Crime and the Minimum Wage*

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Abstract

How does the minimum wage affect crime rates? Empirical research suggests that increasing a worker's wage can deter him from committing crimes. On the other hand, if that worker becomes displaced as a result of the minimum wage, he may be more likely to commit a crime. In this paper, I describe a frictional world in which a worker's criminal actions are linked to his labor market outcomes. The model is calibrated to match labor market outcomes and crime decisions of workers from the National Longitudinal Survey of Youth 1997, and shows that the relationship between the aggregate crime rate and the minimum wage is U-shaped. The results from the calibrated model as well as empirical evidence from county level crime data and state level minimum wage changes from 1995 to 2014 suggest that the crime minimizing minimum to median wage ratio for 16-19 year olds is 0.91. However, the welfare maximizing minimum to median wage ratio is 0.88, not equal to the crime minimizing value.

JEL: J08, J38, J64

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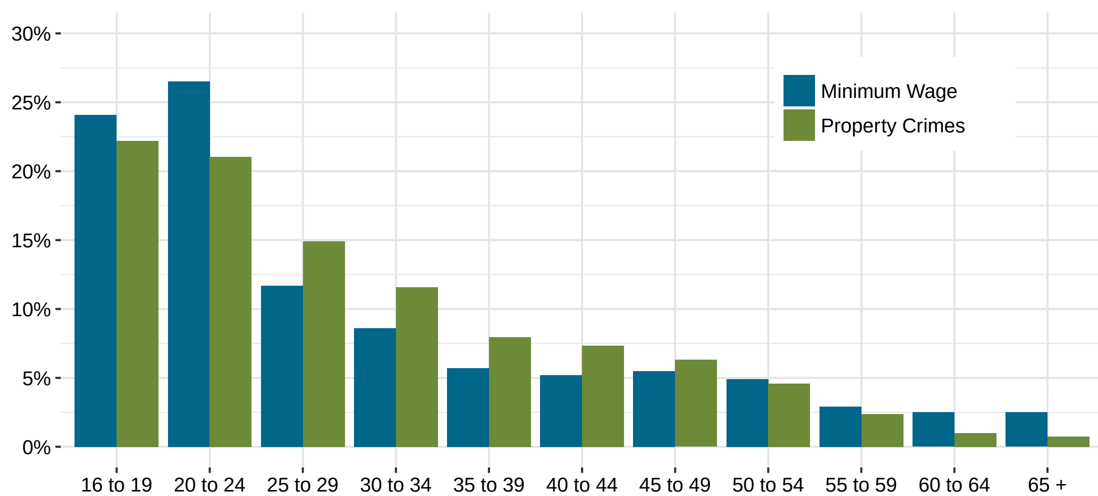
1 Introduction

The minimum wage has once again made it to the front lines of political discussion in the United States. Both the Democratic and Republican party have come out in favor of substantial increases. An unprecedented number of cities have proposed legislation for higher local minimum wages and for the first time ever, a majority of states have minimum wages higher than the federal level. California and New York City have passed laws raising the minimum wage to $15 within a few years, bringing about some of the largest real increases since 1949. Economists have long debated the labor market effects of a minimum wage, dating back to Stigler (1946) who first drew attention to possible employment effects after a 21% erosion of the real wage floor induced a public outcry for a higher minimum. While nearly all of the arguments hinge on employment, in this paper I ask how changes in the minimum wage affect criminal activity? Given that the policy is primarily aimed at improving labor market conditions for young and unskilled workers, who are also most at risk in terms of criminal activity, see Figure 1, potential changes in crime should be part of the policy debate.

Figure 1: Characteristics of Minimum Wage Workers and Criminals



Notes: Plotted in blue is the percent distribution of hourly workers working at or below the minimum wage by age in 2012. The data come from the Bureau of Labor Statistics Characteristics of Minimum Wage Workers Report. Plotted in green is the percent distribution of arrests for Type 1 Property Crimes as defined by the Federal Bureau of Investigation (FBI) by age in 2012. The data come from the FBI's Uniform Crime Reports.

Many economists have tested how the decision to commit crimes changes with respect to the probability or severity of punishment.[1] However, it was not until Schmidt and Witte (1984) and Grogger (1998) that they began to test the effects of labor market changes on people's criminal actions. The conclusions from these studies are as economic theory suggests: people choose to commit more

[1] See for example: Becker (1968); Ehrlich (1973); Myers (1983); Grogger (1991); Owens (2009); Hansen (2014)

crimes when unemployment increases and less when they receive higher wages.[2] Therefore, economic theory alone can not determine how an increase in the minimum wage will affect the crime rate. Increasing the minimum wage can raise wages for workers, thus deterring them from crime. However, there exists empirical evidence that the minimum wage will displace some workers from jobs,[3] thus enticing them to commit more crimes.

To find the direction of the effect, I use a search-theoretic framework to describe a world in which people make crime and labor market decisions jointly. I calibrate the model to match aggregate statistics of crime and the labor market to analyze the quantitative implications of changing the minimum wage. The existing literature trying to identify and quantify the effect of the minimum wage on crime rates is sparse. Hashimoto (1987) finds evidence of a positive relationship using national time-series data of the minimum wage and teenage arrest rates relative to adults.[4] In a recent micro-level study, Beauchamp and Chan (2014) find a positive effect of minimum wage increases on crime for people employed at a binding wage. I focus on a general equilibrium analysis in which the minimum wage can change all workers' crime decisions and examine the effect on the aggregate crime rate.

In the labor market, workers receive job offers at an exogenous rate and wages are determined by strategic bargaining between workers and firms. Workers are heterogeneous in ability which influences their labor market outcomes; heterogeneity among workers is essential for analyzing the effects of a minimum wage policy on labor market outcomes, since not all workers are affected equally. [5]

The crime market is as in Burdett et al. (2003), workers receive random crime opportunities while employed and unemployed. I add two levels of heterogeneity to capture two important interactions between changes in the labor market and the crime market. First, in contrast to other models of crime and the labor market, workers are ex-ante heterogeneous in ability, making the stock of criminals endogenous and allowing changes in the labor market to have an extensive effect on crime. In Huang et al. (2004), for example, only some workers specialize in criminal activities, however among those that commit crimes, their propensity for criminal behavior is identical. In Burdett et al. (2003) all workers are criminals and have the same propensity for criminal behavior and in Engelhardt et al. (2008) all workers commit crimes with propensities differing across employment states. Second, matches are ex-post heterogeneous with respect to productivity, allowing the "quality" of a job to enter into the

[2]For a more recent literature reaffirming these results see Gould et al. (2002), Mocan and Unel (2011), Machin and Hansen (2003) and Schnepel (2014) for estimates of the elasticity of crime with respect to wages and Gould et al. (2002), Corman and Mocan (2005) and Lin (2008) for estimates of an elasticity of crime with respect to unemployment.

[3]See Neumark and Wascher (2007) for a review of how changes in the minimum wage affect labor market conditions. For new evidence from the Seattle minimum wage increases see Jardim et al. (2017).

[4]Hashimoto (1987) is limited by the use of national data which may lose much of its identifying variation through aggregation and is subject to spurious correlations.

[5]Meyer and Wise (1983a) and Meyer and Wise (1983b) provide evidence of heterogeneities by showing that the effect of a minimum wage on employment and earnings differ across the group of workers for which it is binding.

worker's crime decision, and creating a range of wages for which he commits crimes, in contrast to a single criminal wage as in Burdett et al. (2003) and Burdett et al. (2004).

Using the benchmark model, I introduce a minimum wage by imposing a constraint on the bargaining problem faced by firms and workers. The model is calibrated to match the crime decisions and labor market outcomes of 16-19 year olds from the National Longitudinal Survey of Youth 1997 in 1998. I vet the model by simulating data and estimating the elasticity of crime with respect to wages and the elasticity of employment with respect to the minimum wage - finding that the model generated elasticities, although not targeted in the calibration, are similar to those found in the empirical literature. Increasing the minimum wage within the calibrated model reveals a non-monotomic, U-shape relationship between the minimum wage and the crime rate. The results from the calibrated model and empirical evidence from county level crime data and state level minimum wage changes from 1995 to 2014 suggest that the crime minimizing minimum to median wage ratio for 16-19 year olds is 0.91. However, welfare is not maximized when crime is minimized. The welfare maximizing minimum to median wage ratio is 0.88, which leaves crime at 0.02 crimes per person per month higher than the crime minimizing minimum to median wage ratio. In sum, the results from the calibrated model suggest that real changes in the wage floor as large as those passed in California and New York City may have the unintended consequence of boosting criminal activity among young and unskilled workers.

2 Model

To begin, I describe a world in which people in the labor market receive both exogenous job and crime opportunities and show how they jointly decide whether or not to take a job or act on a crime opportunity in the absencs of a binding minimum wage. The question of interest is, how does a binding minimum wage change the behavior of a worker? How does it change his decision to accept jobs and act on crime opportunities, and in turn how do these changes translate into the aggregate crime rate? To answer these questions, I introduce a minimum wage into the model as a constraint that workers and firms must consider when bargaining over the wage. Using the theoretical framework, I analyze how the existence of such a constraint changes employment decisions and subsequently wages, as well as the crime decisions of employed and unemployed workers.

2.1 Workers

The model is in continuous time and composed of a unit measure of workers, who: are risk neutral, discount at rate r, and are ex-ante heterogeneous in their ability, a, given by the c.d.f. $F(a)$. There exists an exogenous distribution of jobs of productivity λ with c.d.f. $G(\lambda)$. While unemployed, a worker receives flow utility b and matches with a job at exogenous rate μ_j. When a worker of ability a matches with a job of productivity λ the total productivity of the match is $a\lambda$.[6] Wages for the match are determined by strategic bargaining á la Rubinstein's alternating offers, discussed in detail below, and workers separate from jobs at exogenous rate δ.

Workers also receive opportunities to commit crimes at rate μ_u while unemployed and μ_e while employed. If the worker receives a crime opportunity he has the chance to steal some fixed amount g. If a worker commits a crime, the probability he is caught and sent to jail is π. The decision to act on a crime opportunity is based on the expected cost and expected utility from committing the crime. Given the probability is zero that a worker receives both a crime and job opportunity, the expected utility from committing a crime while unemployed, $K_u(a)$, is equal to the instantaneous gain from committing the crime, g, and the weighted average of his continued state: his prison utility if he is caught or his unemployment utility if he is not. The expected utility from committing a crime while employed, $K_e(a, \lambda)$, is calculated analogously. Therefore,

$$K_u(a) = g + \pi V_p(a) + (1 - \pi)V_u(a) \tag{1}$$

$$K_e(a, \lambda) = g + \pi V_p(a) + (1 - \pi)V_e(a, \lambda) \tag{2}$$

where, $V_p(a)$ is the value of prison, $V_u(a)$ is the value of unemployment, and $V_e(a, \lambda)$ is the value of being employed at a job with productivity λ, all defined below. Workers commit crimes rationally; if the expected gain $(K_u(a) - V_u(a))$ of committing the crime is greater than zero a worker will choose to act on the opportunity. Given a crime opportunity, let $\phi_u(a)$ and $\phi_e(a, \lambda)$ be the probability that a worker commits a crime while unemployed and employed at a job of productivity λ. The crime decisions for an unemployed and an employed worker are:

$$\phi_u(a) = \begin{cases} 1 & \text{if } g + \pi(V_p(a) - V_u(a)) > 0 \\ 0 & \text{if } g + \pi(V_p(a) - V_u(a)) \leq 0, \end{cases} \tag{3}$$

$$\phi_e(a, \lambda) = \begin{cases} 1 & \text{if } g + \pi(V_p(a) - V_e(a, \lambda)) > 0 \\ 0 & \text{if } g + \pi(V_p(a) - V_e(a, \lambda)) \leq 0. \end{cases} \tag{4}$$

[6]This assumption is similar to Postel-Vinay and Robin (2002) and Cahuc et al. (2006) who estimate the productivity of a match to have a firm and individual component.

Both employed and unemployed workers can be victims of crime at rate χ; victims of crime suffer a loss of L. The flow return to being unemployed for a worker of ability a, $rV_u(a)$, is equal to the flow utility of unemployment times the workers ability[7], net of being a victim of crime plus the expected value of receiving either a crime or job opportunity:

$$rV_u(a) = ab - \chi L + \mu_u \phi_u [K_u(a) - V_u(a)] + \mu_j \int_\lambda max\{V_e(a, \lambda) - V_u(a), 0\}\, dG(\lambda) \tag{5}$$

Similarly, the flow return of employment for a worker of ability a employed at a job with productivity λ is:

$$rV_e(a, \lambda) = w(a, \lambda) - \chi L + \mu_e \phi_e(a, \lambda)[K_e(a, \lambda) - V_e(a, \lambda)] + \delta[V_u(a) - V_e(a, \lambda)] \tag{6}$$

where $w(a, \lambda)$ is the wage paid to the worker. Workers in jail receive flow value z and are exogenously released at rate γ. All workers released from jail are released into unemployment. The flow return of jail is:

$$rV_p(a) = z + \gamma(V_u(a) - V_p(a)). \tag{7}$$

Notice from equation (3) that the crime decision of an unemployed worker is only a function of his unemployment value. Therefore, there exits a unique value of unemployment that makes workers indifferent to committing crimes while unemployed:

$$V_u(a)^* = \frac{g(r+\gamma)}{r\pi} + \frac{z}{r} \tag{8}$$

If $V_u(a) < V_u(a)^*$, the worker will commit crimes while unemployed and if $V_u(a) \geq V_u(a)^*$ he will not. Since $V_u(a)$ is strictly increasing in a, there exits a unique ability, a^*, such that $V_u(a^*) = V_u(a)^*$, and workers with ability $a < a^*$ commit crimes while unemployed, while workers with ability $a \geq a^*$ do not. Proposition 2.1 proves that workers who do not commit crimes while unemployed also forge crime opportunities while employed. Since workers with ability greater than a^* will never commit crimes, $F(a^*)$ can be thought of as the stock of criminals in the economy.

Proposition 2.1. *If $a \geq a^*$ then $\phi_e(a, \lambda^R(a)) = 0$ for all $\lambda \geq \lambda^R(a)$. Where $\lambda^R(a)$ is the workers reservation job productivity defined as $V_e(a, \lambda^R(a)) = V_u(a)$.*

Proof. If $a \geq a^*$ then $V_u(a) > V_u(a)^*$, thus $\phi_u(a) = 0$. From (3) this implies $g + \pi V_p(a) \leq \pi V_u(a)$. The definition of $\lambda^R(a)$ implies that $g + \pi V_p(a) \leq \pi V_e(a, \lambda^R(a))$. Since (6) is strictly increasing in λ it must be the case that $g + \pi V_p(a) \leq \pi V_e(a, \lambda)$ for all $\lambda \geq \lambda^R(a)$. Thus from (4), $\phi_e(a, \lambda) = 0$ for all $\lambda \geq \lambda^R(a)$. □

[7]This assumption is similar to those made in Postel-Vinay and Robin (2002) and Flinn and Mullins (2015).

