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Can Rescheduling Explain the New Jersey Minimum Wage Studies?

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INTRODUCTION

In a recent and storied paper, David Card and Alan Krueger (1994) claim to find evidence that the 1992 New Jersey minimum wage hike raised the level of employment in fast food restaurants in that state (although not significantly by conventional statistical standards). In a response widely-cited in the press, David Neumark and William Wascher (1995), using data on payroll hours, claim to show that there was a decline in employment in the New Jersey restaurants. While both teams loosely characterize the labor input in terms of "full-time equivalent employees", the Card-Krueger data set includes the number of workers and the Neumark-Wascher data set (with the exception of a subsample described in more detail below) includes the total number of hours. A major issue in this on-going debate, which now includes added papers by Neumark and Wascher (1996, 1998) and Card and Krueger (1998), has been the quality of the respective data sources.

Since firms have the option of cutting back on labor services either by laying off workers or by reducing the length of the scheduled workweek, the question arises: data difficulties aside, is it possible that both studies are right? Since total payroll hours are the product of the number of workers and their average workweek, it is algebraically possible for the number of workers to remain constant while weekly hours per worker (and thus total payroll hours) decline.[1] To explore this rescheduling scenario, we present a simple model of the demand for workers and weekly hours per worker which shows why a wage increase could, in principle, induce firms to hire more workers, (consistent with Card and Krueger's finding) while reducing the workweek. In this model, the firms' total demand for hours will decline (consistent with Neumark and Wascher's finding). This model is then tested in the data sets which these two research teams have made available where the rescheduling hypothesis receives some support.

Neumark and Wascher do make use of a subset of their data (explained in more detail below) which includes the number of workers to reach a conclusion (Neumark and Wascher, 1998, p. 21) broadly consistent with that of the current paper, but their main estimates come from payroll hours data.[2] In their reply to Neumark and Wascher, Card and Krueger (1998, p. 21) make use of the former's data set to examine the issue of scheduling and also report findings similar to that of the current paper. However, they mainly focus on the quality and reliability of the Neumark-Wascher data itself. The current paper adds value by exploring the rescheduling hypothesis in greater detail, including its policy implications.

POLICY FOCUS

How one assesses the evidence about the New Jersey minimum wage experiment depends on whether the purpose of the assessment is to clarify the empirical validity of economic theory or to inform policy. Card and Krueger's interests are chiefly theoretical, since their original finding questions the validity of the competitive model of the firm and points toward an imperfectly competitive monopsonist as representative of the low-wage labor market (Card and Krueger, 1995, pp 11-13). Neumark and Wascher have cast themselves in the role of defenders of the standard competitive model (Neumark and Wascher, 1996, p 57). With these stakes, it makes good sense to scrutinize the data sources meticulously.

From a policy standpoint, however, what matters is whether minimum wage programs effectively redistribute income to the targeted population without too many unwanted side effects. Even if we accept the validity of the data used by Neumark and Wascher, and the conclusions they draw from it, a good case can be made that the New Jersey minimum wage had no effect on the number of workers (i.e., jobs) and that if it had any effect on labor demand it was to reduce weekly hours per worker. Since it probably reduced weekly hours by proportionately less than the wage increased, in all likelihood it left the targeted population better off, earning more income, working fewer hours, and enjoying more leisure. Indeed, that such a conclusion has been reached using data chiefly collected by an institution (the Employment Policy Institute) which is partially funded by the fast-food industry (therefore presumably having a vested interest in discrediting minimum wage programs) creates a classic *a fortiori* case in favor of the minimum wage.

A MODEL OF SCHEDULING

In order to reduce the problem to its most elementary level, we will assume (at least initially) that at the industry level the demand for output is completely inelastic, that the output level remains fixed, and that the number of firms remains constant (restricting us to the short-run effects of a wage increase). These assumptions eliminate any scale or output effects that might complicate the argument, which hinges on the possibility of substituting a larger workforce for shorter hours to produce the same level of output. We also assume a competitive product market.

