

## University of Chicago Legal Forum

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Volume 2017

Article 6

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2018

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### Recommended Citation

Fernández-Villaverde, Jesús (2018) "The Economic Consequences of Labor Market Regulations," *University of Chicago Legal Forum*: Vol. 2017, Article 6.

Available at: <https://chicagounbound.uchicago.edu/uclf/vol2017/iss1/6>

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# The Economic Consequences of Labor Market Regulations

*Jesús Fernández-Villaverde*<sup>†</sup>

## ABSTRACT

*What do we know about the economic consequences of labor market regulations? Few economic policy questions are as contentious as labor market regulations. The effects of minimum wages, collective bargaining provisions, and hiring/firing restrictions generate heated debates in the U.S. and other advanced economies. And yet, establishing empirical lessons about the consequences of these regulations is surprisingly difficult. In this paper, I explain some of the reasons why this is the case, and I critically review the recent findings regarding the effects of minimum wages on employment. Contrary to often asserted statements, the preponderance of the evidence still points toward a negative impact of permanently high minimum wages.*

## I. INTRODUCTION

The labor market is a central institution in any modern economy. This market allocates workers to jobs. If the labor market operates satisfactorily, workers will find employment at the right speed, and these positions will be appropriate to their experience and skill. If the market does not function properly, willing workers will remain unemployed for too long, vacancies will stay unfilled, and many workers will occupy positions that are unsuited for them. Moreover, firms will not appear, grow, or close at the optimal rate.

At the same time, the labor market is characterized by pervasive regulation.<sup>1</sup> Across nations, the labor market is subject to minimum

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<sup>1</sup> See, e.g., Andrew J. Seltzer, *The Effects of the Fair Labor Standards Act of 1938 on the Southern Seamless Hosiery and Lumber Industries*, 57 J. ECON. HIST. 396, 396–415 (1997) (discussing the implementation of the Federal minimum wage via the Fair Labor Standards Act and the resulting impact on Southern industries); see also John Haltiwanger, *Top Ten Signs of Declining Business Dynamism and Entrepreneurship in the U.S.* 9 (Aug. 2015), [http://econweb.umd.edu/~haltiwan/Haltiwanger\\_Kauffman\\_Conference\\_August\\_1\\_2015.pdf](http://econweb.umd.edu/~haltiwan/Haltiwanger_Kauffman_Conference_August_1_2015.pdf) [<https://perma>.

wages, hiring and firing restrictions, compulsory collective bargaining and arbitration, limitations on the number of hours, anti-discrimination clauses, curtailments on work by age, and (mostly in the past) by gender. Some of these regulations, such as well-designed unemployment insurance,<sup>2</sup> improve the behavior of the market. As a society, we want workers to search for a sufficiently lengthy period for a job corresponding to their skills, instead of accepting the first job offer they get, as could be the case if workers did not have any insurance and lacked savings.<sup>3</sup>

But there are also other regulations, such as excessive firing costs or restrictive collective bargaining rules, that lower economic performance.<sup>4</sup> Unfortunately, many of these harmful regulations are adopted, ignoring what economists have learned about how the labor market works (and economists' vocal opposition to them). Whether this is due to political-economic pressures (i.e., politically powerful groups can gain from these regulations what they could not obtain in a free market) or to a misunderstanding of economics is irrelevant to my argument. Bad regulations hurt workers and firms and lower welfare. Southern European countries are the poster children of these maladies. My own native Spain, for example, has endured fifty-five quarters of unemployment above 20% since 1980 and the unemployment rate has fallen below 8% only for one quarter (2007.Q2, at 7.93%), despite two vigorous economic expansions.<sup>5</sup>

If costly labor market regulations were limited to Mediterranean countries, one could dismiss them as universal justice getting even with countries blessed with lovely weather, natural beauty, and civilized food. In fact, this is implicitly the response of many defenders of regulations in Southern Europe: unemployment just happens, and labor

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cc/5FS4-9K2G] (written for the Kauffman Foundation New Entrepreneurial Growth Conf.) (stating that regulations may create barriers for firms and workers acclimating to economic changes, and analogizing the subsequent friction to "death by a thousand cuts").

<sup>2</sup> See Daron Acemoglu & Robert Shimer, *Efficient Unemployment Insurance*, 107 J. POL. ECON. 893, 894 (1999) (arguing that moderate levels of unemployment insurance produce optimal levels of labor search efforts).

<sup>3</sup> See *id.* (A more generous unemployment insurance also lowers the intensity of job search. A wise policymaker must balance this lower search effort against the benefits of better employment matches.)

