
Year 96 dummy	No	-	No	-	No	-	0.212	0.039	0.488
							(0.002)		
Constant	-2.345		-1.478		-1.093		-1.628		
	(0.000)		(0.000)		(0.008)		(0.000)		
N	29445		29445		29445		29445		
Obs.P		0.11761		0.11761		0.11761		0.11761	
Pred. P (at x-bar)		0.10548		0.10548		0.10548		0.10548	
Pseudo R square	0.0571		0.0576		0.0618		0.0622		

*** Significant at 1-percent level
** Significant at 5-percent level
* Significant at 10-percent level

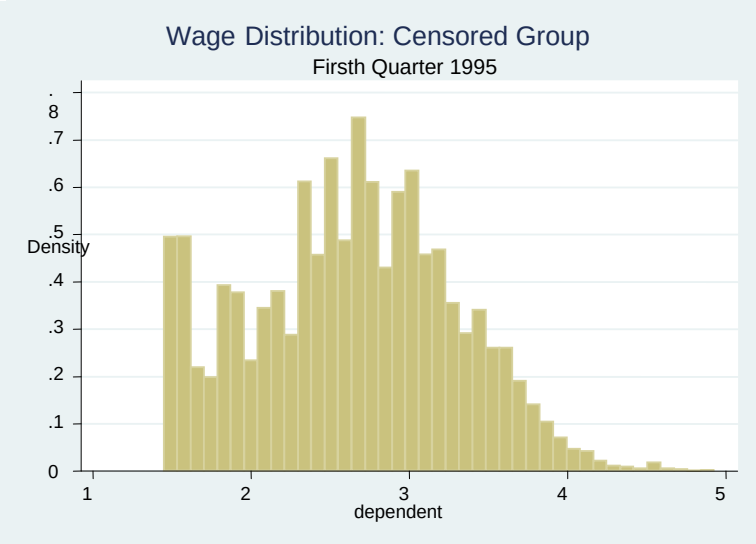
Months Since Last MW

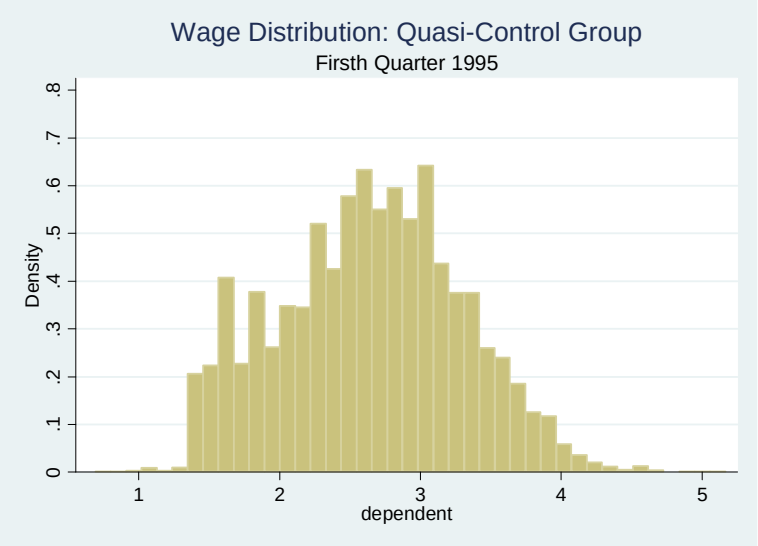


Month Until Next MW



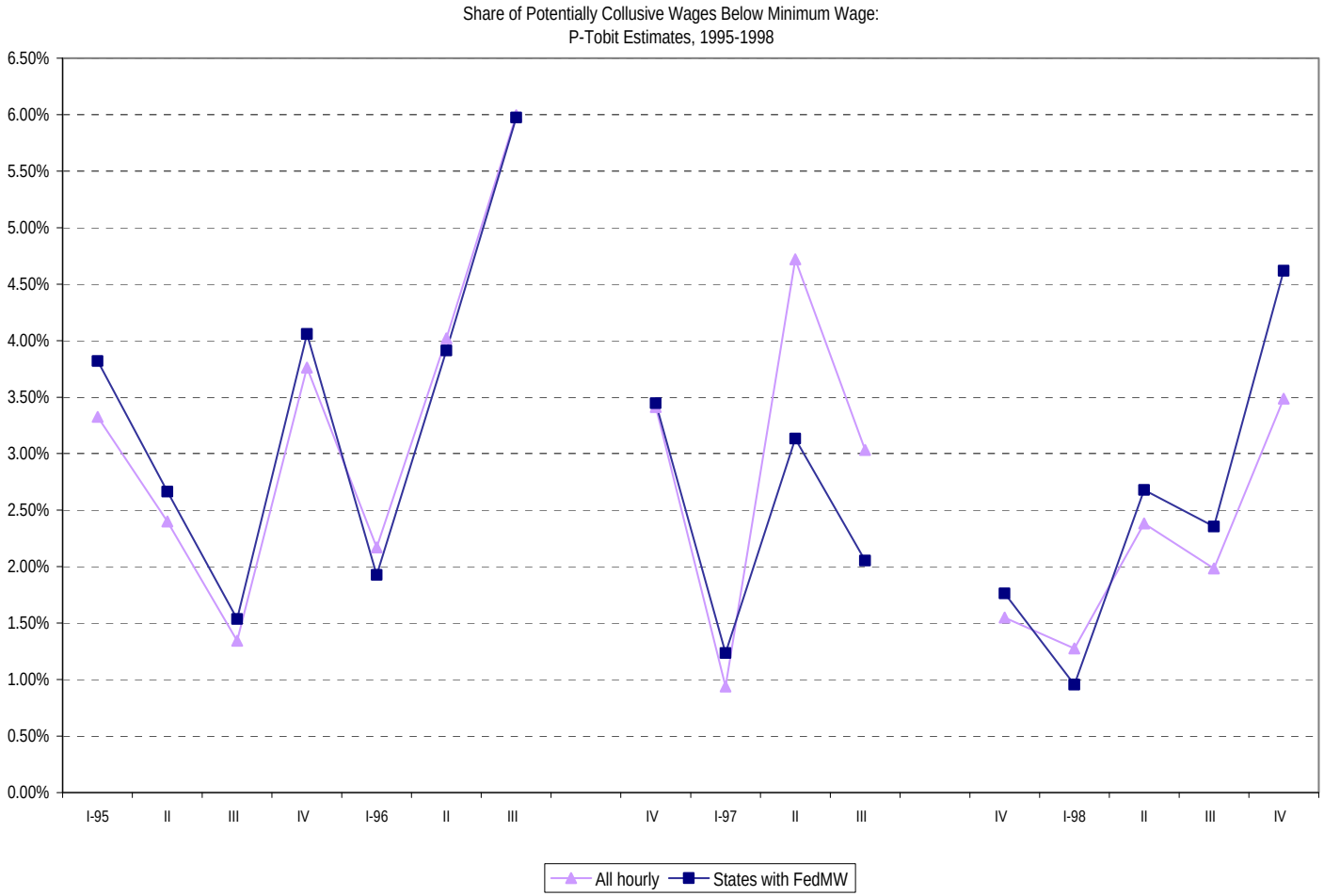
Example of wage distributions used in P-Tobit estimations (log wages, hourly employees)





Shares of Potentially Collusive Wages At/Below Minimum Wage By Quarter: 1995-1998