For concreteness and simplicity, let us implement this model with a production function in Cobb-Douglas form having no other inputs except hours and workers, such as:

$$q = h^{\alpha} N^{\beta} \qquad 0 < \alpha < \beta < 1$$

In this production function, q is the output level of the representative firm which hires N workers and schedules them to work h hours per week (ignoring integer constraints, or literally permitting the firm to hire one-half a person.) Notice that total payroll hours, E, are simply the product hN. Payroll hours are not an adequate measure of labor input because weekly hours per worker and workers are not equally productive of effective labor services. The motivation for entering hours per worker and workers separately in the production function and giving hours a smaller output elasticity $(\alpha > \beta)$ is that as the workweek lengthens, workers become less effective due to fatigue or lessened motivation.[3] In keeping output constant when the workweek lengthens by one per cent, the firm will be unable to lay off a full one per cent of its workers.[4]

The representative firm will produce its output level, q_0, using the number of workers and hours per week that minimizes its costs, C. Let there be a fixed cost, F, for each worker (fringe benefits, recruiting costs and training costs are possible examples) and let the hourly wage be represented by w. For technical reasons, we also need to include some other fixed cost M, such as a franchise or incorporation fee.[5] The firm's optimization problem then is

$$\text{minimize } C = M + FN + whN$$

$$\text{subject to } q = h^{\alpha} N^{\beta} \text{ and } q = q_0 .$$

From the first order conditions for this problem we can derive the following conditional demand functions for weekly hours per worker and workers:

$$h^* = \frac{\alpha F}{w(\beta - \alpha)}$$

$$N^* = (q_0^{1/\beta})h^{*-\alpha/\beta}$$

The demand for workers and weekly hours per worker conforms to textbook wisdom and common sense.[6] An increase in the fixed cost of hiring workers will induce firms to lengthen the working week and shed workers. An increase in the cost of employing hours per worker (i.e., the wage) will induce firms to reduce the working week, and take on additional workers. These are pure substitution effects that move the firms along a scheduling isoquant.

Curiously, the level of output does not affect the optimal schedule; it only affects the optimal number of hires. We exploit this fact below in discussing the complications that would arise if scale effects were to enter the picture.

Since total payroll hours are the product of the number of workers and their weekly hours, we could also write down a demand curve for these. This is left to the reader. Taking logs and differentiating with respect to the log wage yields the following expression for δ, the wage elasticity of total hours:

$$\delta = \frac{\alpha - \beta}{\beta}$$

We can see immediately that payroll hours would decline after a wage increase (since we know that $\alpha < \beta$). Therefore, this simple model is consistent with both the findings of the Neumark and Wascher study (showing that payroll hours declined after an increase in the minimum wage) and those of the Card and Krueger study (showing that the number of employees may have increased at the same time). Put differently, in no way can it be concluded that Neumark and Wascher have "refuted" the Card-Krueger study, as several prominent economists clumsily asserted in public discussions, since the theoretical possibility exists for both results to be consistent.[7] We will show in the next section that there is some evidence that this is in fact a likely explanation, and not merely a theoretical possibility.

How would a New Jersey-style minimum wage increase (roughly 17 per cent) affect the welfare of the workers? The elasticity of hours per worker with respect to the wage is clearly -1. (Again, take logs of the demand for hours above and differentiate with respect to the log wage.) Therefore, the aftermath of a wage increase (let us take it to be 17 per cent, although it would probably be less since many workers receive wages just above the minimum) finds the existing staff working roughly 17 per cent fewer hours per week, and receiving the same weekly pay. They should have no complaints. The newly hired workers are also presumably made better off. There is no support here for the claim made publicly by several prominent economists that Neumark and Wascher's study shows that there must have been losers among the low-wage workers of New Jersey in this episode.

Introducing a scale effect in the form of a decline in the demand for output could explain why Card and Krueger found no statistically significant effect on the number of workers.[8] Consider the case where the substitution effect (increasing the demand for workers) and scale effect (decreasing the demand for workers) are a wash. Total payroll hours decline because of the substitution effect, which reduces the scheduled workweek of the existing workers. However, because weekly hours per worker are not affected by the level of output, a scale effect that merely washes out the substitution effect does not alter our earlier conclusion that there are only winners among the existing workforce in this model, who will still be working fewer hours to earn the same monetary income.