<sup>4</sup> See Charles Brown, *Minimum Wages, Employment, and the Distribution of Income*, in 3 HANDBOOK OF LABOR ECONOMICS 2101, 2101–63 (Orley Ashenfelter & David Card eds., 1st ed. 1999) (describing how voluntary turnover can help mitigate some of the high costs of firing); see also Daniel Aaronson, et al., *Industry Dynamics and the Minimum Wage: A Putty-Clay Approach*, 58 INT'L ECON. REV. (forthcoming 2017) (arguing that putty-clay models change our assessment of the effects of firing costs, labor market policies, and taxes).

<sup>5</sup> *Economically Active Population Survey*, INSTITUTO NACIONAL DE ESTADÍSTICA, [http://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica\\_C&cid=1254736176918&menu=resultados&secc=1254736195129&idp=1254735976595](http://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176918&menu=resultados&secc=1254736195129&idp=1254735976595) [<https://perma.cc/774K-WAEP>].

law does not have anything to do with it.<sup>6</sup> Disappointingly, perverse labor market regulations can be found everywhere. Even more worrisome are the growing signs in the U.S. that the labor market is performing worse than in the past, a situation that has large potential consequences for productivity growth and welfare.<sup>7</sup> The effects, in the long-run, of even small reductions in the trend of productivity growth are so severe that they deserve careful examination and, if possible, immediate corrective action. In comparison, slightly better or worse fiscal and monetary policies, and the feed of daily media discussion, are much less consequential for aggregate welfare.<sup>8</sup>

In this paper, I will start by analyzing data from the U.S. labor market (Section 2) and outlining a few implications from the evidence (Section 3). Next, I will use changes in the minimum wage as a case study of what we know about the effects of labor market regulations. In that way, I will explain how economists have looked at the empirical evidence (Section 4), the problems of this evidence (Section 5). I will conclude with why these problems still suggest a negative assessment of “fight for \$15” and some final brief remarks (Section 6).

## II. FIRST, SOME DATA

A starting point to study the U.S. labor market is two datasets elaborated by the U.S. Bureau of Labor Statistics. The first dataset is the Business Employment Dynamics (BED), which reports quarterly series of gross job gains and gross job losses by establishments since 1992 for the entire economy (with a few minor exceptions).<sup>9</sup> An establishment is an economic unit, typically at one location (e.g., the Chicago office of a law firm).<sup>10</sup> The firm is a collection of one or more establishments (e.g., the Chicago and the New York offices of a law

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<sup>6</sup> It is tragicomic to read the remembrances of one Spanish economist, Juan Francisco Jimeno, who has been involved for decades in trying (and failing) to convince politicians, trade unionists, and labor law professors that counterproductive labor protections were behind the Spanish labor market’s dysfunctionality. See JUAN FRANCISCO JIMENO, *CRECIMIENTO Y EMPLEO* (2016).

<sup>7</sup> Haltiwanger, *supra* note 1, at 1 (noting flexibility is imperative to economic growth, and acknowledging that “declines in dynamism and fluidity” have adverse effects on economic growth).

<sup>8</sup> Robert E. Lucas, Jr., *Macroeconomic Priorities*, 93 AM. ECON. REV. 1, 11 (2003) (concluding fiscal and monetary policies have an impact on welfare, but general stabilization attempts through such policies are far inferior to “supply-side fiscal reforms”).

<sup>9</sup> *Business Employment Dynamics*, U.S. DEP’T LAB., BUREAU OF LAB. STAT., <https://www.bls.gov/bdm/> [<https://perma.cc/35CU-7PLL>].

<sup>10</sup> See *Quarterly Census of Employment and Wages: Frequently Asked Questions*, U.S. DEP’T LAB., BUREAU OF LAB. STAT. (Dec. 16, 2016), <https://www.bls.gov/cew/cewfaq.htm> [<https://perma.cc/3JQF-TR2B>].

firm).<sup>11</sup> The changes in establishment employment are measured from the third month of each quarter.

The second dataset is the Job Openings and Labor Turnover Survey (JOLTS), a monthly representative sample of around 16,000 U.S. business establishments, which measures hires, separations, and job openings.<sup>12</sup> In this survey, hires and separations are collected for the entire calendar month and employment at the end of the month.

The main difference between these two datasets is their focus. BED measures job flows: job creation by opening and expanding establishments and job destruction by closing and contracting establishments.<sup>13</sup> Let us go back to the office of a law firm as an example of an establishment. If the firm employs ten persons in the third month of Q1 and twelve in the third month of Q2, the job creation rate in quarter two would be 18.2%. If, in the third month of Q3, the firm employs eleven persons, the job destruction rate in Q3 would be 8.7%. However, the employees that are employed throughout these quarters may be different persons. In comparison, JOLTS measures worker flows: hires, layoffs, quits, and job openings.<sup>14</sup> Often, layoffs and quits are grouped as separations, since ascertaining whether these separations were voluntary can be difficult. (For example, was a quit a few days before a foreseen layoff voluntary?) An establishment with no job creation/destruction can experience hires, layoffs, and quits. Similarly, an establishment with job creation can have separations and an establishment with job destruction can have hires.