Censoring at Minimum Wage	1995 I quarter	1995 II quarter	1995 III quarter	1995 IV quarter	1996 I quarter	1996 II quarter	1996 III quarter	1996 IV quarter	1997 I quarter	1997 II quarter	1997 III quarter	1997 IV quarter	1998 I quarter	1998 II quarter	1998 III quarter	1998 IV quarter
All hourly employees																
I. Rho: Robust st.errors, non-weighted regression	0.00105	0.00072	0.00037	0.00107	0.00059	0.00105	0.00153	0.00143	0.00037	0.00180	0.00117	0.00077	0.00057	0.00099	0.00074	0.00117
(significance level)	(0.008)	(0.051)	(0.159)	(0.004)	0.0720	(0.007)	(0.001)	(0.002)	(0.257)	(0.001)	(0.012)	(0.069)	(0.173)	(0.013)	(0.044)	(0.007)
Sigma	0.388	0.382	0.392	0.376	0.380	0.385	0.377	0.375	0.370	0.374	0.381	0.374	0.374	0.379	0.380	0.379
(significance level)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Shares of wage observations below or equal to point of censoring, %	3.10%	2.81%	2.77%	2.80%	2.78%	2.58%	2.51%	4.06%	3.84%	3.63%	3.76%	4.74%	4.34%	3.99%	3.46%	3.16%
Share of potentially collusive wages within specified interval	3.30%	2.47%	1.31%	3.72%	2.04%	3.98%	5.92%	3.37%	0.93%	4.78%	3.00%	1.55%	1.26%	2.38%	2.08%	3.59%
II. Rho: Weighted regression, no heteroscedasticity correction	0.00170	0.00047	0.00067	0.00114	0.00074	0.00097	0.00145	0.00169	0.00039	0.00177	0.00122	0.00060	0.00056	0.00107	0.00088	0.00123
(significance level)	(0.010)	(0.131)	(0.168)	(0.013)	(0.099)	(0.013)	(0.002)	(0.003)	(0.280)	(0.003)	(0.015)	(0.153)	(0.236)	(0.015)	(0.050)	(0.010)
Sigma	0.388	0.384	0.392	0.375	0.378	0.383	0.375	0.375	0.371	0.376	0.379	0.374	0.375	0.379	0.380	0.377
(significance level)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Shares of wage observations below or equal to point of censoring, %	3.08%	2.89%	2.71%	2.77%	2.62%	2.55%	2.48%	4.01%	3.80%	3.68%	3.72%	4.75%	4.29%	3.99%	3.62%	3.26%
Share of potentially collusive wages within specified interval	5.36%	1.56%	2.42%	3.99%	2.75%	3.71%	5.70%	4.05%	0.99%	4.64%	3.16%	1.21%	1.25%	2.57%	2.34%	3.65%
N	25956	25719	27140	26119	22683	22901	24143	24228	23496	23688	24297	24057	23700	23715	24364	24196
Robust estimates over weighted number of observations below/equal the minimum wage)	3.33%	2.40%	1.34%	3.76%	2.17%	4.02%	6.00%	3.41%	0.94%	4.72%	3.03%	1.55%	1.28%	2.38%	1.98%	3.49%
Hourly employees in states with federal minimum wage																
I. Rho: Robust st.errors, non-weighted regression	0.00121	0.00079	0.00042	0.00112	0.00052	0.00098	0.00144	0.00147	0.00046	0.00101	0.00077	0.00089	0.00041	0.00103	0.00074	0.00138
(significance level)	(0.033)	(0.049)	(0.146)	(0.007)	(0.134)	(0.017)	(0.004)	(0.002)	(0.208)	(0.025)	(0.056)	(0.055)	(0.283)	(0.018)	(0.058)	(0.005)
Sigma	0.390	0.383	0.390	0.375	0.378	0.383	0.376	0.374	0.368	0.370	0.378	0.373	0.371	0.377	0.376	0.377
(significance level)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Shares of wage observations below or equal to point of censoring (log)	3.05%	2.77%	2.65%	2.67%	2.72%	2.47%	2.33%	4.11%	3.65%	3.11%	3.65%	4.83%	4.23%	3.81%	3.07%	2.93%
Share of potentially collusive wages within specified interval	3.84%	2.76%	1.53%	4.10%	1.86%	3.89%	6.06%	3.43%	1.22%	3.16%	2.04%	1.74%	0.93%	2.60%	2.32%	4.57%
II. Rho: Weighted regression, no heteroscedasticity correction	0.00149	0.00050	0.00076	0.00123	0.00090	0.00102	0.00133	0.00175	0.00047	0.00100	0.00076	0.00067	0.00048	0.00112	0.00078	0.00145
(significance level)	(0.028)	(0.129)	(0.153)	(0.015)	(0.091)	(0.019)	(0.006)	(0.003)	(0.234)	(0.048)	(0.061)	(0.140)	(0.292)	(0.020)	(0.074)	(0.007)
Sigma	0.387	0.385	0.391	0.376	0.377	0.383	0.374	0.374	0.370	0.370	0.376	0.374	0.374	0.378	0.375	0.374
(significance level)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Shares of wage observations below or equal to point of censoring (log)	3.07%	2.87%	2.64%	2.70%	2.62%	2.45%	2.36%	4.09%	3.61%	3.13%	3.63%	4.78%	4.12%	3.70%	3.03%	2.90%
Share of potentially collusive wages within specified interval	4.72%	1.70%	2.81%	4.45%	3.32%	4.06%	5.51%	4.11%	1.25%	3.09%	2.02%	1.33%	1.13%	2.92%	2.50%	4.87%
N	22706	22368	23557	22677	19145	19240	20380	22781	20276	19033	20646	22428	21450	20253	20697	20411
Robust estimates over weighted number of observations below/equal the minimum wage)	3.82%	2.66%	1.54%	4.06%	1.93%	3.91%	5.97%	3.45%	1.24%	3.13%	2.05%	1.76%	0.96%	2.68%	2.35%	4.62%