2.2 Jobs

There exist a continuum of firms that randomly meet workers. After a firm meets a worker, the firm observes the productivity of the job, λ, and the ability of the worker, a. The value of a successful match with a worker of ability a, a job productivity λ and a wage w is:

$$J(w, a, \lambda) = \frac{a\lambda - w}{r + \delta + \mu_e \phi_e(a, \lambda)\pi}. \tag{9}$$

Notice that the expected duration of the job depends on the worker's decision to commit crimes while employed. If the worker chooses to commit crimes while employed the job can end with him getting caught and going to prison. If the match is not successful the worker and firm part ways, in which case the firm receives a payoff of zero.

For tractability of the model, I do not explicitly model the matching process. From the worker perspective, he only cares about the probability of a successful match, that is, the probability of meeting a firm, μ_j, times the probability that the total job productivity is above his reservation wage. With the implementation of a binding minimum wage, the meeting probability remains fixed, however the probability that the match is successful now hinges on whether the total job productivity is above the value of the minimum wage. Thus as the minimum wage increases, the job finding rate for the worker decreases.

This is analogous to a model in which there exists a distribution of firms with different productivities that choose to post vacancies, thus endogenizing the meeting rate. In such a model, a minimum wage would force less productive firms out of the market, decreasing the meeting rate, μ_j. However, when a firm and worker do meet, the total job productivity would always be above the minimum wage, ensuring a successful match. Again, the worker only cares about the probability of a successful match, thus these approaches are indistinguishable from the worker's perspective.

2.3 Wages

As noted by Engelhardt et al. (2008), when the worker can choose to commit crimes while employed, the feasible set of allocations that split the surplus of the match is non-convex, therefore the axiomatic approach to bargaining cannot be implemented.[8] I choose to split the surplus through strategic bargaining: the worker and the firm determine the wage in a two stage game à la Rubinstein's alternating offers.

In the first stage the firm offers the worker a wage. If he accepts the offer, bargaining ends and the

[8] The problem is similar to that of on the job search, see Shimer (2006) for details.

job begins at the offered wage. If he rejects the wage the game moves to the second stage where he gets to set the final wage with probability β and the firm gets to set the final wage with probability $1-\beta$. The probability that the match breaks up during negotiations is zero and neither the firm nor the worker discount the future during the bargaining process.

At this point it is simplest to rewrite the flow return of employment as a function of the wage instead of the workers ability and the productivity of the job; let $V_e(w(a,\lambda))$ denote the value of employment for a worker of ability a employed at a job or productivity λ which pays wage $w(a,\lambda)$. There are two wages that are of particular interest. First the reservation wage, $w_R(a)$[9], defined as $V_u = V_e(w_R(a))$ such that if $w \geq w_R(a)$ the worker chooses to stop searching and accept the job. By the value of unemployment, (6), and the fact that a worker who chooses not to commit crimes while unemployed, will never commit a crime while employed, Proposition 2.1, the reservation wage is

$$w_R(a) = \begin{cases} \chi L + rV_u(a) - \mu_e\left[g + \pi\left(\frac{z - rV_u(a)}{r+\gamma}\right)\right] & \text{if } V_u(a) < V_u(a)^* \\ \chi L + rV_u(a) & \text{if } V_u(a) \geq V_u(a)^*. \end{cases} \tag{10}$$

The second wage of interest is the crime reservation wage, $w_C(a)$ defined as $g+\pi[V_p - V_e(w_C(a))] = 0$ such that if $w \geq w_C(a)$ the worker chooses to stop searching, accept the job and does not commit crimes while employed.[10] Again using the value of unemployment, (6), one can solve for the crime reservation wage:

$$w_C(a) = \chi L + \frac{r(r+\delta)}{r+\gamma}V_u(a)^* + \frac{r(\gamma-\delta)}{r+\gamma}V_u(a) \tag{11}$$

for $V_u(a) < V_u(a)^*$. Workers that do not commit crimes while unemployed do not have a crime reservation wage since they forgo crime opportunities for all wages.

Equilibrium wages can be found by solving the two stage game through backwards induction, first solving the optimal wage offers in the second stage for the worker and the firm, then solving for the firm's optimal offer in the first stage given the second stage outcomes. In the first stage the firm offers the profit maximizing wage subject to the worker accepting the offer. Therefore, in equilibrium wages will be determined without delay.

In the second stage, if a worker of ability a gets to set the final wage he will choose to set the wage equal to the total productivity of the match, $w = a\lambda$, thus taking the entire surplus of the match. If the worker is a criminal, then he continues to commit crimes while employed if $a\lambda < w_C(a)$ and forges crime if $a\lambda \geq w_C(a)$. If the firm matches with a criminal and gets to set the final wage in the second

[9] I have suppressed the job productivity value since workers only care about the wage they receive, not the productivity of the job.

[10] I will assumed that workers are moral, such that a worker that is indifferent to committing crimes will chose not to commit crimes.

stage, the firm must choose between setting the wage at the reservation wage or setting the wage at the crime reservation wage. So for $V_u(a) < V_u(a)^*$, the firm faces the following problem in the second stage:

$$w(a,\lambda) = \operatorname*{argmax}_{\{w_R, w_C\}} \left\{ \frac{a\lambda - w_R(a)}{r+\delta+\mu_e\pi}, \frac{a\lambda - w_C(a)}{r+\delta} \right\} \tag{12}$$

It is easy to show that $w_R(a) < w_C(a)$, therefore the firm faces a trade off between receiving a higher flow value for the job for a shorter expected duration, or a lower flow value for the job for a longer expected duration. Problem (12) has a unique solution for the job productivity that equates the two choices, call it $\lambda^{D2}(a)$:

$$\lambda^{D2}(a) = \frac{(r+\delta+\mu_e\pi)w_C(a) - (r+\delta)w_R(a)}{a\mu_e\pi}. \tag{13}$$

If $\lambda < \lambda^{D2}(a)$ the firm sets the wage $w_R(a)$ and if $\lambda \geq \lambda^{D2}(a)$ then the firm sets the wage $w_C(a)$ in the second stage. If the firm matches with a non-criminal, $V_u(a) \geq V_u(a)^*$, then it has no choice to make and it sets the wage to the workers reservation wage, $w_R(a)$.

In the first stage the firm chooses to offer the wage that maximizes profits subject to the worker accepting the offer. The worker will accept the offer if it is at least as large as his expected value of the second stage. For non-criminals, the expected value of the second stage is $\beta\lambda + (1-\beta)w_R(V_u)$, so the firm faces the following problem in the first stage:

$$w(a,\lambda) = \operatorname*{argmax}_{w} \frac{a\lambda - w}{r+\delta} \quad \text{s.t.} \quad w \geq \beta a\lambda + (1-\beta)w_R(a). \tag{14}$$

Therefore, the firm offers wage $w(a,\lambda) = \beta a\lambda + (1-\beta)w_R(a)$ whenever $V_u(a) \geq V_u(a)^*$ and the worker accepts the offer. Since matches are heterogeneous in their productivity, not all matches lead to a filled job. When a worker matches with a firm the productivity must be high enough for him to give up his value of continued search and enter employment. The worker will choose employment whenever $w(\lambda, a) \geq w_R(a)$, so his reservation match value is $\lambda^R(a) = w_R(a)/a$.

If the firm matches with a criminal, the problem it faces in the first stage depends on the productivity of the job. For matches with $\lambda > \lambda^{D2}(a)$ the expected value of the second stage is $\beta a\lambda + (1-\beta)w_C(a)$. If $\beta > 0$ then the expected value of the second stage is greater than or equal to $w_C(a)$, implying that if the firm deters a worker from crime in the second stage it will also deter him the first stage. Therefore the firm's first stage problem is:

$$w(a,\lambda) = \operatorname*{argmax}_{w} \frac{a\lambda - w}{r+\delta} \quad \text{s.t.} \quad w \geq \beta a\lambda + (1-\beta)w_C(a). \tag{15}$$

Again the firm offers the worker the expected value of the second stage $w(a, \lambda) = \beta a\lambda + (1-\beta)w_C(a)$, and the worker accepts the job and does not commit crimes while employed.

If the firm does not choose to deter in the second stage, i.e. for productivities $\lambda < \lambda^{D2}(a)$, it still offers a wage that maximizes profits subject to the worker accepting the offer. However, since the firm does not deter in the second stage, the expected value of the second stage might not be high enough to deter the worker from crime. Again, the firm must choose whether or not to deter the worker in the first stage and faces the following problem:

$$w(a, \lambda) = \operatorname*{argmax}_{w} \left\{ \operatorname*{argmax}_{\substack{w \\ \text{s.t.} \quad w \geq w_C(a) \; \& \; w \geq \beta a\lambda + (1-\beta)w_R(a)}} \frac{a\lambda - w}{r + \delta} \quad , \quad \operatorname*{argmax}_{\substack{w \\ \text{s.t.} \quad w_C(a) > w \geq \beta a\lambda + (1-\beta)w_R(a)}} \frac{a\lambda - w}{r + \delta + \mu_e \pi} \right\}. \tag{16}$$

As before, the firm faces the trade off between a higher flow value for a shorter duration or a lower flow value for a longer duration.

First, one can show that if $(r + \delta)/\mu_e\pi \leq (1-\beta)/\beta$ then $w_C(a) \geq \beta a\lambda + (1-\beta)w_R(a)$ for all $\lambda \geq \lambda^{D2}(a)$.[11] That is, the expected value of the second stage is always less than the crime reservation wage. If this is the case, there exists a productivity, $\lambda^{D1}(a)$, such that if $\lambda < \lambda^{D1}(a)$ the firm will offer the expected value of the second stage and the worker will accept the job, at which he continues to commit crimes. If $\lambda \geq \lambda^{D1}(a)$ the firm will offer the crime reservation wage and the worker will accept the offer, since it is above the expected value of the second stage. While employed at $w_C(a)$, the worker will not commit crimes. The productivity above which firms deter workers from crime in the first stage is

$$\lambda^{D1}(a) = \frac{(r + \delta + \mu_e\pi)w_C(a) - (1-\beta)(r+\delta)w_R(a)}{\mu_e\pi + \beta(r+\delta)}. \tag{17}$$

The full wage profile for criminals in this case is:

$$w(a, \lambda) = \begin{cases} \beta\lambda + (1-\beta)w_R(a) & \text{if } \lambda^R(a) \leq \lambda < \lambda^{D1}(a) \\ w_C(a) & \text{if } \lambda^{D1}(a) \leq \lambda < \lambda^{D2}(a) \\ \beta\lambda + (1-\beta)w_C(a) & \text{if } \lambda \geq \lambda^{D2}(a). \end{cases} \tag{18}$$

Figure 2 shows the wage profile for a worker of type $V_u(a) < V_u(a)^*$. The worker gets the expected value of the second stage for all matches with productivity $\lambda^R(a) < \lambda < \lambda^{D1}(a)$, the crime reservation wage for matches with productivity $\lambda^{D1}(a) \leq \lambda < \lambda^{D2}(a)$ and the expected value of the second stage for matches with productivity $\lambda \geq \lambda^{D2}(a)$. Proposition 2.2 gives a summary of the worker's employment and crime decisions for all match values.

[11] When $(r+\delta)/\mu_e\pi > (1-\beta)/\beta$, the expected value of the second stage is greater than the crime reservation wage for some productivities. The intuition and mechanism is the same as when $(r+\delta)/\mu_e\pi \leq (1-\beta)/\beta$. Therefore for the sake of brevity the wage profile for this case can be found in the appendix section A.1.

Figure 2: Wage Profile for Workers with $V_u(a) < V_u(a)^*$

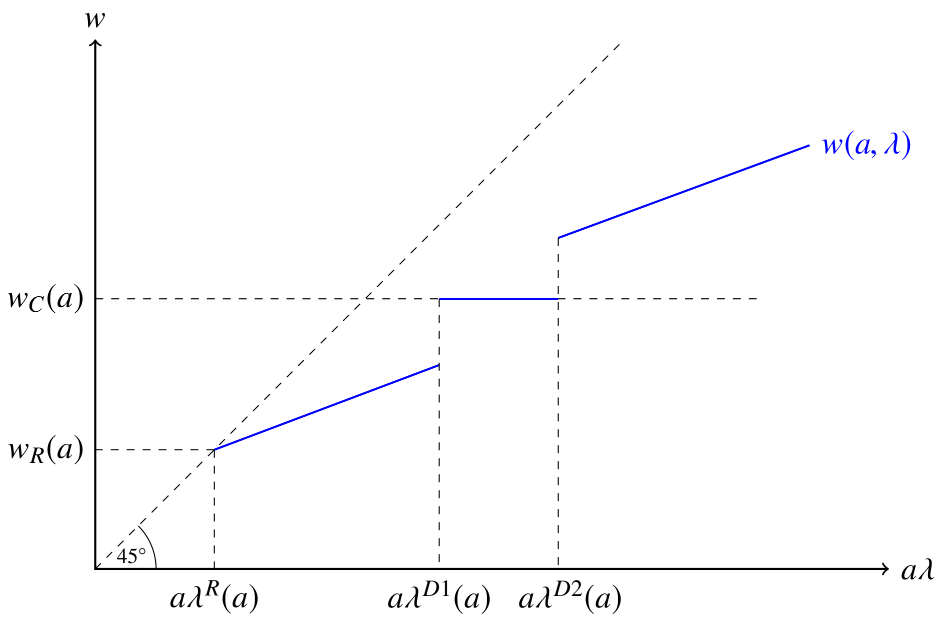
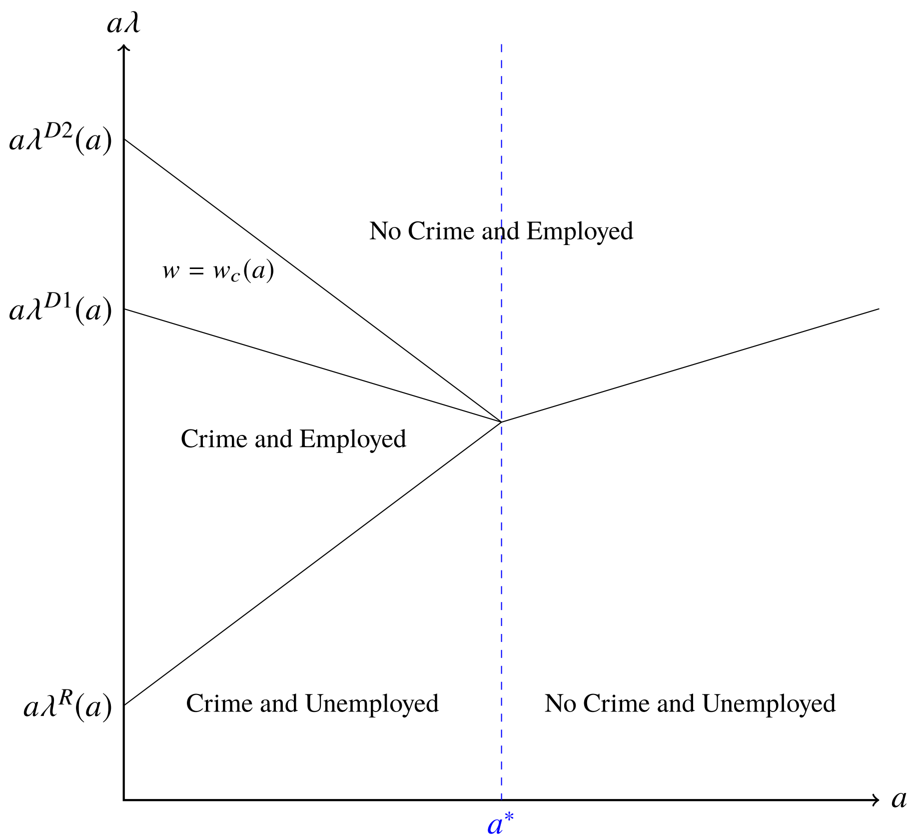


Figure 3: Reservation match values and decision rules



Proposition 2.2. *If* $(r + \delta)/\mu_e \pi \leq (1 - \beta)/\beta$ *then,*

a. If $\phi_u(a) = 0$ *then for all* $\lambda \geq \lambda^R(a)$ *the worker accepts the job and* $\phi_e(w(a, \lambda)) = 0$.

b. If $\phi_u(a) = 1$ then for all $\lambda^R(a) \leq \lambda \leq \lambda^{D1}(a)$ the worker accepts the job and $\phi_e(w(a, \lambda)) = 1$.

c. If $\phi_u(a) = 1$ then for all $\lambda \geq \lambda^{D1}(a)$ the worker accepts the job and $\phi_e(w(a, \lambda)) = 0$.