Both BED and JOLTS are collected at the establishment level, not at the firm level. This choice avoids dealing with legal issues regarding corporate forms. Furthermore, establishments reflect better than firms the underlying structure of economic activity and the changes to resource allocation over time. A disadvantage of these data is that we do not know the extent of reallocation within the establishment. For example, if a paralegal completes law school at night, passes her bar exam, and becomes an associate, but within the same law office, even if her job may have changed dramatically, she will not be counted either

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<sup>11</sup> The Bureau of Labor Statistics states: “An establishment is commonly understood as a single economic unit, such as a farm, a mine, a factory, or a store, that produces goods or services. Establishments are typically at one physical location and engaged in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. A firm, or a company, is a business and may consist of one or more establishments, where each establishment may participate in different predominant economic activity.” *Id.*

<sup>12</sup> *Job Openings and Labor Turnover Survey: JOLTS Overview*, U.S. DEP’T LAB., BUREAU OF LAB. STAT. (July 14, 2014), <https://www.bls.gov/jlt/jltover.htm> [<https://perma.cc/2ECE-6DAW>] [hereinafter *JOLTS Overview*].

<sup>13</sup> See *Business Employment Dynamics*, *supra* note 9.

<sup>14</sup> See *JOLTS Overview*, *supra* note 12.

as a job or a worker flow. Many economists suspect that internal reallocation is a central mechanism of the labor market and key for firms' growth.<sup>15</sup>

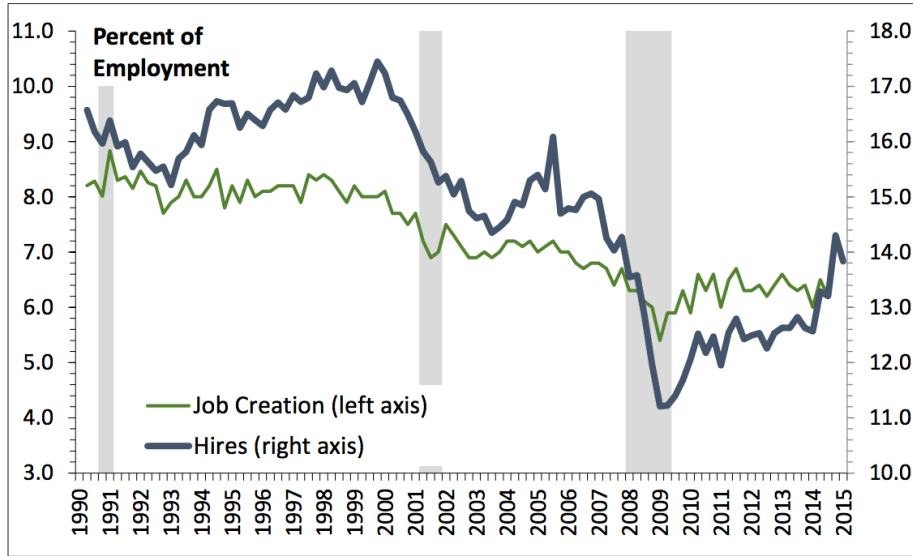


Figure 1: Hires and job creation for U.S. private non-farm, quarterly<sup>16</sup>

We can plot the information from BED and JOLTS to gain a quick sense of the behavior of the U.S. labor market. In Figure 1, Professor Haltiwanger plots the job creation rate of the U.S. economy (total job creation divided by total employment) and hires (total hires divided by total employment), with shaded areas representing economic recessions in the U.S. as defined by the NBER (the conventional source for such dating). Job creation fluctuated around 8% during the 1990s and declined during the 2000s until 2009, when it reached a minimum below 6% and started growing again, but without returning to the same levels as at the beginning of the sample. Note how, even at the bottom of the financial crisis, job creation was still considerable. When BED data were first made available in the 1990s, economists were surprised by the stability of job creation over recessions. Hires were always higher, with peaks of nearly 18% and troughs of around 11%. Again, we saw a long-term decline in the hiring rate (even sharper than the one in the job creation rate) that the current expansion has partially reversed.

<sup>15</sup> Haltiwanger, *supra* note 1, at 1, 8 (implying “that there should be a rise in dynamism as there are increased incentives for reallocation”).

<sup>16</sup> *Id.* at 20.