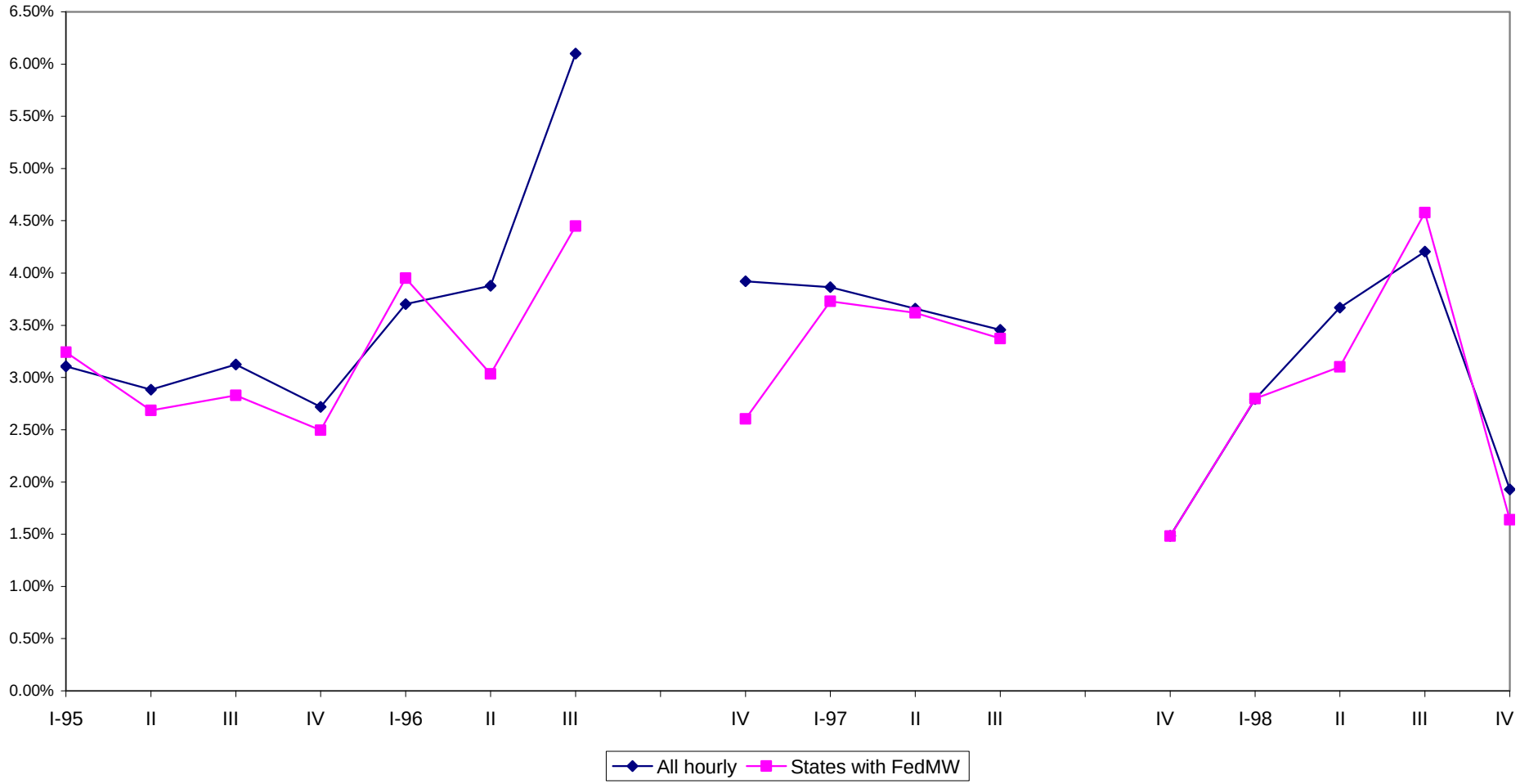

Share of Potentially Collusive Wages Below Minimum Wage:
P-Tobit Estimates, 1995-1998
6.50%
6.00%
5.50%
5.00%
4.50%
4.00%
3.50%
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
I-95
II
III
IV
I-96
II
III
IV
I-97
II
III
IV
I-98
II
III
IV
All hourly
States with FedMW