Figure 3 gives a graphical representation of Proposition 2.2; note the figure plots total match productivity on the y-axis. The slopes of the deterrence match values, $\lambda^{D1}(a)$ and $\lambda^{D2}(a)$, depend on parameter values and can be either negative or positive, however since the worker's reservation wage is always less than his crime reservation wage one can show that $\lambda^{D1}(a) < \lambda^{D2}(a)$. The figure shows the case where both $\lambda^{D1}(a)$ and $\lambda^{D2}(a)$ are decreasing in ability.

3 Steady State

To solve for the steady-state distribution of workers across states. First define for workers with ability a the measure $u(a)$, unemployed; $e_c(a)$, employed and committing crimes; $e_{nc}(a)$, employed and not committing crimes; and $p(a)$, in prison. A worker with $a < a^*$ is a potential criminal and can flow between all four states, and a worker with $a \geq a^*$ will never commit a crime and can only flow between $u(a)$ and $e_{nc}(a)$.

For a potential criminal the flow from unemployment to employment and crime is equal to the probability that he receives a job offer times the probability that the productivity of the job is above his reservation match value and below the productivity at which a firm will deter him from crime:

$$\mu_j \left[G\left(\lambda^{D1}(a)\right) - G\left(\lambda^R(a)\right) \right] \equiv \mu_j D(a). \tag{19}$$

The flow from unemployment to employment and not committing crimes is equal to the probability that the worker receives a job offer, times the probability that the productivity of the job is above the value at which a firm will deter him from crime:

$$\mu_j \left[1 - G\left(\lambda^{D1}(a)\right) \right] \equiv \mu_j A(b). \tag{20}$$

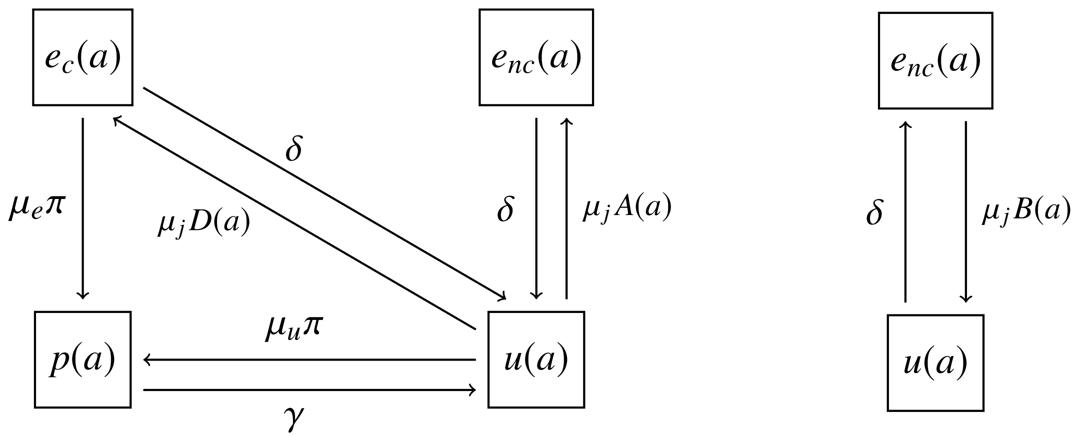
For a non-criminal, the flow from unemployment to employment is equal to the probability that he receives a job offer, times the probability that the productivity of the job is above his reservation match value:

$$\mu_j \left[1 - G\left(\lambda^R(a)\right) \right] \equiv \mu_j B(a). \tag{21}$$

Figure 4 shows the labor market flows for both types of workers.

A steady state is a set of measures $\{u(a), e_c(a), e_{nc}(a), p(a)\}$ for all a such that the flows between states are equal. The solution to the steady state measures can be found in the Appendix A.2. The

Figure 4: Labor Market Flows



(a) Flows for $a < a^*$

(b) Flows for $a > a^*$

aggregate measure of unemployed criminals and aggregate measure of unemployed non-criminals are:

$$u_c = \int^{a^*} u(a)\, dF(a) \tag{22}$$

$$u_{nc} = \int_{a^*} u(a)\, dF(a) \tag{23}$$

The aggregate measure of workers employed and committing crimes and the aggregate measure of workers employed and not committing crimes are:

$$e_c = \int^{a^*} e_c(a)\, dF(a) \tag{24}$$

$$e_{nc} = \int e_{nc}(a)\, dF(a) \tag{25}$$

The aggregate measure of workers in prison is:

$$p = \int^{a^*} p(a)\, dF(a) \tag{26}$$

The steady state unemployment rate is:

$$U = \int \frac{u(a)}{1 - p(a)}\, dF(a) \tag{27}$$

and the crime rate is:

$$C = \int^{a^*} \frac{\mu_u u(a) + \mu_e e_c(a)}{1 - p(a)}\, dF(a). \tag{28}$$

Here I have use the non-institutionalized population as the denominator for the aggregate unemployment rate and the aggregate crime rate.

4 A Binding Minimum Wage

The minimum wage will change the interactions between the firm and the worker by acting as a constraint that each must consider when making a wage offer. I will assume the minimum wage, m, is set exogenously by the government and that all matches are subject to this constraint. Since wages are the only transfer from the firm to the worker, the firm cannot alter any other forms of compensation to undo the effect of the minimum wage. A minimum wage is binding if it alters the outcome of the bargaining problem for at least one type of worker and at least one job productivity. The question of interest is then: how does the minimum wage change wages and in turn a worker's decision to commit crimes?

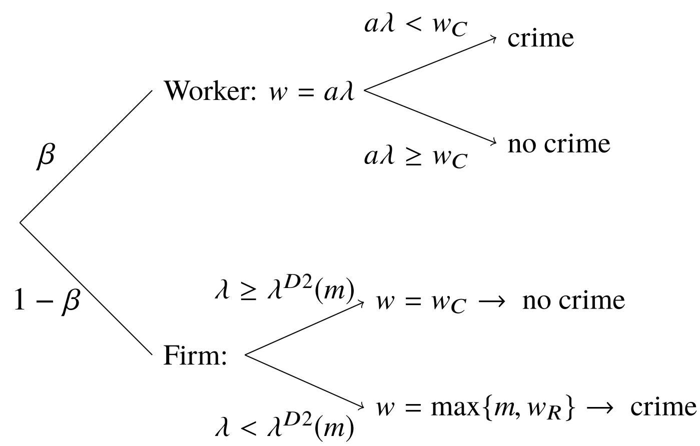
4.1 Wages

The minimum wage enters the bargaining problem as a constraint; firms and workers can never offer a wage below m in the first stage or the second stage of the bargaining process. Under the constrained game, there exists a new value of unemployment for the worker that will depend on the minimum wage, I denote this value as $V_u(a, m)$. First, the lowest wage payed to a worker of ability a is $a\lambda^R(a, m)$, thus any minimum wage for which there exists an a such that $m > a\lambda^R(a, m) = w_R(a)$ is binding. An immediate implication of a binding minimum wage is that matches with total productivity less than m are no longer feasible.

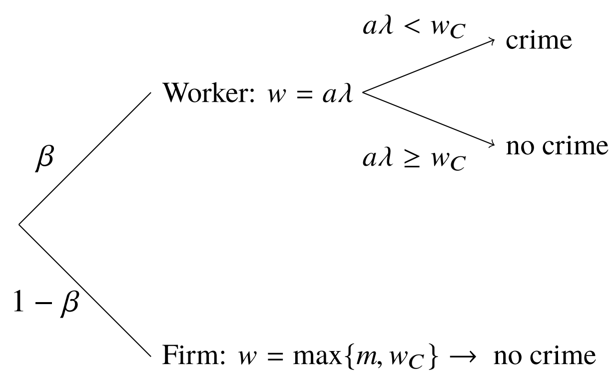
Starting with the simplest case, if the minimum wage is binding for a non-criminal the firm must offer at least m in the second stage. The expected value of the second stage for the worker becomes $\beta a\lambda + (1 - \beta)m$. In the first stage the firm offers a wage that maximizes profits subject to the worker accepting the offer. As before, it offers the value of the second stage and since $m > a\lambda^R(a, m)$, wages increase for all productivities.

For a potential criminal, the solution to the constrained bargaining problem depends on whether or not the minimum wage is larger than the crime reservation wage. If $m < w_C(a)$ then only jobs with productivities at which the firm does not deter the worker in the second stage are constrained. Figure 5a shows the constrained second stage. Since the minimum wage is less than the worker's crime reservation wage the firm must choose whether or not to deter the worker from crime in the second

Figure 5: Constrained Second Stage



(a) For a worker of ability a with $m < w_C(a)$



(b) For a worker of ability a with $m \geq w_C(a)$

stage. The firm faces the following problem in the second stage:

$$w(a, \lambda) = \underset{\{m, w_C\}}{\operatorname{argmax}} \left\{ \frac{a\lambda - m}{r + \delta + \mu_e \pi}, \frac{a\lambda - w_C(a)}{r + \delta} \right\}. \tag{29}$$

As with the unconstrained problem, for low productivity jobs, the firm will choose to pay the minimum wage and have a shorter job duration. The match value that makes the firm indifferent between deterring and not deterring the worker in the second stage is now,

$$\lambda^{D2}(a, m) = \frac{(r + \delta + \mu_e \pi) w_C(a) - (r + \delta) m}{\mu_e \pi} \tag{30}$$

above which the firm will choose to offer the crime reservation wage and receive a lower flow value for a longer duration. In the case that a firm and a worker match at a productivity less than $\lambda^{D2}(a, m)$, a binding minimum wage implies that the expected value of the second stage is now $\beta a\lambda + (1-\beta)m$, and the firm faces the following first stage problem:

$$w(a,\lambda) = \underset{w}{\text{argmax}} \left\{ \underset{\substack{w \\ \text{s.t.} \quad w \geq w_C(a) \ \&\ w \geq \beta a\lambda + (1-\beta)m}}{\text{argmax}} \frac{a\lambda - w}{r+\delta} \quad , \quad \underset{\substack{w \\ \text{s.t.} \quad w_C(a) > w \geq \beta a\lambda + (1-\beta)m}}{\text{argmax}} \frac{a\lambda - w}{r+\delta+\mu_e\pi} \right\}. \tag{31}$$

The solution is similar to the unconstrained problem: the firm pays the expected value of the second stage for low productivities and there exits some productivity, $\lambda^{D1}(a,m)$, above which the firm deters the worker from crime by offering the crime reservation wage.

$$\lambda^{D1}(a,m) = \frac{(r+\delta+\mu_e\pi)w_C(a) - (1-\beta)(r+\delta)m}{\mu_e\pi + \beta(r+\delta)} \tag{32}$$

Figure 6 shows the wage profile with the minimum wage imposed. The new wage offered by the firm is

$$\tilde{w}(a,\lambda;m) = \begin{cases} \beta\lambda + (1-\beta)m & \text{if } m \leq \lambda < \lambda^{D1}(a,m) \\ w_C(a) & \text{if } \lambda^{D1}(a,m) \leq \lambda < \lambda^{D2}(a,m) \\ \beta\lambda + (1-\beta)w_C(a) & \text{if } \lambda \geq \lambda^{D2}(a,m). \end{cases} \tag{33}$$

Figure 6 shows that a binding minimum wage compresses the wage distribution for a worker up to $\lambda^{D2}(a)$. Proposition 4.1 summarizes the effects on the wage distribution. Part a.i. implies that a firm will deter the worker from crime for a larger range of productivities. With the minimum wage, the flow value of a filled job decreases since the expected value of the second stage increases. A reduction in the flow value of the job reduces the benefit to the firm from offering a wage lower than the worker's crime reservation wage, and therefore the firm will choose to deter the worker from crime for more job productivities.

Proposition 4.1.

a. If $(r+\delta)/\mu_e\pi \leq (1-\beta)/\beta$ and $m < w_C(a)$ then

i. $\frac{\partial\lambda^{D1}(a,m)}{\partial m} < 0$

i. $\frac{\partial\lambda^{D2}(a,m)}{\partial m} < 0$

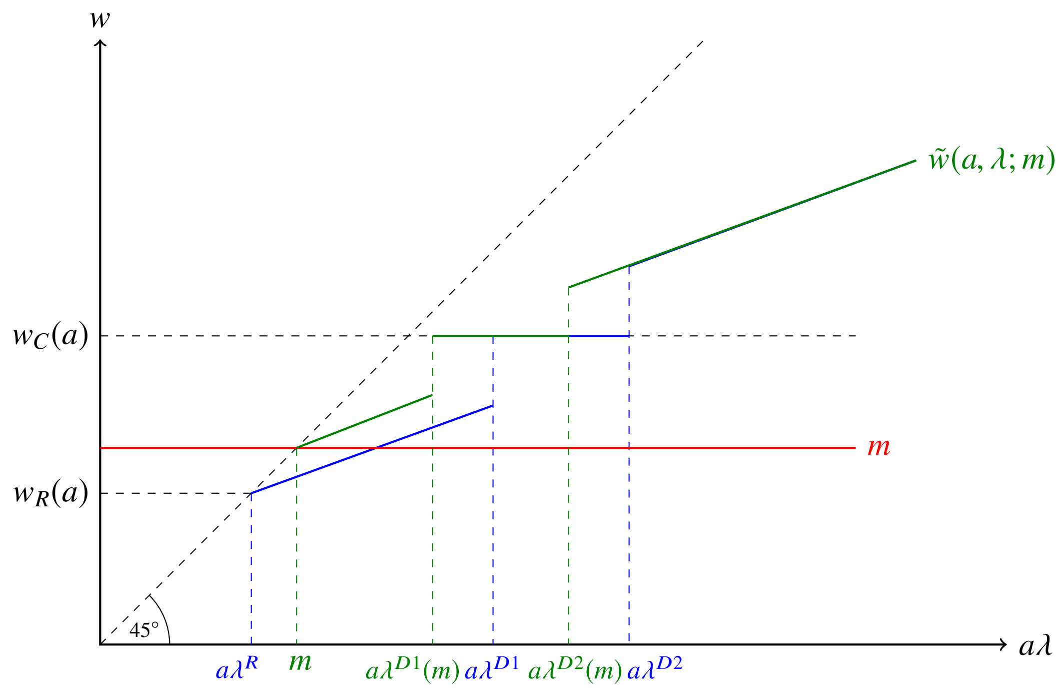
iii. $\left|\frac{\partial\lambda^{D1}(a,m)}{\partial m}\right| > \left|\frac{\partial\lambda^{D2}(a,m)}{\partial m}\right|$

iv. $\tilde{w}(a,\lambda;m) \geq w(a,\lambda)$ *for all* $m \leq \lambda < \lambda^{D2}(a,m)$

b. If $m \geq w_C(a)$ then $\tilde{w}(a,\lambda;m) > w(a,\lambda)$ for all matches values that lead to a filled job.