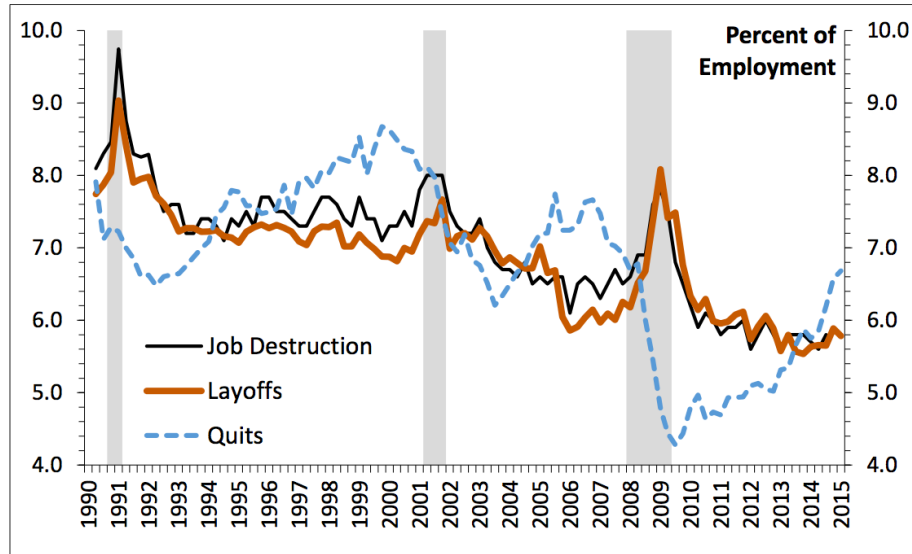


Figure 2: Layoffs, quits and job destruction for U.S. private non-farm, quarterly, 1990.Q2–2015.Q1.<sup>17</sup>

In Figure 2, Professor Haltiwanger plots the job destruction rate of the U.S. economy (total job destruction divided by total employment), layoffs (total layoffs divided by total employment), and quits (total quits divided by total employment). We see, first, that the U.S. economy is a net creator of jobs over time: job destruction is nearly always below job creation, except during the financial crisis and its immediate aftermath (2007.Q4–2010.Q1). Second, job destruction and layoffs are roughly constant during expansions (although, as with job destruction, with a negative trend over time), but they peak during recessions, in particular in 1992 and 2008–2009. Unemployment grows in recessions primarily not because fewer jobs are created, but because more jobs are destroyed. Finally, quits are strongly countercyclical: workers leave their jobs during the late phase of expansions (1996–2000, 2005–2007), but they are reluctant to do so during a recession (note the huge drop between 2007 and 2010). Over time, layoffs and separations have a similar mean, roughly doubling—when added together—the rate of job destruction.

<sup>17</sup> *Id.* at 21.

## III. SOME IMPLICATIONS OF THE FACTS

The previous section presented basic facts about turnover in the U.S. labor market. However, these findings were expressed in units (percentages of employment) that may say little to many readers.

Let me, thus, recast the data in a more salient form. In 2016.Q1, the most recent vintage of data as of December 2016, the job destruction rate in the private sector was 5.7%, in line with previous quarters.<sup>18</sup> This 5.7% corresponds, given the around 121 million employees of the U.S. private sector, to 6.78 million destroyed private jobs (seasonally adjusted). There are around 500 regular business hours in a quarter.<sup>19</sup> If we divide 6.78 million jobs by 500 hours, we get that 13,566 jobs are destroyed per regular business hour or around 226 jobs per minute. Even accounting for longer hours per quarter of substantial economic activity, the amount of job creation and destruction that the U.S. economy seems to require in every minute it operates even in good times is staggering.

The total number of separations is even more impressive. There were 15.23 million separations in 2016.Q1 (also seasonally adjusted) in the non-farm sector. Repeating the same calculation as before, we get around 508 separations per minute. In less time than it took you to read this page, 508 workers in the U.S. private sector have abandoned the establishment where they used to work. The numbers for job creation and hires are slightly higher since, in 2016.Q1, the U.S. private sector added 197,000 net jobs. And, because of data limitations, we are not accounting for reallocations of jobs within a given establishment.

The U.S. labor market is a complex system. Its emerging properties are the product of thousands of decisions made every minute about what, how, and where to produce, whom to hire, fire, or promote, how to supervise, compensate, or penalize workers, and plenty of other considerations.

Our understanding of how this market works is extremely limited. Even our statistical sources are quite scarce.<sup>20</sup> BED and JOLTS,

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<sup>18</sup> *Business Employment Dynamics*, supra note 9.

<sup>19</sup> There are 62.5 business days on average per quarter. If we multiply those by 8 hours per day, we get 500 hours. Seasonal adjustment takes care of the different number of business days across quarters of the year.