Shares of Potentially Collusive Wages Up To10th Percentile By Quarter: 1995-1998

Appendix 10A

	1995				1996				1997				1998			
	I quarter	II quarter	III quarter	IV quarter	I quarter	II quarter	III quarter	IV quarter	I quarter	II quarter	III quarter	IV quarter	I quarter	II quarter	III quarter	IV quarter
All hourly employees																
I. Rho: Robust st.errors, non-weighted regression	0.00347	0.00330	0.00348	0.00311	0.00424	0.00436	0.00702	0.00442	0.00439	0.00411	0.00389	0.00168	0.00320	0.00415	0.00476	0.00216
(significance level)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000	0.000	0.006
Sigma	0.400	0.389	0.400	0.384	0.388	0.392	0.385	0.381	0.377	0.381	0.388	0.380	0.380	0.385	0.388	0.387
(significance level)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Shares of wage observations below or equal to point of censoring, %	10.01%	10.05%	10.02%	10.02%	10.04%	10.03%	10.02%	10.05%	10.03%	10.02%	10.04%	10.06%	10.04%	10.03%	10.03%	10.04%
Share of potentially collusive wages within specified interval	3.12%	2.95%	3.13%	2.80%	3.80%	3.91%	6.30%	3.95%	3.94%	3.69%	3.49%	1.50%	2.87%	3.72%	4.27%	1.94%
Average wage at censoring point	$5.40	$5.48	$5.59	$5.46	$5.52	$5.63	$5.72	$5.69	$5.69	$5.84	$6.00	$5.96	$6.09	$6.14	$6.25	$6.24
II. Rho: Weighted regression, no heteroscedastic. correction	0.00357	0.00312	0.00404	0.00348	0.00443	0.00384	0.00740	0.00489	0.00426	0.00439	0.00360	0.00199	0.00323	0.00548	0.00467	0.00138
(significance level)	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.001	0.000	0.000	0.042
Sigma	0.396	0.392	0.401	0.384	0.386	0.391	0.383	0.381	0.378	0.383	0.386	0.380	0.381	0.385	0.387	0.385
(significance level)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Shares of wage observations below or equal to point of censoring, %	10.04%	10.26%	10.03%	10.28%	10.28%	10.10%	10.31%	10.13%	10.20%	10.09%	10.11%	10.15%	10.29%	10.16%	10.16%	10.07%
Share of potentially collusive wages within specified interval	3.20%	2.73%	3.63%	3.04%	3.87%	3.42%	6.44%	4.34%	3.75%	3.91%	3.20%	1.76%	2.81%	4.85%	4.13%	1.23%
N	25956	25719	27140	26119	22683	22901	24143	24228	23496	23688	24297	24057	23700	23715	24364	24196
Average wage at censoring point	$5.38	$5.45	$5.59	$5.45	$5.53	$5.62	$5.73	$5.69	$5.69	$5.87	$5.99	$5.95	$6.12	$6.17	$6.24	$6.25
Robust estimates over weighted number of observations below/equal the minimum wage)	3.11%	2.88%	3.13%	2.72%	3.70%	3.88%	6.10%	3.92%	3.87%	3.66%	3.46%	1.49%	2.79%	3.67%	4.21%	1.93%