If the minimum wage is above the crime reservation wage the firm has no decision to make in the second stage since all wages it can offer will deter the worker from crime while employed. Figure 5b shows the constrained second stage for which the expected value is now $\beta a\lambda + (1-\beta)m$ for all

Figure 6: Wage Profile for Constrained Workers with $V_u(a) < V_u(a)^*$



feasible matches. If there is some positive probability that the worker gets to set the wage in the second stage, then the expected value of the second stage is strictly greater than the crime reservation wage. Therefore, the firm does not need to decide whether or not to deter the worker from crime in the first stage and faces the following problem in the first stage:

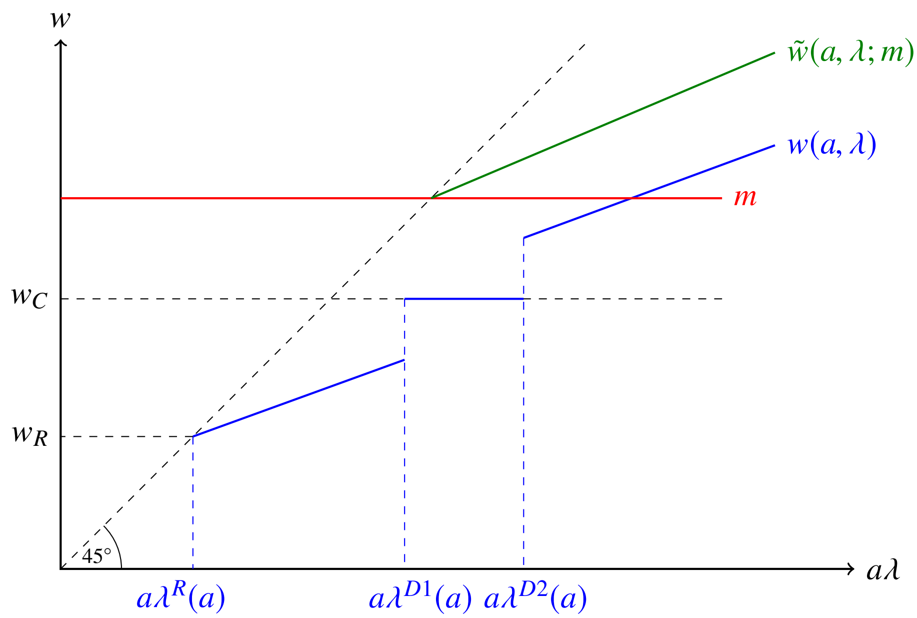
$$w(a, \lambda) = \underset{w}{\operatorname{argmax}} \frac{\lambda - w}{r + \delta} \text{ s.t. } w \geq \beta\lambda + (1 - \beta)m. \tag{34}$$

The firm maximizes profits by offering the expected value of the second stage which the worker will accept and forgo crimes while employed. The wage is simply $\tilde{w}(a, \lambda; m) = \beta a\lambda + (1 - \beta)m$ for all $\lambda \geq m$. Part b. of Proposition 4.1 summarizes the effect of a minimum wage in this case and Figure 7 shows the effect on the worker's wage profile, which increases for all feasible matches.

4.2 Workers

Since meeting rates are exogenous the minimum wage will have no effect on the rate at which a worker meets with a firm. However, the minimum wage will change the range of productivities at which a worker will choose to commit crimes and therefore the rate at which he flows into and out of a criminal state. A potential criminal will commit crimes for all matchs with productivity less than $\lambda^{D1}(a, m)$; if the productivity is less than $\max\{m/a, \lambda^R(a, m)\}$ he will commit crimes at rate μ_u because he is

Figure 7: Constrained Wage Profile for workers with $V_u(a) < V_u(a)^*$ when $m \geq w_C(a)$



unemployed and if the productivity is greater than $\max\{m/a, \lambda^R(a, m)\}$ but less than $\lambda^{D1}(a, m)$ he will commit crimes at rate μ_e because the wage offered by such a job is not high enough to deter him from crime.

A binding minimum wage will have three effects on a worker's propensity to commit crimes: a wage effect, an unemployment effect, and an indirect effect. The wage effect occurs when workers are deterred from committing crimes due to receiving a higher wage. The unemployment effect occurs when either: (1) a worker is displaced from jobs at which he would not have committed crimes or (2) the rate at which he receives crime opportunities differs across states and he is displaced from any job. The indirect effect is driven by changes in the unemployment value, $V_u(a, m)$. A change in the minimum wage will affect a worker's value of unemployment and therefore indirectly affect the flows between criminal and non-criminal states.

4.2.1 Wage Effect

Since all workers affected by the minimum wage experience an increase in wages for a range of productivities, the wage effect exists for all workers with a reservation wage less than the minimum wage. In Figure 8a this is all workers with ability less than a_1. For a worker with ability less than a_2 in Figure 8a, the minimum wage is higher than his crime reservation wage, and he will never commit crimes while employed. Therefore, he flows out of a criminal state if he receive a job offer with productivity greater than or equal to the m/a.

For a worker with ability greater than a_2 but less than a_1 in Figure 8a, the crime reservation wage is above the minimum wage and he will continue to commit crimes while employed at some jobs. However, the range of productivities for which he commits crimes has decreased (part a.i. of Proposition 4.1.) as shown by the fact that $\lambda^{D1}(a)$ is greater than $\lambda^{D1}(a, m)$ in Figure 8a. All together, the blue shaded region of Figure 8a shows the matches that no longer lead to crime while employed due to an increase in wages. In Figure 8b the minimum wage is above all workers' crime reservation wage and therefore all workers forgo crime while employed. Again, the wage effect corresponds to the blue shaded region; these are matches that which a worker would have committed crimes before the minimum wage.

4.2.2 Unemployment Effect

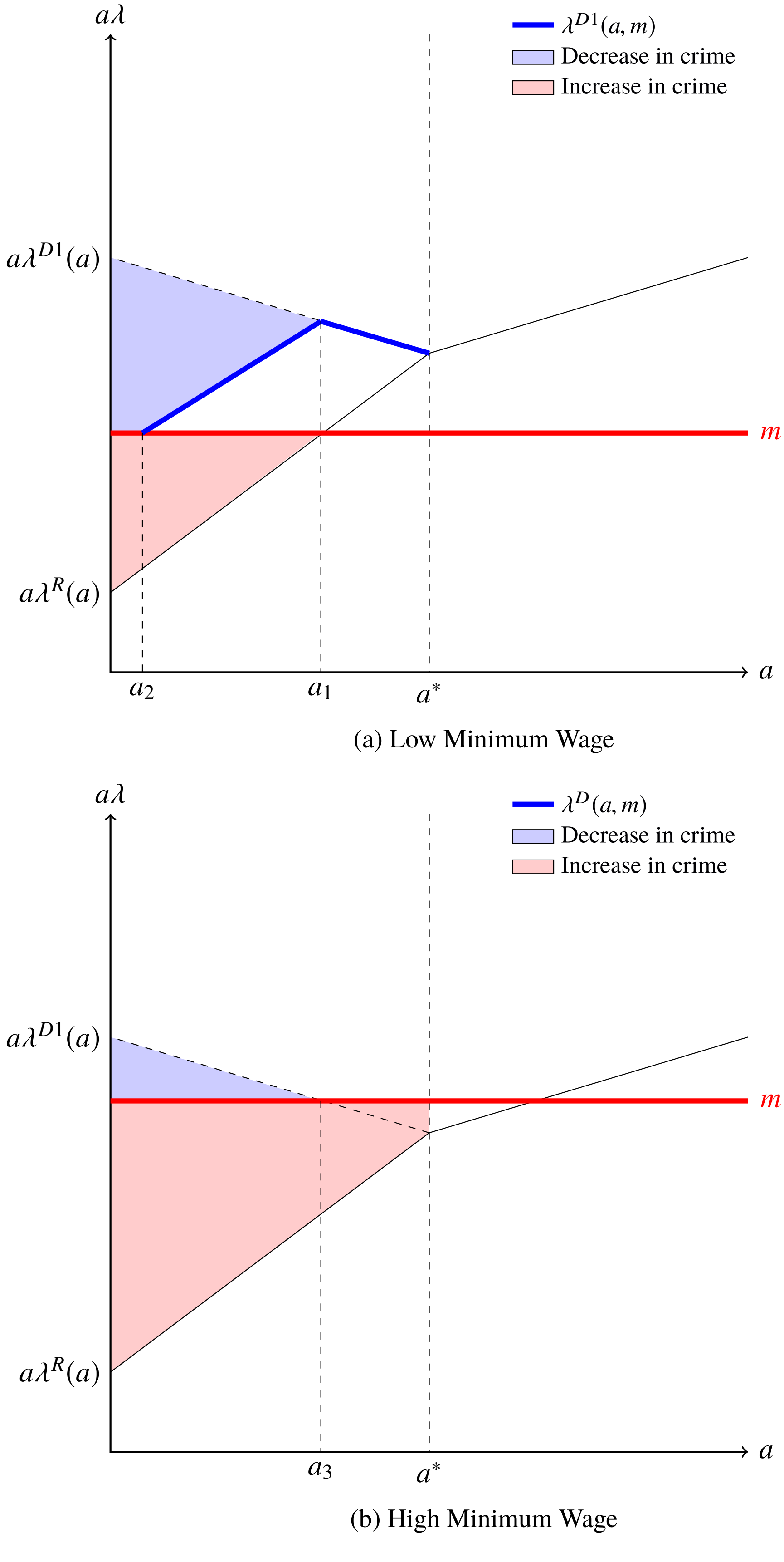
There are two channels through which a worker will change the amount of crimes he commits due to unemployment. First, if the rate at which he receive crime opportunities differs across states. Specifically, if he receives more crime opportunities while unemployed, $\mu_e < \mu_u$, then when he is displaced from a job, he will commit more crimes. In Figure 8a, this corresponds to the red shaded region; these are productivities at which workers would have accepted a job and committed less crime in the absence of the minimum wage.

Second, if a worker is displaced from a job at which he would not have committed a crime, then the minimum wage will increases the amount of crimes he commits. This occurs when the minimum wage is above the productivity at which the firm would have chosen to deterred the worker from crime. This corresponds to matches with a total productivity greater than $a\lambda^{D1}(a)$ and less than m in Figure 8a. Only workers with ability greater than a_3 and less than a^* are displaced from jobs at which they would not have committed crimes. The red shaded region of Figures 8a and 8b show the matches that lead to an increase in crime through both channels.

4.2.3 Indirect Effect

The indirect effect of the minimum wage on a worker's crime decisions is driven by changes in his value of unemployment. Take, for example, a worker with ability greater than a_2 and less than a_1. From Figure 8a it is clear that his value of unemployment has changed for two reasons: (1) some matches are no longer feasible and (2) some matches experience a wage increase. The fact that some matches no longer lead to filled jobs decreases his value of unemployment. On the other hand, the wage increase for some matches increases his value of unemployment. Therefore, the overall effect of a minimum wage on the worker's value of unemployment is ambiguous, depends on the size of the minimum wage, and varies across workers.

Figure 8: Minimum Wage Effects on Matches



(a) Low Minimum Wage

(b) High Minimum Wage

4.3 Equilibrium Crime Rate

The equilibrium crime rate given in equation (28) depends on the steady state measures, $u(a)$, $e_c(a)$, and $p(a)$, and the rates at which workers receive crime opportunities while employed, μ_e, and unemployed, μ_u. When the minimum wage changes, the aggregate crime rate is affected by changes in workers' decisions to commit crimes and accept jobs. From Figure 8a it is clear that workers are affected differentially by the minimum wage; some workers are deterred from crime for more job productivities and are displaced from more jobs. Therefore, analytical results for a change in the crime rate depend on the distribution of ability, the distribution of job productivities and the size of the minimum wage.

5 Calibration

The unit of time is one month and the rate of time preference is $r = 0.0101$. The model is calibrated to match the crime and labor market in 1998. The model is normalized by setting the flow utility of prison, z, equal to zero.[12] The probability a worker gets to set the wage in the second stage, β, acts as the worker's bargaining power, which is set to $\beta = 0.4$ as estimated by Flinn (2006).

The crimes considered are Type 1 property crimes defined by the Federal Bureau of Investigation (FBI) as larceny, burglary and motor vehicle theft. The probability of being caught is derived from the clearance rate and the incarceration rate of these crimes as reported by the FBI's Uniform Crime Reports (UCR). The UCR defines the clearance rate as the ratio of arrests to crimes reported and the incarceration rate as the the ratio of convictions to arrests. In 1998 the clearance rate for property crimes was 17.5% and the incarceration rate for property crimes was 65%, implying the probability a worker goes to prison is $\pi = 0.175 * 0.65 = 0.114$. The prison release rate is calibrated to target the average time in prison for property crimes as reported by the National Corrections Reporting Program. In 1998, the average time in prison for property crimes was 20 months implying $\gamma = 1/20 = 0.05$. The UCR reports that the average loss per property crime in 1998 was \$1,407 implying the gain from crime is $g = \$1,407$. The expected loss, χL, is set such that the crime market is in equilibrium, that is, the expected loss is the gain from crime times the crime rate, which is calculated below.