EVIDENCE SUPPORTING THE SCHEDULING HYPOTHESIS

We can test the rescheduling hypothesis generated by the model developed above, to some extent at least, in the data sets that have been made available by Neumark and Wascher and Card and Krueger.[9] The Neumark-Wascher data set was collected in several steps by both the economists themselves and by the Employment Policies Institute three years after the New Jersey minimum wage took effect through a questionnaire asking for the number of non-management payroll hours in February and November of 1992. The details of this data collection can be found in Neumark and Wascher (1998) or Card and Krueger (1998). For our purposes, what is important is that a subset of 52 restaurants responded by volunteering data on the *number* of non-management employees as well as their total payroll hours. We test the rescheduling hypothesis in this data subset.

The data were reported in each of two waves (i.e., before and after the minimum wage took effect) according to the length of the payroll period, weekly or bi-weekly. (The data subset contains no observations with monthly reporting, although the full data set does contain such observations.) Thus, for each wave (corresponding to one month) there are up to four separate observations. In order to obtain a matched set on workers and hours per worker, I calculate the average number of workers and average payroll hours per week over each of the two waves of observation.[10]

The obvious way to implement the scheduling model in this data would be to estimate the scheduling isoquant for the restaurants (to see if the model goes through in the data), and to test for any special behavior among the New Jersey restaurants consistent with the rescheduling hypothesis. The basic log-log estimating form would be

$$\ln h = \frac{1}{\alpha}\ln q - \frac{\beta}{\alpha}\ln N$$

Unfortunately, the data subset contains no measure of the level of output or sales, so we are restricted to estimating an equation with a left-out variable that is strongly correlated with the independent variable, workers, and (if the assumptions of the model are right) uncorrelated with the dependent variable. The correlation between workers and output is likely to be quite strong, so the resulting estimate of the coefficient on workers will be biased upward, making it pointless to test for the restriction that $\alpha < \beta$.

We can reduce the problem somewhat by means of a dummy variable on the second wave observations made after the New Jersey minimum wage took effect. Table 1 shows the results of this estimation. The apparent slope of the isoquant is too small for the inequality restriction, as expected, but it is clearly significant by ordinary standards. The dummy for wave two suggests that restaurants in this whole region (New Jersey-Pennsylvania) enjoyed buoyant demand conditions and expanded their employment (both hours per worker and number of workers) by just under ten per cent. (Note that this buoyancy is not so evident in the Card-Krueger data reviewed below.) Adding the wave two dummy raises (slightly) the coefficient on log workers, as expected. Adding a dummy for restaurants in New Jersey raises shows that there was some tendency for the New Jersey establishments to be larger than their Pennsylvanian counterparts (another characteristic not evident in the Card-Krueger data).

The rescheduling hypothesis receives some support in column 4 of Table 1, which adds an interaction term between the New Jersey and wave two dummies. If wages went up in the subset of observations in New Jersey in wave two, this variable should have a negative sign indicating that firms substituted workers for hours per worker. Thus, the sign on this variable is consistent with the rescheduling hypothesis, and its magnitude is plausible, but it is not estimated very precisely and falls well short of statistical significance.[11] We can visualize this implementation of the scheduling model in Figure 1, which shows log workers and log hours per worker for each of the two waves, as well as the predicted isoquants from column 4 of Table 1 (evaluated at dummy variable means).

Since we do not know exactly how much wages increased in New Jersey, we can only put the wage elasticity of hours per worker in a range. At most the wage increased by the full amount of the statutory mandate, 17 per cent. Card-Krueger estimate (1995, Table 2.3) that the average starting wage increased by around 11 per cent, which is probably an upper bound on the increase in the effective wage for all workers, including seasoned veterans. Thus, the implied elasticity of hours per worker with respect to the wage is no lower than 0.30 but is probably higher than 0.46. If the effective wage increase was around 5 per cent, the elasticity would conform to the prediction of the theoretical model with Cobb-Douglas isoquants.

Results of a difference-in-differences analysis, which has the advantage that it imposes less structure on the data, are reported in Table 2. Once again, the results are consistent with the rescheduling hypothesis. The New Jersey restaurants enjoyed somewhat greater growth in the number of workers than the Pennsylvania restaurants, but somewhat less growth in hours per worker. The differences-in-differences for employment and payroll hours are not statistically significant. However, the relative decline in hours per worker in New Jersey restaurants is statistically significant at the 10 per cent level and just misses significance at the 5 per cent level in log differences.[12] Thus, these results are consistent with Card and Krueger's original finding that employment (number of workers) was not affected significantly by the New Jersey minimum wage, as well as being consistent with (or at least not contradicting) Neumark and Wascher's finding that there was a relative decline in payroll hours among the New Jersey restaurants. It would appear that the typical fast-food worker experienced no change in employment status and a reduction in the range of 1.22 to 1.48 hours worked per week (i.e., between one hour and fifteen minutes to one hour and a half). If wages increased by the full 11 per cent by which starting wages were apparently increased, this would mean the typical worker enjoyed an increase in weekly pay of around 5 or 6 per cent, with a proportional increase in leisure time of comparable magnitude. Even if wages increased by only around 5 or 6 per cent (in conformity with the theoretical model), the typical worker would be working fewer hours for the same income and enjoying an improvement in welfare driven by increased leisure.