Hourly employees in states with federal minimum wage																
I. Rho: Robust st.errors, non-weighted regression	0.00362	0.00306	0.00316	0.00286	0.00453	0.00341	0.00513	0.00294	0.00423	0.00407	0.00381	0.00167	0.00321	0.00350	0.00519	0.00183
(significance level)	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.018	0.001	0.000	0.000	0.018
Sigma	0.398	0.390	0.399	0.384	0.386	0.393	0.384	0.381	0.375	0.378	0.386	0.378	0.377	0.384	0.383	0.384
(significance level)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Shares of wage observations below or equal to point of censoring	10.01%	10.04%	10.03%	10.01%	10.04%	10.04%	10.04%	10.05%	10.03%	10.02%	10.03%	10.06%	10.04%	10.02%	10.03%	10.04%
Share of potentially collusive wages within specified interval	3.25%	2.75%	2.83%	2.57%	4.06%	3.06%	4.60%	2.63%	3.80%	3.65%	3.42%	1.50%	2.88%	3.14%	4.66%	1.64%
Average wage at censoring point	$5.30	$5.39	$5.54	$5.40	$5.43	$5.52	$5.64	$5.63	$5.64	$5.79	$5.93	$5.89	$6.03	$6.07	$6.20	$6.18
II. Rho: Weighted regression, no heteroscedastic. correction	0.00389	0.00263	0.00366	0.00371	0.00419	0.00412	0.00593	0.00314	0.00434	0.00451	0.00355	0.00192	0.00330	0.00472	0.00523	0.00131
(significance level)	0.000	0.006	0.001	0.002	0.001	0.001	0.000	0.000	0.000	0.048	0.001	0.025	0.002	0.000	0.000	0.052
Sigma	0.395	0.393	0.400	0.385	0.386	0.392	0.383	0.381	0.377	0.377	0.384	0.380	0.380	0.384	0.384	0.381
(significance level)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Shares of wage observations below or equal to point of censoring	10.04%	10.24%	10.05%	10.28%	10.29%	10.10%	10.34%	10.13%	10.20%	10.10%	10.15%	10.15%	10.30%	10.14%	10.19%	10.07%
Share of potentially collusive wages within specified interval	3.48%	2.31%	3.28%	3.23%	3.65%	3.66%	5.14%	2.79%	3.82%	4.01%	3.15%	1.70%	2.87%	4.18%	4.61%	1.17%
N	22706	22368	23557	22677	19145	19240	20380	22781	20276	19033	20646	22428	21450	20253	20697	20411
Average wage at censoring point	$5.33	$5.41	$5.55	$5.42	$5.47	$5.55	$5.67	$5.65	$5.66	$5.81	$5.93	$5.91	$6.09	$6.10	$6.24	$6.24
Robust estimates over weighted number of observations below/equal the minimum wage)	3.24%	2.68%	2.83%	2.49%	3.95%	3.03%	4.45%	2.60%	3.73%	3.62%	3.37%	1.48%	2.80%	3.10%	4.58%	1.64%

Percentage of Collusive Wages: Lowest Decile
Hourly Wages, 1995-1998



Shares of Observations Below the Imputed 95% CI, May 1996
Hourly Paid Employees