The remaining set of parameters (b, μ_e, μ_u, μ_j, μ_λ, σ_λ, μ_a, σ_a, δ), where μ_λ and σ_λ are the mean and standard deviation of the job productivity distribution and μ_a and σ_a are the mean and standard deviation of the ability distribution, are calibrated to match a set of empirical moments derived from the National Longitudinal Survey of Youth 1997 (NLSY97). The data are collected from 8,984 respondents who were ages 12-17 when first interviewed in 1997. Respondents were asked questions about their

[12] Since individuals can not choose how long to say in prison, these does not exist an empirical moment that could pin down the flow utility of prison.

labor market status including employment status, wages, and hours worked. The survey also asks individuals to report the crimes they committed during the year, specifically useful for the question posed here are individuals' responses to the number of times they stole more than $50 worth and the number of times they committed other property crimes such as fencing, receiving, possessing or selling stolen property. In the first round of the survey, respondents were administered the computer-adaptive form of the Armed Services Vocational Aptitude Battery (CAT-ASVAB).[13]

Nine empirical moments are constructed using the NLSY97 data for 1998, to target the remaining parameters. The moments constructed are: the monthly crime rate, the ratio of the crime rate among the unemployed to employed, the monthly unemployment rate, the monthly job finding probability, the monthly separation rate, the 10th percentile to median and median to 90th percentile ratios of the CAT-ASVAB scores, the minimum wage to median wage ratio, and the median to 75th percentile wage ratio. Details of how these moments are constructed can be found appendix section A.4. Table 1 gives a summary of the empirical moments.

Table 1: Summary of Empirical Moments

Moment	Value
Unemployment rate	0.124
Crime rate	0.042
Crime rate of Unemp. / Crime rate of Emp.	1.159
Job finding rate	0.160
Seperation rate	0.011
10th Percentile / 50th Percentile exp(CAT-ASVAB)	0.312
50th Percentile / 90th Percentile exp(CAT-ASVAB)	0.454
Minimum Wage / 50th Percentile Wage	0.880
50th Percentile / 75th Percentile Wage	0.900

Since jobs separate at an exogenous rate in the model, $\delta = 0.011$ to match the monthly separation rate in the NLSY97. The two moments derived from the CAT-ASVAB scores are used to calibrate a distribution of abilities. The CAT-ASVAB scores have a normal distribution in the data; however, since ability multiplicatively enters into the total productivity of a job, a negative ability level would imply never finding a productive job. Therefore, the CAT-ASVAB scores are exponentiated, giving ability a log-normal distribution. Further, since the lower bound of a log-normal distribution is zero, one is added to the exponentiated test scores, again insuring that all individuals have a non-zero probability of finding a productive match. These assumptions lead to a distribution of abilities, $a - 1 \sim \ln N(\mu_a, \sigma_a)$, where μ_a and σ_a are chosen to match the ratio of the 10th/50th percentile and the 50th/90th percentile of

[13]The CAT-ASVAB measures an individual's knowledge in the following areas:Arithmetic Reasoning, Electronics Information, Numerical Operations, Assembling Objects, General Science, Paragraph Comprehension, Auto Information, Mathematics Knowledge, Shop Information, Coding Speed, Mechanical Comprehension, Word Knowledge.

the exponentiated CAT-ASVAB scores. Matching the ratios of test scores assumes test scores ordinally identify ability.

The remaining six parameters, (b, μ_e, μ_u,μ_j,μ_λ, σ_λ), are calibrated to match the remaining six moments jointly using simulated method of moments. Although all six parameters influence all six moments, intuitively the job productivity parameters, μ_λ and σ_λ, are chosen to target the ratios of the wage distribution. The distribution for job productivities is log normal, $\lambda \sim \ln N(\mu_\lambda, \sigma_\lambda)$. The crime arrival rates μ_u and μ_e are chosen to target the aggregate crime rate and relative crime rate of the unemployed to employed. The job contact rate, μ_j, is chosen to target the job finding rate and the flow value of unemployment b is chosen to target the unemployment rate.

The average weekly hours worked in the NLSY97 for 1998 was 21.7 and the minimum wage in 1998 wage \$5.15 implying a monthly minimum wage of $m = 5.15 \times 21.7 \times 4 = 446.06$. The monthly crime rate in 1998 measured from the NLSY97 was 0.042 and the gain from crime was 1,407 so the expected loss from crime is $\chi L = \$58.47$. Table 2 and Table 3 summarize all parameters and Table 4 gives the empirical and model generated moments.

Table 2: Parameter Values

Parameter	Value	Description
r	0.0101	real interest rate
β	0.4	bargaining power of workers
χL	\$58.47	expected loss from crime
z	0	prison utility
γ	0.05	prison release rate
π	0.114	probability of getting caught
m	\$446.06	minimum wage job
g	\$1,407	gain from crime

The estimated crime arrival rates are 0.23 while employed and 0.05 while unemployed, implying a monthly probability of finding a crime opportunity of 0.21 while employed and 0.05 while unemployed. The job offer rate is 4.1, implying a monthly probability of receiving a job offer of 0.98. The calibrated mean and variance of the job productivity distribution and the ability distribution imply a mean total job productivity, $a\lambda$, of \$347.62 and a standard deviation of \$350.33.

5.1 Model Generated Elasticities

Since the effect of the minimum wage on the crime rate is driven through changes in the labor market, I test the model in two dimensions: the response of workers' crime decisions with respect to changes in the labor market and changes in the labor market with respect to changes in the minimum wage.

Table 3: Simulated Method of Moments Estimates

Parameter	Estimate	p5	p95	Description
δ	0.011	0.001	0.013	separation rate
b	−26.66	−30.73	−24.75	flow utility of unemployment
μ_e	0.2296	0.1691	0.3019	arrival rate of crime opp. while emp.
μ_u	0.0478	0.0229	0.0584	arrival rate of crime opp. while unemp.
μ_j	4.0928	3.4901	4.8657	arrival rate of jobs opportunities
μ_λ	0.8619	0.6730	0.9666	mean of productivity distribution
σ_λ	0.5271	0.4937	0.5819	s.d. of productivity distribution
μ_a	4.6256	4.5545	4.7296	mean ability
σ_a	0.6293	0.5945	0.6738	s.d. of ability

Note: The columns labeled p5 and p95 give the 5th and 95th percentile of estimates from 500 bootstrapped samples.

Table 4: Moments Matched

Moment	Empirical	Model
Unemployment rate	0.124	0.124
Crime rate	0.042	0.042
Crime rate of Unemp. / Crime rate of Emp.	1.159	1.158
Job finding rate	0.160	0.160
10th Percentile / 50th Percentile exp(CAT-ASVAB)	0.312	0.312
50th Percentile / 90th Percentile exp(CAT-ASVAB)	0.454	0.454
Minimum Wage / 50th Percentile Wage	0.880	0.881
50th Percentile / 75th Percentile Wage	0.900	0.900

Specifically, two data sets are generated through simulation of the model, similar to those used by empirical researchers, and estimate the elasticity of crime with respect to unemployment and wages and the elasticity of employment and earnings with respect to the minimum wage. I compare the estimated elasticities that the calibrated model delivers to those found in the empirical literature to validate the relationship between the labor market and criminal propensity and the minimum wage and the labor market. Both data sets are generated based on variation in the real minimum wage observed across states from 1990 to 2011. Table 5 summaries the variation in the minimum wage across the sample; the real binding minimum wage is the maximum of the state and federal minimum wage in 1998 dollars.

The first data generated is a panel of 1,000 individuals for every unique realization of the real binding minimum wage; this gives a total sample size of 204,000. For each individual the probability of unemployment and employment, probability of committing a crime, and expected wage are simulated using the calibrated parameters. Full details of the simulations can be found in appendix section

Table 5: Minimum Wage Summary Statistics

	Mean	St. dev.	Min	Max
Federal Min. Wage	5.24	0.99	3.80	7.25
State Min. Wage	5.30	1.31	1.6	8.67
Binding Min. Wage	5.46	1.15	3.80	8.67
Real Binding Min. Wage	5.09	0.55	4.34	6.83

A.5. Using the simulated unemployment probability and simulated expected wage, expected monthly earnings are calculated as the unemployment probability times the expected wage. Panel A of Table 6 gives the summary statistics for the generated sample.

The generated sample is used to estimate the elasticity of workers' crime decisions with respect to unemployment and wages and compare the model generated elasticities to those found in the empirical literature. The model generated elasticities are :

$$(1) \quad \ln crime_{i,m} = \alpha_0 + \alpha_1 U_m + \varepsilon_{i,m}$$

$$(2) \quad \ln crime_{i,m} = \beta_0 + \beta_1 \ln earnings_{i,m} + \varepsilon_{i,m}$$

where $\ln crime_{i,m}$ is the natural log of the simulated probability of committing a crime for worker i for minimum wage m, U_m is the unemployment probability for minimum wage m, $\ln earnings_{i,m}$ is the natural log of earnings for worker i at minimum wage m and $\varepsilon_{i,m}$ is statistical noise generated in the simulation through the random draw of a crime opportunity and job productivity. Panel B of Table 6 gives the regression results.

Several empirical studies have estimated the elasticity of crime with respect to unemployment and wages and find a semi-elasticity of crime with respect to unemployment, $\hat{\alpha}_1$, of 1.2 to 2, and an elasticity of crime with respect to earnings, $\hat{\beta}_1$, of -0.5 to -2 (Gould et al., 2002; Mocan and Unel, 2011; Schnepel, 2014). The model generated elasticity of crime with respect to earnings, -0.47, is on the low side of the empirically estimated range. The model generates an elasticity of crime with respect to unemployment, 2.13, that is slightly higher than the empirically estimated elasticities.

To estimate the response of the labor market to changes in the minimum wage within the model, a cross section of aggregate employment probabilities, and expected wages for every realization of the real binding minimum wage within the sample is generated. The generated data has a sample size of 1,122. Full details of the simulations can be found in appendix section A.5. Aggregate monthly earnings are constructed by multiplying the unemployment rate by wages. Using the aggregate sample,

Table 6: Simulated Individual Analysis

Panel A: Simulated Data Summary Statistics

	Mean	St. dev.	Min	Max
Crime	0.036	0.034	0	0.147
Wage	610.95	215.13	395.08	2434.29
Earnings	535.07	266.84	0	2395.34
Unemployment	0.140	0.236	0	1

Panel B: Regression Results

	ln Crime (1)	ln Crime (2)
Unemployment	2.13	
ln (Earnings)		−0.47
N	*204,000*	*204,000*

Note: Observations for which crime or earnings equal 0 were replace with 0.0001 before taking logs.

the model's generated elasticities are estimated by the following regressions:

$$\text{(1)} \quad \ln Emp_m = \xi_0 + \xi_1 \ln MinWage_m + \varepsilon_m$$

$$\text{(2)} \quad \ln Earnings_m = \psi_0 + \psi_1 \ln MinWage_m + \varepsilon_m$$

where $\ln Emp_m$ is the natural log of the average employment probability for minimum wage m, $\ln Earnings_m$ is the natural log of average earnings for minimum wage m, and ε_m is statistical noise generated from the random draws from the productivity distribution. Panel A of Table 7 gives summary statistics for the aggregate data and Panel B of Table 7 gives the regression results.

The literature on employment effects of the minimum wage is lengthy and mixed, see Neumark and Wascher (2007) for a review. Dube et al. (2010) study employment effects on restaurant workers and find no significant effect. The employment effects from the minimum wage on teen employment is mixed as well; Allegretto et al. (2010) finding no significant employment effects and Neumark et al. (2014) finding significant employment effects on teens with estimated elasticities around −0.3. The estimated elasticity of employment with respect to the minimum wage within the calibrated model −0.257, lower than the upper bound of the empirical literature. However, recent work from Jardim et al. (2017) suggests that the elasticity of employment with respect to the minimum wage may be much higher than previously estimated. The empirically estimated elasticity of wages with respect to the minimum wage is between 0.15 and 0.22 (Dube et al., 2010; Allegretto et al., 2010). The model delivers an estimated elasticity of 0.30, slightly higher than the empirical literature.

Table 7: Simulated Aggregates Analysis

Panel A: Simulated Data Summary Statistics

	Mean	St. dev.	Min	Max
Unemployment	0.125	0.026	0.072	0.219
Employment	0.875	0.026	0.781	0.928
Wage	600.19	36.85	535.61	724.61
Earnings	524.35	19.71	469.12	594.73

Panel B: Regression Results

	Dependent Variable	
	$\ln Emp$	$\ln Wage$
ln MinWage	−0.257	0.305
N	*1,122*	*1,122*

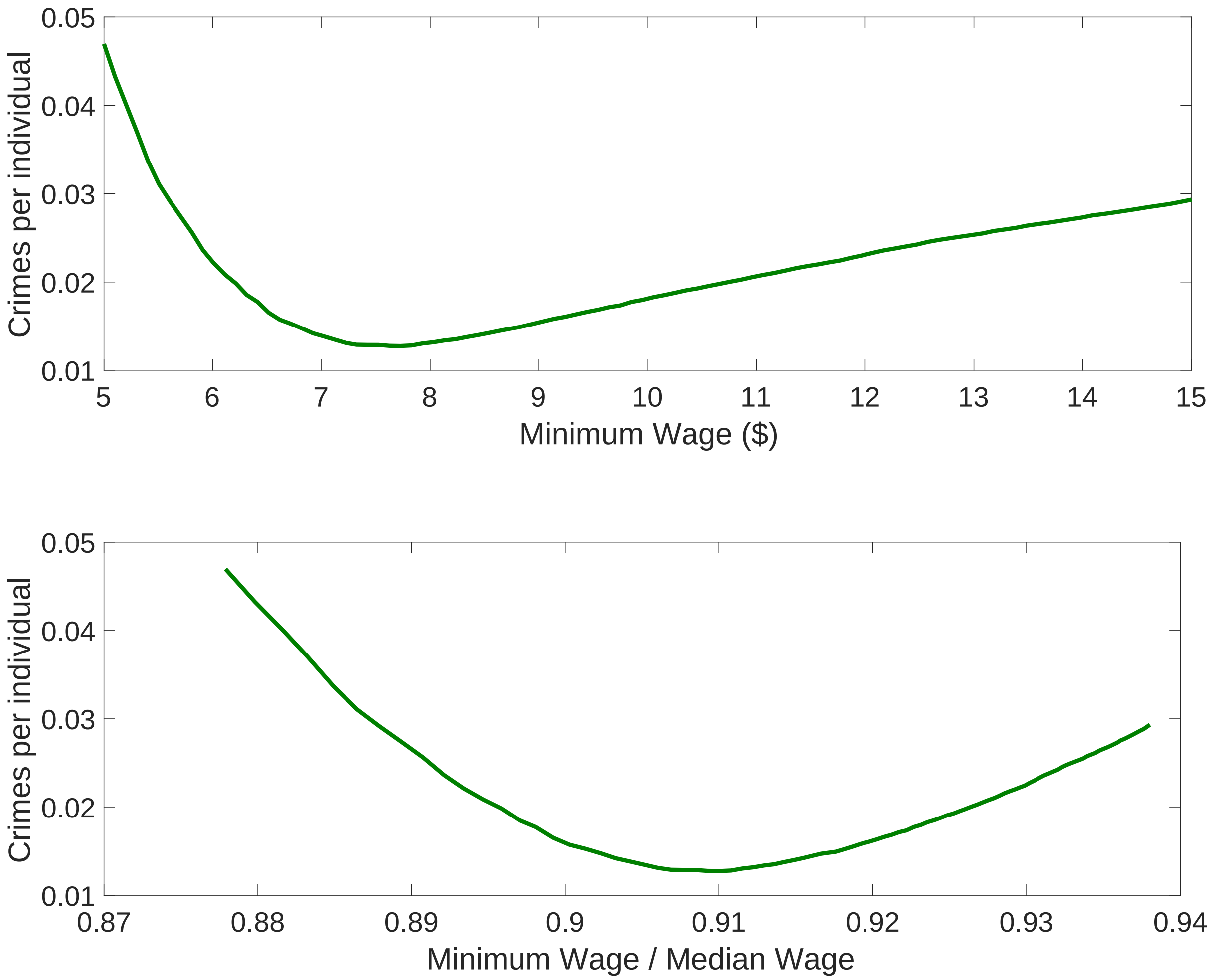
Overall, the calibrated model generates elasticities similar to those estimated in the empirical literature; changes in labor market conditions within the calibrated model affect individual's crime decisions similarly to what can be observed in the data. Furthermore, the effect of minimum wages on aggregate labor market conditions within the calibrated model are comparable to those estimated in the empirical literature. Since the calibrated model does not match these elasticities I argue that these results establish a degree of external validity for the calibrated model.