As a final exercise, let us turn to the Card-Krueger data set, which distinguishes between part-time, full-time and managerial employees. One might expect the ratio of full-time to total employment to be a good metric for the average number of hours per worker. Under this interpretation, the Card-Krueger data flatly contradict the rescheduling hypothesis. Card and Krueger themselves found some evidence that they describe as "ambiguous" (1995, p. 47) for an increase in the proportion of full-time workers. This result is apparent in the descriptive statistics reported in Table 3. Card and Krueger calculate full-time equivalents (FTE's) by adding together the full-time workers, the managers, and one-half the part-time workers, and they measure the fraction full-time by dividing full-time workers (but not managers) by FTE's. It is clear that in the New Jersey restaurants, the fraction full-time increased slightly, while in the Pennsylvania restaurants this fraction decreased, in apparent contradiction to the rescheduling hypothesis.

One might object that these definitions do not conform to the earlier measures, which covered non-managerial employees only and which did not bother with converting to full-time equivalents. To meet this objection, Table 3 reports a simple "head count" of non-managerial workers, and the fraction of such workers who are full-time. Again, however, the fraction full-time increased slightly in New Jersey restaurants while declining in the Pennsylvania sample.[13] The average New Jersey restaurant experienced little change in total employment but one worker was promoted to full-time, while the average Pennsylvania restaurant experienced a loss of almost two full-time workers, again at odds with the rescheduling hypothesis.

On the other hand the simple correlations between the fraction full-time and total employment (however these are measured), calculated separately in each wave in the last two columns of Table 3, do not support the interpretation that these data represent movement along a scheduling isoquant. In the case of Card and Krueger's definitions, there is a *positive* correlation between fraction full-time and FTE's, in marked contrast to the clear inverse relationship between hours per worker and total employment apparent in Table 1 or Figure 1. For the "head count" definitions, the correlations are small and change sign, surely not suggestive of a scheduling isoquant. Explaining the behavior of the fraction full-time remains an open question, but it does not seem problematic from the perspective of the rescheduling hypothesis maintained in this paper.[14] If there is anything we can learn from the mix of full- and part-time workers, it is that fast-food workers are so overwhelmingly part-time (over 70 per cent in the combined sample) that they make good candidates for rescheduling in response to an exogenous shock.

CONCLUSION

How one views the interpretation of the New Jersey natural experiment depends on whether the main issue is theoretical importance or policy relevance. From the theoretical point of view, Card and Krueger's original findings are consistent with heterodox models of the labor market, characterized by imperfect competition, information asymmetries, or other deviations from the standard competitive model, and for that reason they richly deserve the attention they have received. The findings of Neumark and Wascher, as well as the rescheduling hypothesis maintained in this paper, are consistent with the standard competitive model of the firm. In policy debates on the other hand, both research teams have been cited by advocates or opponents of the minimum wage, yet it is now clear that whatever the disagreements, their results are both consistent with the conclusion that the New Jersey minimum wage probably increased the economic well-being of the targeted low-wage workers, at least those in the fast-food industry.

As this paper has tried to clarify, a quite plausible interpretation of the New Jersey experiment is that it resulted in some rescheduling of workers without reducing the overall number of workers on the payrolls of New Jersey fast-food restaurants. Since the reductions in hours per worker were probably much smaller than the increases in the wage, the incomes of low-waged workers would have been enlarged by this policy. Hours per worker appear to have declined by around 5 per cent, or by about one hour and fifteen minutes per week. It seems very unlikely that average wages failed to rise by at least 5 per cent after the 17 per cent increase in New Jersey's statutory minimum wage.[15] If the theoretical model which begins the paper is correct and the scheduling isoquant is Cobb-Douglas, the average worker will have experienced an increase in leisure time with no change in weekly income.