<sup>20</sup> See, e.g., Friedrich August von Hayek, *The Pretence of Knowledge*, 79 AM. ECON. REV. 3, 4 (1989) (discussing how researchers can determine what conditions might create a market equilibrium, but that econometric methods cannot show how the “prevailing prices and wages deviate from those which would secure a continuous sale of the current supply of labour”); see also Charles Brown, et al., *The Effect of the Minimum Wage on Employment and Unemployment*, 20 J. ECON. LIT. 487, 500 (1982) (recognizing the difficulties in statistically separating the effects of minimum wage increases and coverage extensions).



valuable as they are, only scratch the surface of what we would like to document. For example, and as I already mentioned, we have little information about job reallocation within firms, about on-the-job training, or about how workers allocate their time on the job, such as how much time an average manager spend supervising subordinates vs. meeting with clients. We know, however, that the economy requires colossal amounts of resource reallocation per quarter. The fact that such reallocation is slowing down (as shown by the decreasing trends of job creation and job destruction in Figure 1 and Figure 2) precisely at the time when labor productivity is growing at a crawl suggests a link between the former and the latter. Less reallocation limits the economy's ability to take advantage of new technologies and opportunities.<sup>21</sup>

Given our poor understanding of how the labor market operates, prudence dictates extreme care before changing the rules that govern it. Furthermore, one must be concerned about the regulatory innovations introduced during the last two decades (plus the uncertainty associated with their vagueness and often changing interpretation by administrative agencies). More (and more uncertain) regulations are usually associated with less reallocation in markets. Regulations tend to make it costlier to switch jobs or to create openings (for example, due to higher compliance costs). Greater uncertainty induces what economists call "precautionary behavior," which in this case manifests itself as a bias toward the status quo. The pretense of knowledge, the seductive yet ultimately treacherous tempter of social scientists, is peculiarly dangerous in this area.<sup>22</sup>

As we will see in the next sections, the minimum wage offers a splendid example of the unintended consequences of well-meaning, but ill-informed regulation of a complex system.

#### IV. A CHANGING VIEW?

The traditional view among economists of the effect of minimum wages is simple. The market for labor (more properly, for a specific type of labor at a particular location, such as low-skill workers in Chicago's downtown) is characterized by a supply function for labor and a demand

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<sup>21</sup> Real output per hour in the non-farm business sector as computed by the Bureau of Labor Statistics increased 3.6% in the 5 years between 2011.Q3 and 2016.Q3, an annualized rate of 0.72% a year. Between 1947.Q1 and 2011.Q3, the annual rate was 2.24% a year. At the 1947.Q1/2011.Q3 rate, labor productivity doubles every 31 years. At the 2011.Q3/2016.Q3 rate, labor productivity doubles every 97 years.

<sup>22</sup> Hayek, *supra* note 20, at 3 (stating that economists attempt to imitate successful physical sciences, but the aspects for which economists "can get quantitative data are necessarily limited and may not include the important ones").

function for labor (see Figure 3).<sup>23</sup> The supply function increases with wages: a higher wage induces more persons into the labor force and those who are already employed to work more hours. The demand function falls with wages: as wages rise, firms use less labor—perhaps using more or newer machines, scaling back operations and only doing more profitable projects or closing less profitable locations, offshoring, or, in the case of the minimum wage, substituting to higher-priced but more productive workers. The supply and demand function intersects at a wage,  $w$ , that clears the market at level  $q$ .

A legally imposed minimum wage,  $w_m$ , above  $w$ , prevents the market from clearing: supply,  $q_s$ , is too high and demand,  $q_d$ , too low. Instead, the market clears on the short side. In other words, the amount of labor transacted in the market is demand-determined:

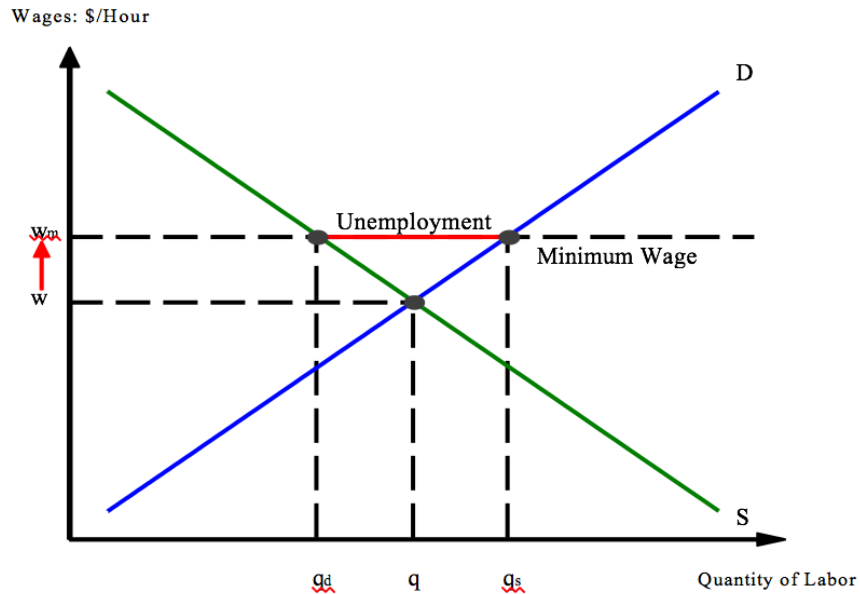


Figure 3: Labor market and effects of the minimum wage<sup>24</sup>

Unemployment is equal to the difference between demand,  $q_d$ , and supply,  $q_s$ . The higher the minimum wage,  $w_m$ , the higher the level of unemployment. The size of the gap between demand and supply will depend on the elasticities of each side of the market.

<sup>23</sup> The market for labor described here is a streamlined textbook representation. Models used in research are more nuanced. More concretely, these models emphasize the search and matching problem at the core of the pairing of workers and firms. For a review of labor economics, see PIERRE CAHUC & ANDRÉ ZYLBERBERG, *LABOR ECONOMICS* 718–19 (2004).

<sup>24</sup> See Brown, *supra* note 4 at 2104; see also Brown et al., *supra* note 20, at 488.

This traditional view, taught to generations of undergraduates, was supported by a large body of empirical research summarized by Brown, Gilroy, and Kohen,<sup>25</sup> who concluded: “On balance, a 10% increase in the minimum wage is estimated to result in about a 1–3% reduction in total teenage employment.”<sup>26</sup>

This core understanding of how the labor market works was shaken by the publication of Card and Krueger (1994)<sup>27</sup> and, one year later, by a companion book, *Myth and Measurement* (Card and Krueger 1995),<sup>28</sup> to wide praise.

Card and Krueger were interested in quantifying the effects of the minimum wage on employment.<sup>29</sup> With that goal in mind, they laid down a transparent research design that took advantage of a “quasi-natural experiment.” On April 1, 1992, New Jersey increased the minimum hourly wage from \$4.25 to \$5.05. Pennsylvania, in contrast, kept the minimum wage at \$4.25.<sup>30</sup>

Exploiting this sudden difference in minimum wages between two regions, New Jersey and Eastern Pennsylvania, that share a common socio-economic environment, Card and Krueger surveyed by phone the employment levels, ten months later, of 410 fast-food restaurants in the area and compared them with the employment levels before the change in New Jersey’s legislation. The map in Figure 4, reproduced from Card and Krueger 1995,<sup>31</sup> plots the location of the surveyed restaurants.<sup>32</sup>

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<sup>25</sup> Brown et al., *supra* note 20, at 488.

<sup>26</sup> *Id.* at 505.

<sup>27</sup> David Card & Alan B. Krueger, *Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania*, 84 AM. ECON. REV. 772 (1994).

<sup>28</sup> DAVID CARD & ALAN B. KRUEGER, *MYTH AND MEASUREMENT: THE NEW ECONOMICS OF THE MINIMUM WAGE* (1995).

<sup>29</sup> Card & Krueger, *supra* note 27, at 773.

<sup>30</sup> *Id.* at 772.

<sup>31</sup> CARD & KRUEGER, *supra* note 28, at 28.

<sup>32</sup> A total of 473 restaurants were sampled and replies were obtained from 410 of them, 331 in New Jersey and 79 in Pennsylvania. Card & Krueger, *supra* note 27, at 774. Note that for the research design to be informative, we do not need a full equivalence of initial conditions between New Jersey and Pennsylvania, just that the changes both regions experienced during the subsequent ten months (business cycle effects, demographic variations, etc.) were roughly equivalent. This requirement is called the parallel trend assumption. See Alberto Abadie, *Semiparametric Difference-in-Differences Estimators*, 72 REV. ECON. STUD. 1, 1–2 (2005) (explaining the parallel trend assumption as a concept in which “the conventional [difference-in-differences] estimator requires that in absence of the treatment, the average outcomes for treated and controls would have followed parallel paths over time”).