6 Increasing the Minimum Wage

Using the calibrated parameters, I solve the model for minimum wages between \$5 and \$15. For this exercise, the probability of being victimized, χ, is endogenized such that it is equal to the crime rate in steady state. Figure 9 shows the change in the aggregate crime rate, equation (28), over the range of minimum wages. The figure shows that the aggregate crime rate decreases with minimum wages between \$5 and \$7.50, implying that the wage effect outweighs the unemployment effect over this range. With minimum wages above \$7.50, the crime rate begins to increase as the unemployment effect begins to dominate. Figure 9 also plots the crime rate with respect to the minimum to median wage ratio. Since increases in the minimum wage affect the entire wage distribution, observing how the crime rate changes with respect to the minimum to median wage ratio is more informative for optimal policy. The model reveals that the crime rate is minimized when the minimum wage is 0.91 of the median wage of 16 to 19 year olds.

The fact that the aggregate crime rate responds more to changes in wages than to changes in

Figure 9: Crime Rate

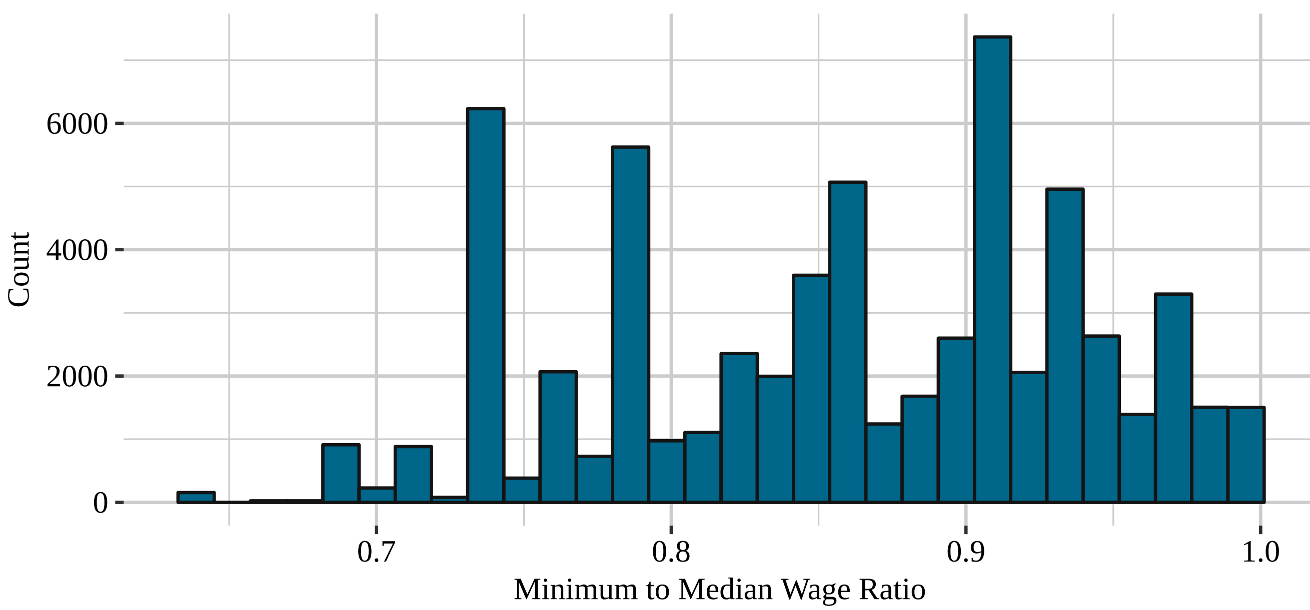


unemployment for relatively small increases in the minimum wage stems from the fact that employment decreases only marginally. This finding is similar to Imrohoroglu et al. (2004) who find that rising average incomes from 1980 to 1996 alone could account for 20% of the decrease in crime observed over the period, whereas the small increases in youth unemployment over the same period had no effect on the aggregate crime rate. The non-monotonicity of the crime rate is driven by a similar mechanism as in Engelhardt et al. (2008), who show that the crime rate is non-monotonic in the worker's bargaining power. For low minimum wages, as for low bargaining powers, the worker has a larger incentive to commit crimes because his labor market outcomes are low in terms of wages. As the minimum wage increases, or bargaining power increases, the worker's incentive to commit crimes decreases because his labor market outcomes in terms of wages increase. However, once the minimum wage increase above a certain point, the probability he finds a feasible match is too low and his labor market outcomes decease because of high unemployment, which increases his incentive to commit crime. Similarly in Engelhardt et al. (2008) a high bargaining power for the worker decreases the firms incentive to open vacancies, decreasing the workers labor market outcomes through high unemployment, increasing his incentive to commit crimes. As Flinn (2006) points out, one can think of the minimum wage as a policy tool that increases the worker's bargaining power.

6.1 Empirical Evidence

Figure 9 shows that the model predicts the minimum wage to have a U-shape effect on the crime rate. In this section I use county level crime data from 1995 to 2014 to test this prediction. The county level crime data come from the FBI's UCR; the data include the number of Type 1 property primes (burglary, larceny, and motor vehicle theft) and the number of robberies, classified as a Type 1 violent crime, reported to the police. The variable of interest is the minimum to median wage ratio, which is constructed at the state level for 16 to 19 year olds using the Current Population Survey's Outgoing Rotation Groups. Since crimes reported to the police can not be broken up by age, I test the U-shape prediction on the aggregate crime rate in the county. Figure 10 shows the variation of the minimum to median wage ratio over the full sample. The average minimum to median wage ratio is 0.86 with a standard deviation of 0.08. A full description of the data can be found in appendix section A.4.

Figure 10: Minimum to Median Wage Ratio Histogram



I test the prediction of the model using a non-parametric regression of county level crime rates on state level variation of the minimum to median wage ratio. The minimum to median wage ratio is binned into quintiles; Table 8 gives the mean and median value in each quintile. The model that is

Table 8: Mean Real Binding Minimum Wage by Quantile

Quintile	Min-to-Median Ratio	
	Mean	Median
1	0.738	0.736
2	0.816	0.817
3	0.871	0.863
4	0.915	0.906
5	0.962	0.964

estimated is as follows:

$$\text{crime}_{ct} = \beta_1 + \sum_{j=2}^{5} \beta_j^1 \mathbb{1}\{MM_{st} \in (q(j-1), q(j)]\} + \beta_6 X_{ct} + \beta_7 \text{crime}_{ct-1} + \gamma_c + \varepsilon_{ct} \tag{35}$$

where $q(j)$ is the j^{th} quintile of the minimum to median wage ratio (MM) in state s at time t, and $\mathbb{1}$ is the indicator function. γ_c are county fixed effects and X_{ct} are demographic controls, the poverty rate, and the log of average household income in county c in year t. The specification includes a lag dependent variable to capture county level trends in the crime rate. The specification is estimated for five dependent variables: burglary, larceny, motor vehicle theft, total Type 1 property crimes (the sum of burglary, larceny and motor vehicle theft) and robbery.

Table 9 gives the estimated coefficients on the quintiles of the minimum to median wage ratio for each dependent variable. Column (1) of Table 9 shows that moving from the first quintile to the third quintile of the minimum to median wage ratio has a negative and significant affect on property crimes within the county, decreasing property crimes by 82 crimes per 100,000 people. Moving from the first to the fourth quintile decreases property crimes by 120 crimes per 100,000 people. Moving from the first to the fifth quintile has a negative and significant effect on crime, however, the effect is less than when moving to the fourth quintile. A move from the first quintile to the fifth quintile decreases crime by 98 crimes per 100,000 people. Panel (a) of Figure 11 plots the estimated coefficients at the mean minimum to median wage ratio of each quintile, along with the 95% confidence intervals. The figure reveals a clear U-shape in the relationship between the minimum to median wage ratio and the property crime rate. Comparing panel (a) of Figure 11 to Figure 9 shows that the model and empirical exercise predict that the crime minimizing minimum to median wage ratio for 16 to 19 year olds is 0.91. Columns (2) – (5) of Table 9 and panels (b) – (e) reveal similar U-shaped relationships for the disaggregated categories of Type 1 property crimes and robbery.

To test the strength of the U-shape relationships revealed in the non-parametric regression, I test

Table 9: Regression Results

	(1) Property Crimes	(2) Burglary	(3) Larceny	(4) Motor Vehicle Theft	(5) Robbery
Quintile of Min-to-Median Ratio					
2nd.	-8.785	0.999	5.733	-5.829***	-0.569
	(7.762)	(2.386)	(5.199)	(0.950)	(0.318)
3rd.	-81.74***	-6.178*	-15.13*	-9.961***	-1.491***
	(8.996)	(2.739)	(6.093)	(1.131)	(0.399)
4th.	-120.4***	8.876**	-8.960	-15.53***	-1.883***
	(8.988)	(2.878)	(5.835)	(1.134)	(0.414)
5th.	-97.76***	19.94***	2.854	-13.90***	-0.515
	(9.572)	(3.073)	(6.450)	(1.123)	(0.399)
Mean Dep. Variable	2370.83	564.94	1566.92	152.30	40.61
N	51,418	51,418	51,418	51,418	51,418

Standard errors clustered at the county level. All specifications include demographic controls, county fixed effects, household income, poverty levels and a lag dependent variable. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 11: Regression Coefficients

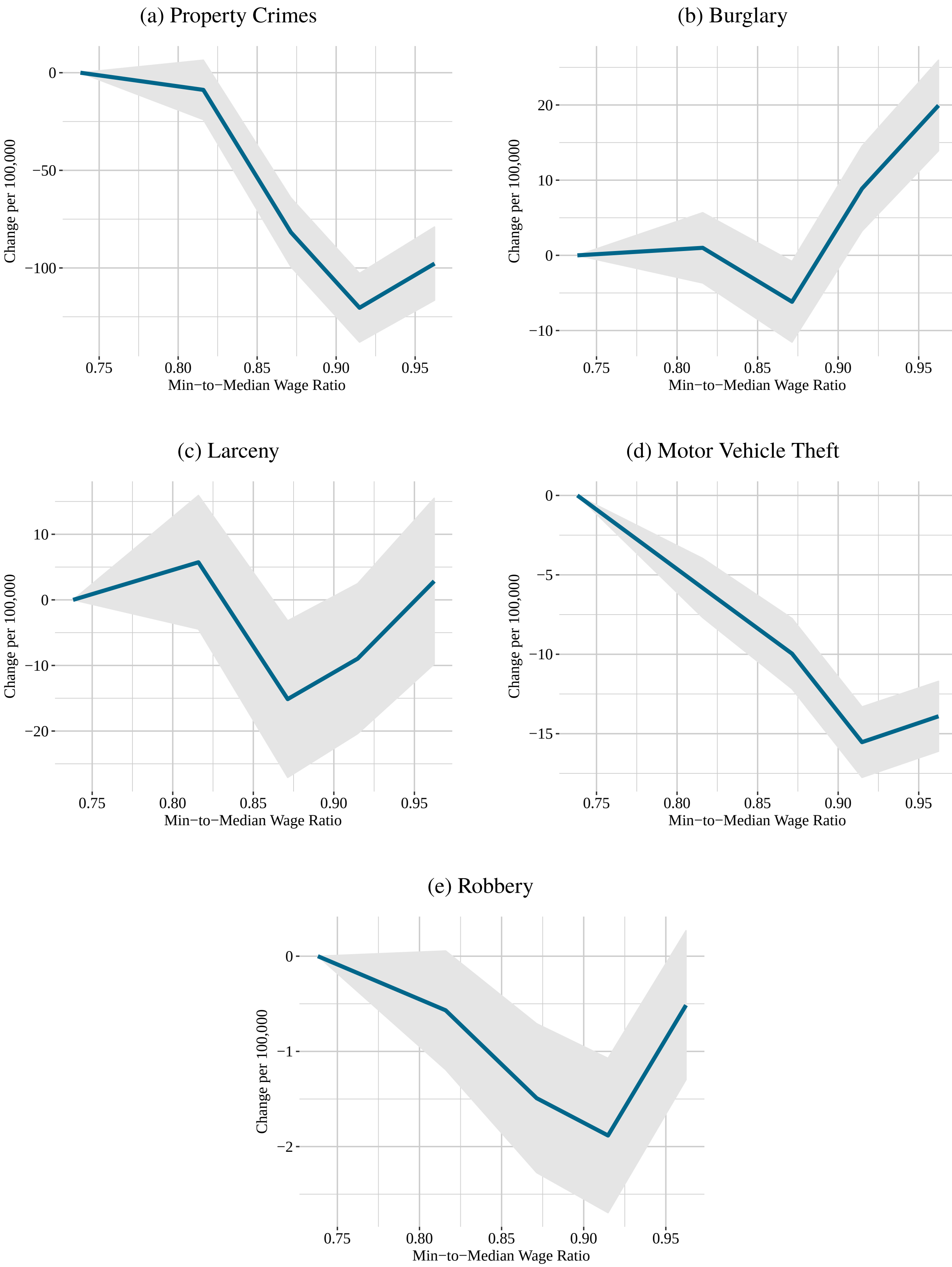


Table 10: Significance of Coefficients

	Test of Coefficient on Quintile			
	(1) 2 = 3	(2) 3 = 4	(3) 4 = 5	(4) 2 = 3 = 4 = 5
Property Crimes				
F-stat	66.39	27.17	9.13	50.16
p-value	0.000	0.000	0.003	0.000
Burglary				
F-stat	6.56	33.30	16.77	30.21
p-value	0.011	0.000	0.000	0.000
Larceny				
F-stat	11.46	1.47	5.57	5.97
p-value	0.001	0.225	0.018	0.001
Motor Vehicle Theft				
F-stat	17.75	32.73	3.87	34.92
p-value	0.000	0.000	0.049	0.000
Robbery				
F-stat	5.51	1.39	21.58	9.12
p-value	0.019	0.238	0.000	0.000

for equality among the estimated coefficients on the quintiles of the minimum to median wage ratio. Table 10 gives the F statistic and corresponding p-values for each test. Column (4) tests if all coefficients are simultaneously equal; the test shows a constant effect of the minimum to median wage ratio on all crimes can be ruled out. Since the estimated coefficient on the fifth quintile is less than the fourth quintile for property crimes, column (3) tests for the U-shape relationship. Column (3) rules out that the decrease in property crimes from moving from the first quintile to the fourth quintile is equal to a move from the first quintile to the fifth quintile of the minimum to median wage ratio with a p-value of 0.003. The one sided t-test for the hypothesis that $\beta_4 > \beta_5$ on the fourth and fifth quintile of the effect of the minimum to median wage ratio on property crimes has a p-value of 0.0015 and rules out that the effect of the minimum to median wage ratio on property crimes is linear. Similarly, linearity can be ruled out for the other crime categories.