Two admonitions sum up. First, we should be careful about how we use the term "employment" since it can mean the number of workers or total payroll hours. It would not be a freak occurrence for the number of workers and total hours to move in opposite directions while still obeying the laws of algebra. Second, greater efforts to secure data on both the number of workers and their weekly schedules would be helpful in order to make reasonably precise statements about the effects of the minimum wage.

ENDNOTES

1.I originally advanced this resolution of the apparent conflict in a review (Michl 1996a) of Card and Krueger's book. An earlier version of the current paper (Michl 1996b) circulated under the title "A Note on Hiring, Scheduling and the Minimum Wage." The current paper has been retitled and rewritten to incorporate results which were obtained by implementing the original model in the data set which David Neumark has graciously made available on his web site.

2.It is noteworthy that Neumark and Wascher's views seem to have evolved on this point. In their early work (1995, 1996) they are relatively indifferent to the workers-hours distinction, while in their most recent work they admit that their evidence suggesting a decline in payroll hours "does not necessarily carry over to the number of workers employed" (1998, p. 21).

3.This assumption is fairly standard in the literature on workers and hours. See Feldstein (1967) or Ehrenberg (1971).

4.The restriction that b not exceed unity is necessary for a rising marginal cost in the model developed below.

5.This fixed cost is necessary in order to make the cost function consistent with an initial long run equilibrium having a finite number of firms. It plays no essential role in the argument.

6.For a textbook treatment, see Borjas (1996, pp. 144-147).

7.This statement refers to the employment results in Neumark and Wascher's work, not their claims about the unreliability of the Card-Krueger data set.

8.Card and Krueger did not collect data on the level of output, as far as I can tell. They did examine the price effects, with mixed results. Prices rose faster in New Jersey restaurants than in the control group of restaurants in Pennsylvania. See Card and Krueger (1995, pp. 52-56) for detailed discussion.

9.The Neumark-Wascher data set was obtained at www.econ.msu.edu. The Card-Krueger data set can be obtained through anonymous FTP from the MINIMUM directory at IRS.PRINCETON.EDU.

10.This practice deviates slightly from that of Card and Krueger (1998), who examined this data set as well as their own and chose to average the hours data but not the worker data over the whole month. Card and Krueger generously shared their SAS code with me, so I am reasonably confident of the accuracy of this statement with respect to their methods. Neumark and Wascher (1998) are not explicit about this point. At any rate, nothing substantive rests on these different practices.

11.Adding controls for chain (i.e., Burger King or KFC, the only chains in this subset) had no substantive effect on the results in Table 1.

12.Card and Krueger perform a similar analysis and find that the decline in hours per worker is slightly larger in magnitude. Recall that they have calculated employment in a slightly different way.

13.Card and Krueger's findings in (1995, Table 2.6) for the fraction full-time go through as well for the "head count" definition, with a similar coefficient (8.00) and standard error (4.01). In other words, their finding that there was an increase in the fraction full-time in New Jersey establishments does not seem dependent on their methodology.

14. Of course, these findings do raise the question of how the rescheduling is distributed among the existing workforce. It is still theoretically possible that some workers found their hours so sharply reduced that they experienced a diminution of economic well-being, although how likely remains an open question.

15.Even if wages failed to increase by 5 per cent or hours per worker declined by more than wages increased so that a particular worker's income fell, she might still experience a welfare improvement because of the increase in leisure time. During public discussions this elementary but important point is too often forgotten in the heat of debate.

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Table 1. Estimates of Scheduling Isoquants for
New Jersey and Pennsylvania Restaurants
(Neumark-Wascher Data Set)

	Regressions			
Variable	1	2	3	4
Intercept	4.032	4.127	4.000	3.977
	(0.226)	(0.218)	(0.228)	(0.230)
Log Workers	-0.270	-0.313	-0.280	-0.276
	(0.067)	(0.066)	(0.068)	(0.068)
Wave 2 Dummy		0.092	0.090	0.108
		(0.029)	(0.028)	(0.035)
NJ Dummy			0.052	0.078
			(0.030)	(0.042)
NJ*Wave 2				-0.051
				(0.058)
R^2	0.136	0.217	0.240	0.246
SER	0.022	0.020	0.020	0.020

Notes: Standard error is in parenthesis; the number of observations is 104. Dependent variable is Log Hours per Worker. See text for data sources and methodology.