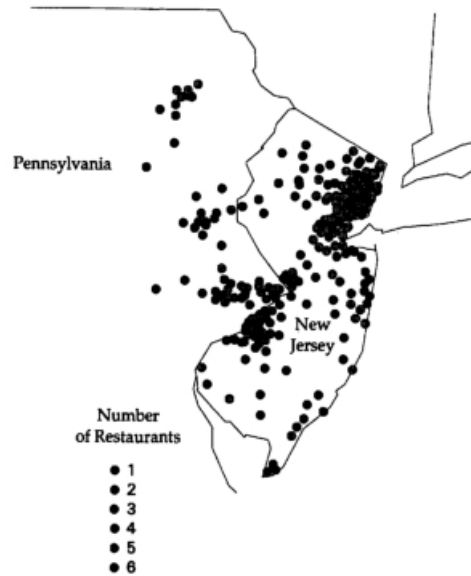


Figure 4: Labor market and effects of the minimum wage

This technique of comparing the evolution of a variable of interest is known as difference in differences (DID).<sup>33</sup> Two groups are observed in two moments in time. One is the “control” group (here, the Pennsylvania restaurants) and the second is the “treatment” group (here, the New Jersey restaurants). The treatment group is exposed to the treatment in the second moment (the higher hourly minimum wage), but not in the first. The control group is not exposed to the treatment in either moment. By comparing the changes in the treatment and the control group over time, we can measure the causal effect of the treatment even if there were additional trends over time unrelated to the treatment.

To most economists’ surprise, Card and Krueger documented a relative increase in employment in New Jersey of 2.76 full-time equivalent (FTE) employees per restaurant.<sup>34</sup> In fact, there was even an absolute increase in employment in New Jersey and a drop in Pennsylvania.<sup>35</sup> While, employment at the restaurants Card and Krueger surveyed in New Jersey went from 20.44 FTE employees per restaurant to 21.03, in Pennsylvania, it fell from 23.33 to 21.17.<sup>36</sup> Card

<sup>33</sup> Abadie, *supra* note 32, at 1 (defining difference-in-differences as “the treatment, an untreated comparison group can be used to identify temporal variation in the outcome that is not due to treatment exposure”).

<sup>34</sup> CARD & KRUEGER, *supra* note 28, at 33.

<sup>35</sup> *Id.* at 34.

<sup>36</sup> *Id.*

and Krueger (1995) conjectured that the result could be due to the monopsony position of the firm.<sup>37</sup> If the firm has market power recruiting workers, it might want to pay them a higher wage to fill its vacancies more quickly. However, if the firm pays more to new recruits, it will be hard for it not to also raise the wage of existing workers, losing more in doing so than the gain in filled vacancies. A small increase in the minimum wage will make the firm lose some profit, but it will fill the vacancies more quickly, leading to a higher level of employment.<sup>38</sup>

Card and Krueger's research has had a large impact in economics and policy circles. As of April 26, 2017, the paper has 2,301 Google scholar citations and the book 2,380.<sup>39</sup> Moreover, Card and Krueger's findings have changed the opinion of many economists.

The Initiative on Global Markets at the University of Chicago Booth School of Business runs a survey of economic experts. In the survey, some of the leading members of the profession are asked about their opinions on public policy issues. In September 2015, the experts were asked: "Question A: If the federal minimum wage is raised gradually to \$15-per-hour by 2020, the employment rate for low-wage US workers will be substantially lower than it would be under the status quo."

Of the forty-two economists who answered the question, 5% strongly agreed with it, 21% agreed with it, 38% were uncertain, 24% disagreed, 0% strongly disagreed, and 0% had no opinion. That 62% of top economists either disagreed or were uncertain about the effects on employment of more than a doubling of the federal minimum wage against the intuition of Figure 3 is a tribute to the importance of Card and Krueger's work. In fact, the studies were mentioned either explicitly or implicitly by several of the respondents.<sup>40</sup>

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<sup>37</sup> *Id.* at 11–13.

<sup>38</sup> The idea that monopsony power may induce an increase in employment after an increase in the minimum wage is an old one. See George J. Stigler, *The Economics of Minimum Wage Legislation*, 36 AM. ECON. REV. 358, 358–365 (1946). A related possibility is that a higher wage might increase productivity by making workers value their jobs more, as in the efficiency wages model of Shapiro and Stiglitz. See Carl Shapiro & Joseph E. Stiglitz, *Equilibrium Unemployment as a Worker Discipline Device*, 74 AM. ECON. REV. 433, 433–44 (1984). Efficiency wages by themselves will limit the effect of a hike in the minimum wage, but in the absence of other complementary mechanisms, they will cause an increase in employment.

<sup>39</sup> *Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania*, GOOGLE SCHOLAR, [https://scholar.google.com/scholar?start=0&q=Minimum+Wages+and+Employment:+Case+Study+of+the+Fast+Food+Industry+in+New+Jersey+and+Pennsylvania+American+Economic+Review&hl=en&as\\_sdt=0,14](https://scholar.google.com/scholar?start=0&q=Minimum+Wages+and+Employment:+Case+Study+of+the+Fast+Food+Industry+in+New+Jersey+and+Pennsylvania+American+Economic+Review&hl=en&as_sdt=0,14) [<https://perma.cc/TE46-LM8Z>]; MYTH AND MEASUREMENT, GOOGLE SCHOLAR, [https://scholar.google.com/scholar?q=myth+and+measurement&btnG=&hl=en&as\\_sdt=0%2C14](https://scholar.google.com/scholar?q=myth+and+measurement&btnG=&hl=en&as_sdt=0%2C14) [<https://perma.cc/2NV6-JPKG>].