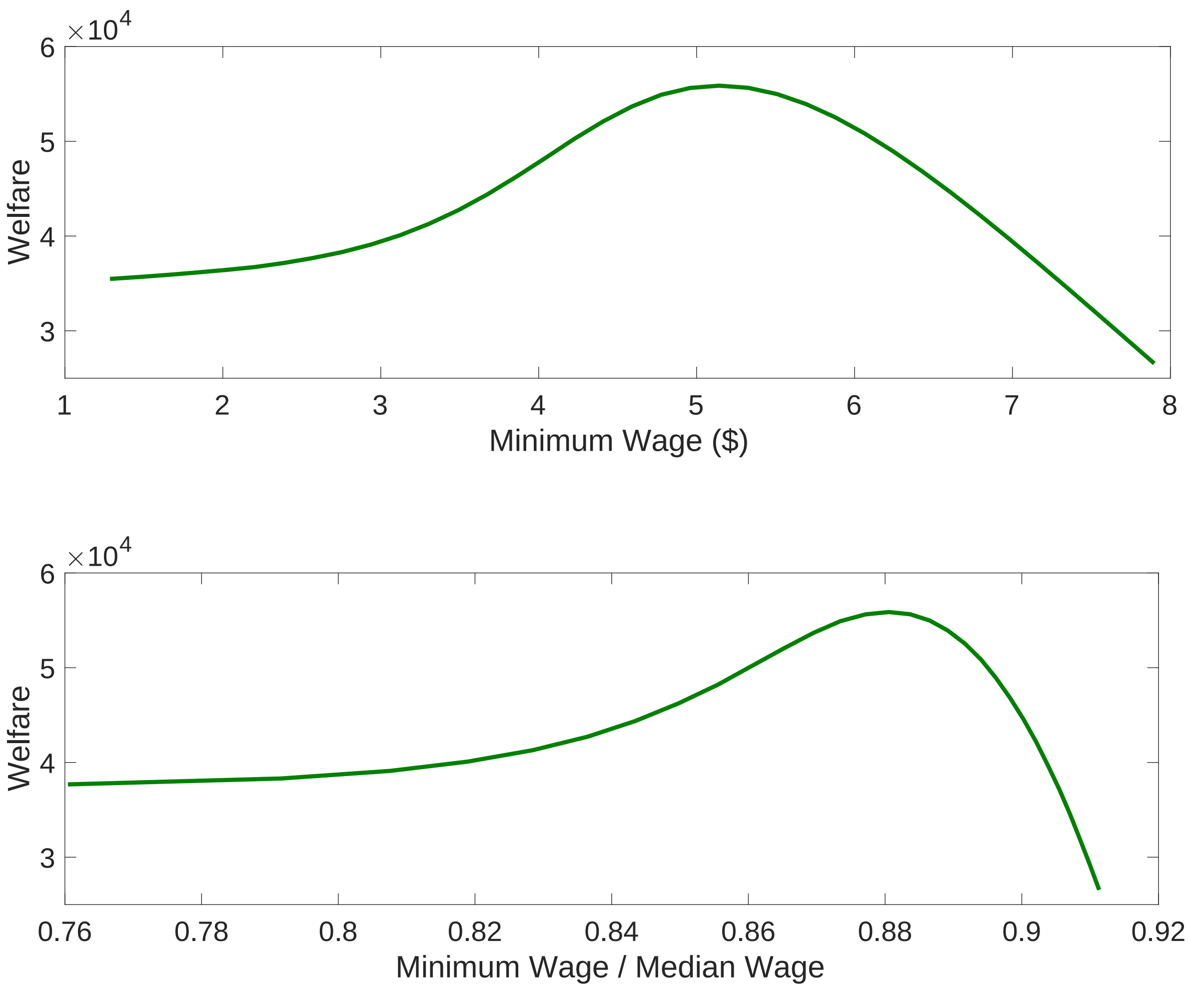
7 Welfare

Since the model is stationary, the welfare analysis in this section will consider the long term outcomes of a minimum wage. The workers in the model can be in one of five states at any given point in time: unemployed and committing crimes (uc), unemployed and not committing crimes (unc), employed and committing crimes (ec), employed and not committing crimes (enc), or in prison (p). Assuming the minimum wage is the only policy instrument available to the social planner, the planner wishes to maximize the following objective function:

$$W(m) = unc(m)\bar{V}_{unc}(m) + uc(m)\bar{V}_{uc}(m) + enc(m)\bar{V}_{enc}(m) + ec(m)\bar{V}_{ec}(m) + p(m)\bar{V}_{p}(m)$$

where $i(m)$ is the size of the set of workers in state $i \in \{uc, unc, ec, enc, p\}$ and $\bar{V}_i$ is the average welfare level in state i, expressions for $\bar{V}_i(m)$ can be found in appendix section A.3.

Figure 12: Welfare



The top panel of Figure 12 plots welfare for different levels of the minimum wage. The figure reveals that welfare is maximized at a $5.14 minimum wage, which corresponds to a minimum to median wage ratio of 0.88, see the bottom panel of Figure 12. The welfare maximizing minimum wage is different than the crime minimizing minimum wage because the minimum wage affects aggregate welfare through changes in the unemployment rate, expected wages and crime. Over the range of minimum wages for which crime is decreasing in the minimum wage, an increase in the minimum wage increases welfare through increases in expected wages and decreases in crime and decreases welfare only through increases in the unemployment probability. For larger minimum wages, in the range over which crime is increasing, an increase in the minimum wage increases welfare only through increases in expected wages and decreases welfare by increasing the crime rate and increasing the unemployment probability. The welfare maximizing minimum wage, \$5.14, implies a monthly crime rate of 0.03 crimes per person, 145% higher than minimum crime rate (0.013) that can be reached with changes in the minimum wage.

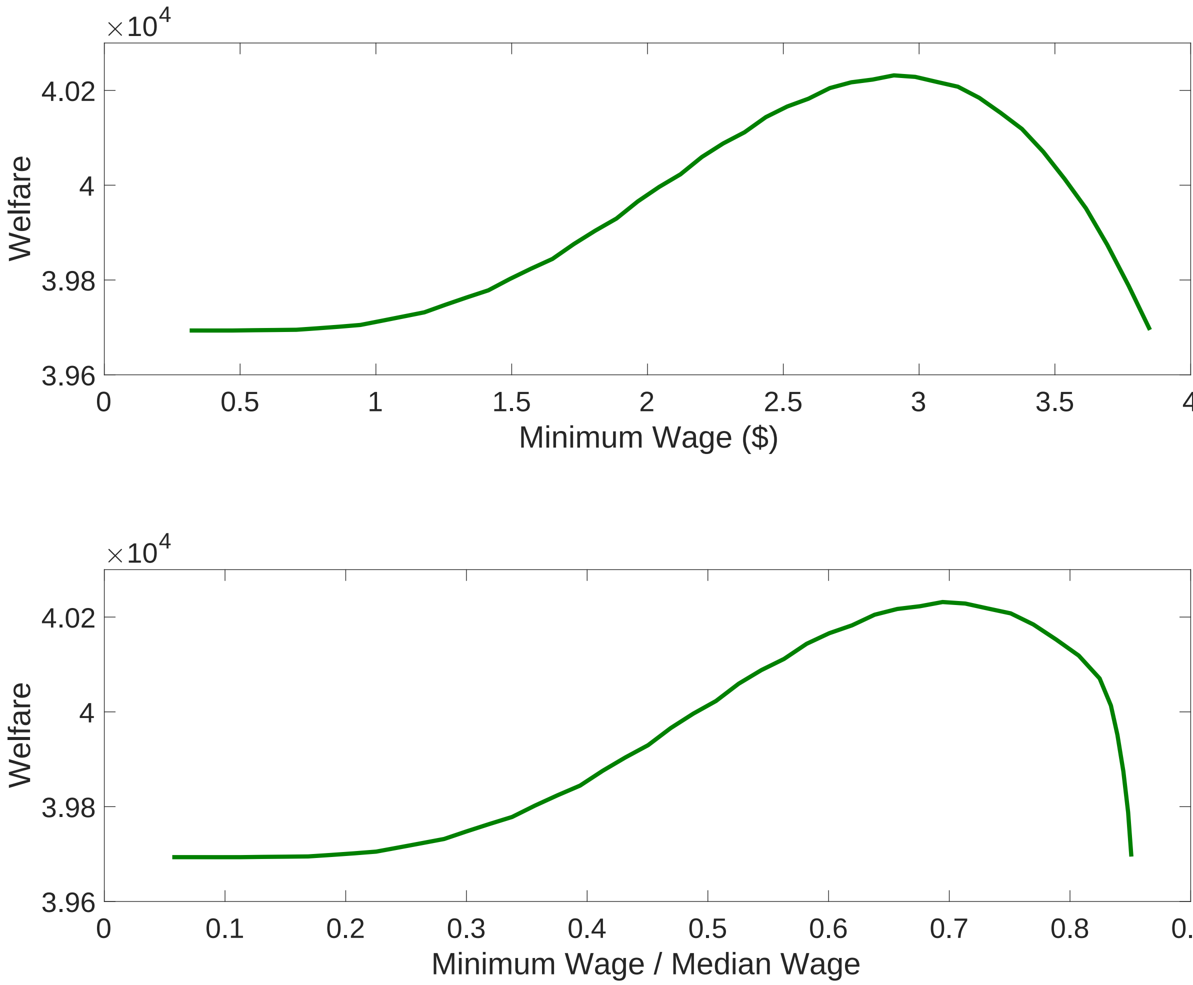
Figure 13 plots the same welfare function for the model without crime ($\mu_e = 0, \mu_u = 0, \chi = 0$)[14]. The welfare maximizing minimum wage in this case is \$3, which corresponds to a minimum to median wage ratio of 0.7. The model does not consider the effect of a minimum wage on crime; therefore, welfare is maximized at a lower minimum wage. In this case, the welfare increases from a decreasing crime rate are ignored. If policy makers ignore the effects of changes in the minimum wage on crime, choosing the welfare maximizing minimum wage, \$3, implies a monthly crime rate of 0.044 crimes per person, 42% higher than when considering the effects of the minimum wage on crime and 246% higher then the minimum crime rate that can be achieved with changes in the minimum wage.

8 Conclusion

The minimum wage has been discussed extensively around the country, leading many states and cities to increases minimum wages by real amounts that we have not seen in the past. The increases are targeted to improve labor market condition primarily for young and unskilled workers; however, increasing the minimum wage may have unforeseen effects on these workers' decisions to commit crimes. I have shown that the relationship between the aggregate crime rate and the minimum wage is U-shaped due to two opposing effects: the wage effect and the unemployment effect. Which effect dominates, and ultimately how the aggregate crime rate will change depends on how much the minimum wage increases. The calibrated model, as well as the empirical evidence from county level crime rates shows that the crime rate is minimized when the minimum wage is 0.91 of the median wage of 16 to 19 year olds. However, the crime minimizing minimum wage is not the welfare maximizing minimum wage, since not only crime effects welfare but all labor market outcomes. The welfare maximizing minimum wage to median wage ratio is 0.88. If policy makers abstract from the effect of a minimum wage on crime, the welfare maximizing minimum to median wage ratio is 0.7, leaving crime 42% higher than

[14]The model without crime was recalibrated to match the unemployment rate, job finding rate, minimum wage to median wage ratio and the median wage to 75th percentile wage ratio. All parameters in Table 2 remain the same. The job destruction rate and parameters of the ability distribution in Table 3 remain the same. The estimated mean and variance of the job productivity distribution, the offer arrival rate, and flow unemployment utility are: $\hat{\mu}_\lambda = 0.8111$, $\hat{\sigma}_\lambda = 0.535$, $\hat{\mu}_j = 3.958$, and $\hat{b} = -28.723$.

Figure 13: Welfare Without Crime



when considering the effects of the wage floor on crime.

The goal of this paper is to establish the relationship between the minimum wage and the crime rate, and quantify the effects. Many cities across the country have recently passed or proposed legislation that moves to increase the minimum wage well above any threshold found in this paper, notably Seattle, New York City and California have moved to push the floor to $15 per hour. These increases would surely lead to minimum to median wage ratios for young and uneducated workers well above not only the welfare maximizing levels, but also the crime minimizing levels. As the discussion about the minimum wage and its effects on the labor market continues, it is my hope that policy makers use the ideas presented in this paper and consider the consequences on crime.