Table 2. Changes in Employment and Hours per Worker in New Jersey and Pennsylvania Restaurants
(Neumark-Wascher Data

	NJ			PA				
	Wave 1	**Wave 2**	**Change**	**Wave 1**	**Wave 2**	**Change**	**Difference in Differences**	**Log Difference in Differences**
Workers	25.5	28.4	2.92	29.1	31.2	2.14	0.78	0.043
	(6.3)	(6.7)	(2.42)	(5.6)	(7.0)	(4.59)	(1.14)	(0.037)
Hours per	23.97	24.61	0.64	21.46	23.32	1.87	-1.22	-0.062
Worker	(4.24)	(4.15)	(2.23)	(4.04)	(3.09)	(2.62)	(0.72)	(0.031)
Payroll	598.6	687.0	88.4	618.0	721.5	103.6	-15.18	-0.018
Hours	(110.8)	(130.0)	(49.1)	(131.8)	(153.9)	(75.5)	(19.36)	(0.029)

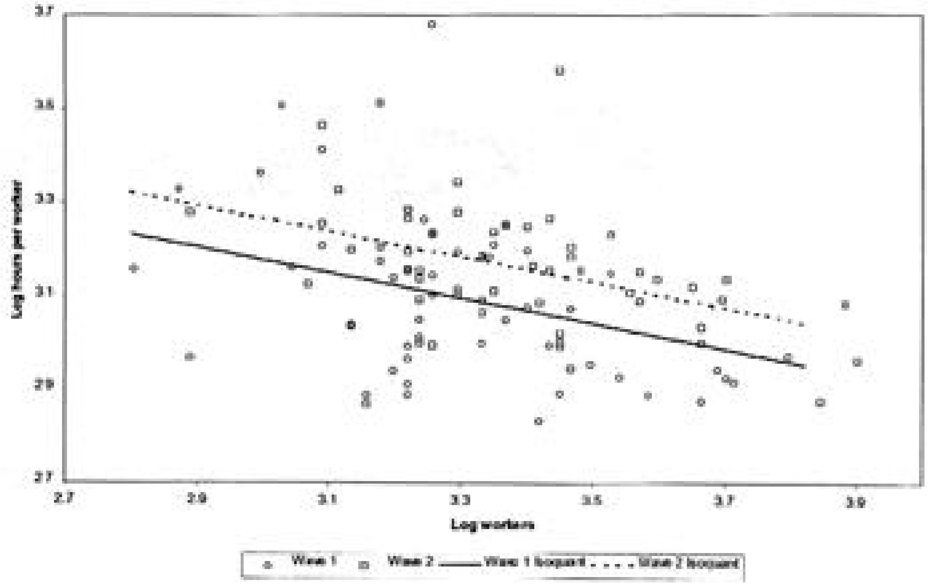
Notes: Standard deviations are in parentheses in first six columns; standard errors are in parentheses in last two columns. For data description and methodology, see text. There are 19 restaurants in New Jersey and 33 in Pennsylvania.

Table 3. Fraction Full-Time and Total Workers in New Jersey and Pennsylvania Restaurants (Card-Krueger Data Set)

	New Jersey		**Pennsylvania**		**Correlation Coefficient**	
	Wave 1	**Wave 2**	**Wave 1**	**Wave 2**	**Wave 1**	**Wave 2**
FTEs	20.4	21.0	23.3	21.2		
	(9.1)	(9.3)	(11.9)	(8.3)		
					0.499	0.451
FT/FTE	0.328	0.358	0.350	0.304		
	(0.238)	(0.245)	(0.239)	(0.245)		
FT+PT	26.4	26.7	29.7	27.5		
	(11.9)	(12.3)	(14.2)	(10.2)		
					0.130	-0.011
FT/(FT+PT)	0.286	0.321	0.303	0.260		
	(0.232)	(0.251)	(0.236)	(0.242)		

Notes: FT represents Full-Time Workers, PT represents Part-Time Workers, and NMGRS represents number of managers. FTE is Full-Time Equivalents using Card and Krueger's definition, or .5(PT)+FT+NMGRS. Standard deviations are in parenthesis.

Figure 1. Scheduling Isoquants For NJ-PA Restaurants



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