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A Appendix

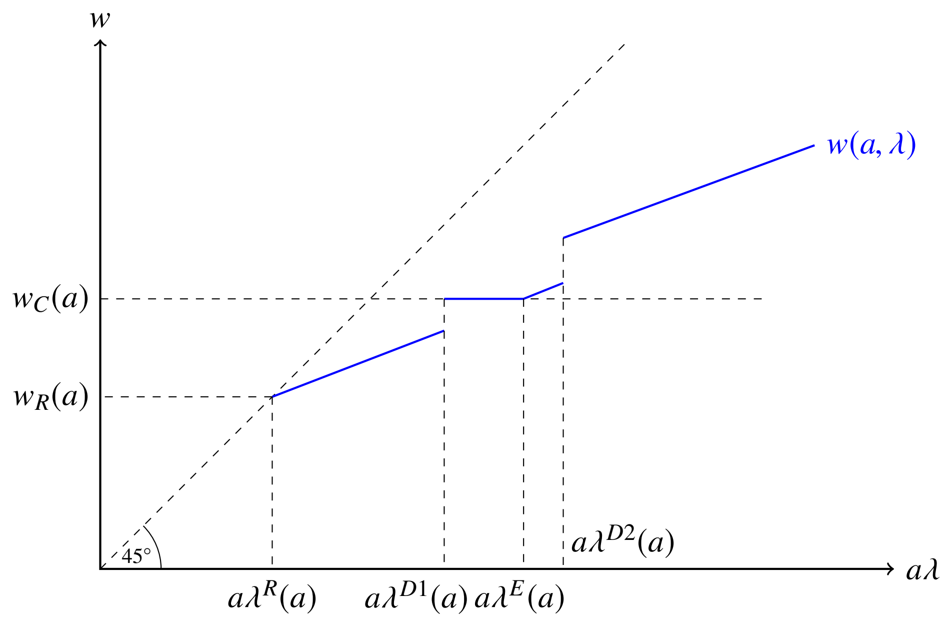
A.1 Wage profile if $(r+\delta)/\mu_e\pi > (1-\beta)/\beta$

If $(r+\delta)/\mu_e\pi > (1-\beta)/\beta$ then there exist some job productivities for which the expected value of the second stage is greater than the crime reservation wage, and for these productivities the worker will not commit crimes when offered the expected value of the second stage. Let $\lambda^E(a)$ be the productivity for which the expected value of the second stage is exactly equal to the crime reservation wage,

$$\lambda^E(a) = \frac{w_C(a) - (1-\beta)w_R(a)}{\beta}. \tag{36}$$

With some algebra one can show that $\lambda^E(a) > \lambda^{D1}(a)$. The firm still faces the same problem as before, should it offer the value of the second stage or the crime reservation wage? The answer is similar to

Figure 14: Wage Profile for Workers with $V_u(a) < V_u(a)^*$



the first case. If the the productivity is below $\lambda^{D1}(a)$, it chooses not to deter and offers the value of the second stage. If the productivity is $\lambda^{D1}(a) \le \lambda < \lambda^E(a)$, it maximizes profits by offering the worker his crime reservation wage, which in turn he will accept and forgo crimes while employed. If the productivity of the job is greater than $\lambda^E(a)$ the expected value of the second stage is greater than the crime reservation wage and the firm must offer the expected value. Again the worker will accept the job and forgo crimes while employed. Putting the pieces together, the full wage profile for the worker is:

$$w(a, \lambda) = \begin{cases} \beta a\lambda + (1-\beta)w_R(a) & \text{if } \lambda^R(a) \le \lambda < \lambda^{D1}(a) \\ w_C(a) & \text{if } \lambda^{D1}(a) \le \lambda < \lambda^E(a) \\ \beta a\lambda + (1-\beta)w_R(a) & \text{if } \lambda^E(a) \le \lambda < \lambda^{D2}(a) \\ \beta a\lambda + (1-\beta)w_C(a) & \text{if } \lambda \ge \lambda^{D2}(a) \end{cases} \tag{37}$$

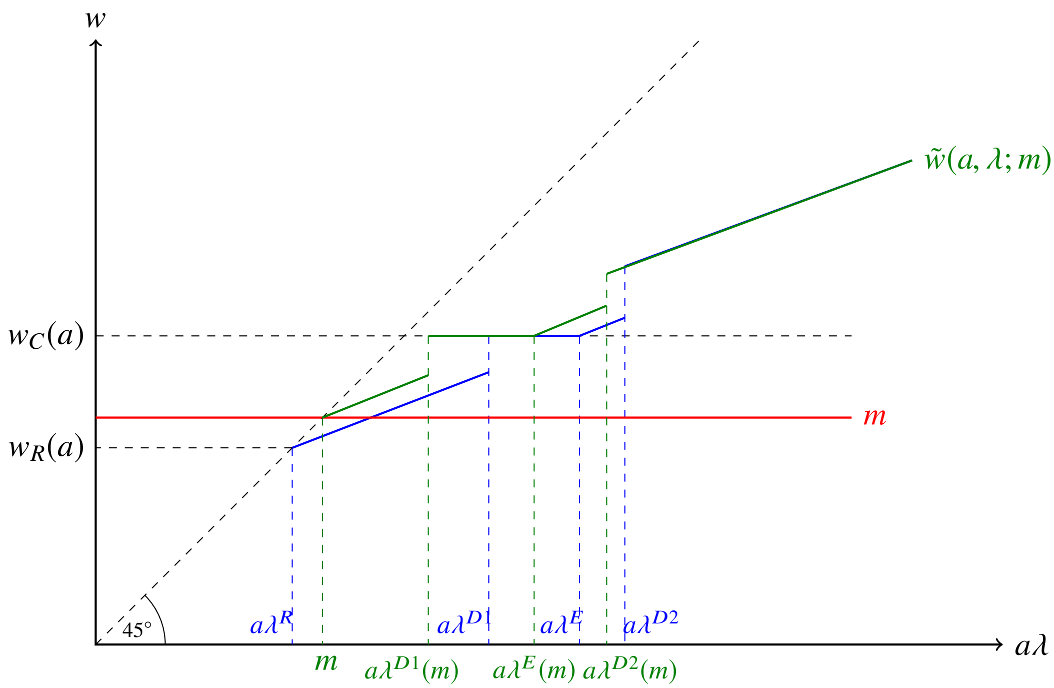
Figure 14 shows the wage profile of a worker with $V_u(a) < V_u(a)^*$.

The solution to the constrained bargaining problem in this case is:

$$w(a, \lambda; m) = \begin{cases} \beta a\lambda + (1-\beta)m & \text{if } m \le \lambda < \lambda^{D1}(a, m) \\ w_C(a) & \text{if } \lambda^{D1}(a, m) \le \lambda < \lambda^E(a, m) \\ \beta a\lambda + (1-\beta)m & \text{if } \lambda^E(a, m) \le \lambda < \lambda^{D2}(a, m) \\ \beta a\lambda + (1-\beta)w_C(a) & \text{if } \lambda \ge \lambda^{D2}(a, m) \end{cases} \tag{38}$$

where $\lambda^E(a, m)$ is the productivity at which the expected value of the second stage is equal to the crime

Figure 15: Wage Profile for Constrained Workers with $V_u(a) < V_u(a)^*$



reservation wage.

$$\lambda^E(a, m) = \frac{w_C(a) - (1-\beta)m}{\beta} \tag{39}$$

Figure 15 shows the wage profile under the constrained game. Again $\frac{\partial \lambda^{D1}(a,m)}{\partial m} < 0$ and therefore the minimum wage compresses the wage distribution from the bottom. The effects of a binding minimum wage in this case are:

Proposition A.1. *If $(r+\delta)/\mu_e\pi\ (1-\beta)/\beta$ and $m < w_C(a)$ then*

i. $\frac{\partial \lambda^{D1}(a,m)}{\partial m} < 0$

ii. $\frac{\partial \lambda^{E}(a,m)}{\partial m} < 0$

iii. $\left|\frac{\partial \lambda^{D1}(a,m)}{\partial m}\right| > \left|\frac{\partial \lambda^{E}(a,m)}{\partial m}\right|$

iv. $\tilde{w}(a, \lambda; m) \geq w(a, \lambda)$ *for all* $m \leq \lambda < \lambda^{D2}(a)$

A.2 Steady State Distributions

Equating the flows from Figure 4 gives the following steady state distributions:

$$u(a) = \begin{cases} \dfrac{\delta\gamma(\mu_e\pi + \delta)}{\Omega(a)} & \text{if } a < a^* \\ \dfrac{\delta}{\mu_j B(a) + \delta} & \text{if } b \geq b^* \end{cases} \tag{40}$$

$$e_{nc}(a) = \begin{cases} \dfrac{\mu_j A(a)\gamma(\mu_e\pi + \delta)}{\Omega(a)} & \text{if } a < a^* \\ \dfrac{\mu_j B(a)}{\mu_j B(a) + \delta} & \text{if } a \geq a^* \end{cases} \tag{41}$$

$$e_c(a) = \begin{cases} \dfrac{\delta\gamma\mu_j D(a)}{\Omega(a)} & \text{if } a < a^* \\ 0 & \text{if } a \geq a^* \end{cases} \tag{42}$$

$$p(a) = \begin{cases} \dfrac{\delta\pi[\mu_u(\mu_e\pi + \delta) + \mu_e\mu_j D(a)]}{\Omega(a)} & \text{if } a < a^* \\ 0 & \text{if } a \geq a^* \end{cases} \tag{43}$$

where $\Omega(a) = (\mu_e\pi + \delta)[\delta(\mu_u\pi + \gamma) + \gamma\mu_j A(a)] + \delta\mu_j D(a)(\mu_u\pi + \gamma)$.

A.3 Welfare

The average values $\bar{V}_i$ for $i \in \{uc, unc, ec, enc, p\}$ are defined as:

$$\bar{V}_{uc} = \int^{a^*} V_(a)\frac{dF(a)}{F(a^*)} \tag{44}$$

$$\bar{V}_{unc} = \int_{a^*} V_u(a)\frac{dF(a)}{1 - F(a^*)} \tag{45}$$

$$\bar{V}_p = \int^{a^*} V_p(a)\frac{dF(a)}{F(a^*)} \tag{46}$$

$$\bar{V}_{ec} = \int^{a^*} E_\lambda\big[V_e(a,\lambda)|\phi_e(a,\lambda = 1)\big]\frac{dF(a)}{F(a^*)} \tag{47}$$

$$\bar{V}_{enc} = \int^{a^*} E_\lambda\big[V_e(a,\lambda)|\phi_e(a,\lambda = 0)\big]dF(a) + \int_{a^*} E_\lambda\big[V_e(a,\lambda)\big]dF(a) \tag{48}$$

A.4 Data

A.4.1 National Longitudinal Survey of Youth 1997

The sample is restricted to individuals who are between the ages of 16 and 19 in 1998. Employment status in the NLSY97 is reported in weekly arrays; employment status consists of an employer ID if employed and one of several categories, including unemployed, if not associated with an employer. First employment status is recoded to equal 1 if associated with an employer in a given week and 0 if unemployed, all other categories are coded as NA's. Weekly employment status is aggregated to a monthly status by taking the mean employment status over the month. Labor force participation status for 1998 is calculated as the sum of months that an individual is either working or unemployed. Individuals with labor force participations of less than 6 months are dropped from the sample.

Individuals report usual weekly hours and an hourly wage for up to nine jobs worked between interview periods. Usual weekly hours from only the first job are used to calculate the average weekly hours worked in the sample. Average hourly wage for each individual is calculated as the weighted average of hourly wages reported for each job; the weights are the fraction of hours worked at each job. Individuals with an average hourly wage less than the minimum wage in 1998, \$5.15, are dropped from the sample.

At each interview, individuals are asked if they have committed a crime since their last interview; specifically, they are asked if they have stolen something worth more than \$50 or have committed any other property crime such fencing, receiving, possessing or selling stolen property, and if so, how many times. The responses to the frequency of crime are top coded at 99. Nine top coded individuals are dropped from the sample, corresponding to about 0.1% of the sample. The aggregate yearly crime rate for the sample is constructed as the sum of all times individuals stole more the \$50 and committed other property crimes divided by the number of individuals in the final sample $(2,356)$. The monthly crime rate is the yearly crime rate divided by 12.

The job finding rate is calculated as the average number of transitions from unemployment to employment, without exiting the labor force in any two consecutive months over all individuals over the 12 months in 1998. Similarly the job destruction rate is calculated as the average number of transitions from employment to unemployment in any two consecutive months over all individuals and months in 1998.

During round 1, individuals participated in the administration of the computer-adaptive form of the Armed Services Vocational Aptitude Battery (CAT-ASVAB) which measures the respondents ability in 12 categories: arithmetic reasoning, electronics information, numerical operations, assembling objects, general science paragraph comprehension, auto information, mathematics knowledge, shop information, coding speed, mechanical comprehension, and word knowledge. An aggregated measure of ability is constructed for each individual as the sum of their scores in the arithmetic reasoning, paragraph comprehension and word knowledge categories. Sampling weights are used in all calculations.

A.4.2 Uniform Crime Reports

The county level data from the Uniform Crime Reports come from the National Archive of Criminal Justice Data[15]. The data include counts of arrests and offenses of Part I offenses (murder, rape, robbery, assault, burglary, larceny, auto theft, and arson) and Part II offenses (forgery, fraud, embezzlement, vandalism, weapons violations, sex offenses, drug and alcohol abuse violations, gambling, vagrancy, curfew violations, and runaways) at the county level. The crime rate for each county is calculated as the number of offenses for each category in each county divided by the population of each county divided by $100,000$. The property crime rate in each county is calculated as the sum of all burglaries, larcenies and motor vehicle thefts divided by the population, divided by $100,000$.

A.4.3 County Demographics and Minimum to Median Wage Ratios

The county level demographic data come from the Survey of Epidemiology and End Results (SEER) that provides estimates of the total population, and estimates of the population by 19 age groups, sex and 3 race groups - white, black and other. The age groups are aggregate to 6 groups: 0 to 14, 15 to 24, 25 to 39, 40 to 59, 60 to 79 and 80 plus. Data on the poverty rate and average household income of each county come from the Census' Small Area Income and Poverty Estimates.

The minimum to median wage ratios are calculated at the state level using data from the Current Populations Outgoing Rotation Groups from 1995 to 2014. The data come from the National Bureau of Economic Research[16]. The sample is restricted to individuals between the ages of 16 and 19. The hourly wages are calculated as reported hourly wage for hourly wage workers and weekly wages divided by usual hours worked per week for individuals who report not working as hourly wage workers. The binding minimum wage in each state in each year is calculated as the maximum of the state and federal minimum wage.

[15]U.S. Dept. of Justice, Federal Bureau of Investigation. UNIFORM CRIME REPORTING PROGRAM DATA [UNITED STATES]: COUNTY-LEVEL DETAILED ARREST AND OFFENSE DATA, 1995-2014. ICPSR ed. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [producer and distributor].

[16]http://www.nber.org/cps/

A.5 Simulations

A.5.1 Panel Data Set

This data set is constructed by simulating data for 1,000 “individuals" at each unique realization of the real binding minimum wage. The real binding minimum wage is the maximum of the state and federal minimum wage in 1998 dollars; from 1990 to 2011 there were 204 unique levels of the real binding minimum wage across states in the US. An individual in this simulation consists of a single draw from the estimated ability distribution, $F(\hat{\mu}_a, \hat{\sigma}_a)$.

For each of the 204 minimum wages, the probability of unemployment, employment and prison for each worker is calculated. To simulate the workers expected wage, 50 realizations from the estimated productivity distribution, $G(\hat{\mu}_\lambda, \hat{\sigma}_\lambda)$, are drawn. For each realization the wage is calculated and the expected wage for each individual at each minimum wage is calculated as the mean wage across realizations of job productivities. This process produces the final data set which includes an expected wage and unemployment probability for each of the 1,000 individuals at each unique minimum wage.

A.5.2 Aggregate Data Set

The aggregate data set consists of observations of the average unemployment probability and average expected wage of all individuals in the economy. The aggregate economy consists of 1,000 individuals and is simulated at every observed real binding minimum wage from 1990 to 2011; there were 1,122 observed real binding minimum wages, 50 states and Washington D.C. times 22 years. For each minimum wage, 1,000 individuals are drawn from the estimated ability distribution, $F(\hat{\mu}_\lambda, \hat{\sigma}_\lambda)$. For each individual, the probability of unemployment and expected wage are calculated. The expected wage for each individual is calculated as the average wage resulting from 100 draws from the estimated job productivity distribution. The aggregate unemployment probability and aggregate expected wage is calculated as the weighed average across individuals; the weights are the estimated probability of observing each type of individual, $f(a|\hat{\mu}_\lambda, \hat{\sigma}_\lambda)$.