<sup>40</sup> Initiative on Global Markets, *\$15 Minimum Wage*, CHICAGO BOOTH (Sept. 22, 2015), <http://www.igmchicago.org/surveys/15-minimum-wage> [<https://perma.cc/52NZ-EGVV>].

## V. NOT SO FAST . . .

Card and Krueger's results were sensational because they challenged a centuries-old understanding in economics. Also, their findings rationalized a policy intervention that has had strong political backing for almost as long. But sensational results invite close examination, and Card and Krueger's findings have not held up to that torrent.

Much of the discussion has involved the construction of the data and an assessment of whether the assumptions behind the DID held in practice. Among issues about data collection, the study of Neumark and Wascher<sup>41</sup> is of particular importance. The authors show how the use of administrative payroll data in a similar sample of fast-food restaurants leads to conclusions opposite to those in the original study.<sup>42</sup> Payroll data is likely to be more reliable than phone survey data because of the restaurants' legal obligations to accurately report taxable income and because it avoids ambiguities in the questions in Card and Krueger's original survey. Neumark and Wascher find that employment in New Jersey fast-food restaurants declined between 3.9% and 4.0% relative to the Pennsylvania control group.<sup>43</sup> This corresponds to a short-run elasticity of -0.21 to -0.22.<sup>44</sup>

Among issues concerning the DID assumptions, the idea that New Jersey and Eastern Pennsylvania shared a common trend is problematic. If you recall the map in Figure 4, the sample of restaurants in New Jersey includes observations in the southern portion of the New York metropolitan area, in the eastern suburbs of Philadelphia, and at the Jersey Shore. These regions, although related, had different trends. More generally, Meer and West argue that the minimum wage impacts employment through changes in growth rates,<sup>45</sup> rather than through an immediate drop in relative employment levels, as Card and Krueger postulate. Finally, the increase in the minimum wage in New Jersey was announced two years in advance (although there was some political uncertainty regarding whether the increase would be implemented).

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<sup>41</sup> David Neumark & William Wascher, *Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania: Comment*, 90 AM. ECON. REV. 1362, 1362–1396 (2000).

<sup>42</sup> *Id.* at 1362–63.

<sup>43</sup> *Id.* at 1363.

<sup>44</sup> For a reply, see David Card & Alan B. Krueger, *A Reanalysis of the Effect of the New Jersey Minimum Wage Increase on the Fast-Food Industry with Representative Payroll Data 1–2* (Nat'l Bureau of Econ. Research, Working Paper No. 6386, 1998) (challenging the research done by Neumark and Wascher, claiming their samples may not have been as representative).

<sup>45</sup> Jonathan Meer & Jeremy West, *Effects of the Minimum Wage on Employment Dynamics*, 51 J. Hum. Resources 500, 500 (2016).

Therefore, the restaurants in New Jersey might have already at least partially responded to the minimum wage hike by the start of the survey.

Other authors looked at borders between other states that had similar experiences. The results of those replication effects are mixed. Reviews of these studies have been compiled by Neumark and Wascher<sup>46</sup> with a negative view on the effects of minimum wages, and by Allegretto, Dube, Reich, and Zipperer,<sup>47</sup> with a more positive assessment.

My reading of this literature is that there is a tentative empirical consensus that the short-run employment effects of temporary, modest minimum wage increases, such as those studied by Card and Krueger, are probably negative, but small. Parsing the previous sentence shows us, however, how limited this statement is. It requires three conditions (“short-run,” “temporary,” and “modest”) and it is subject to non-trivial uncertainty (“probably”). Let us forget about uncertainty, as it is inherent in any social science question and requiring its own comments about decision-making in such circumstances, and let us focus on the three conditions.

#### A. Short-Run

Card and Krueger documented the short-run effects (ten months ahead) of an increase in the minimum wage.<sup>48</sup> But there are many situations in economics where short- and long-run effects can be quite different. For example, most drivers will initially respond little to an increase in gas prices. They need the car to commute to work or to take the kids to school. A higher gas price may only induce more economical driving or the elimination of a few trips. However, when in a few years, drivers face the need to buy a new car, a higher gas price may induce many of them to trade down a gas-guzzling SUV for a thrifty hybrid or, when they change residence, to search for a dwelling closer to work.

A similar mechanism works with fast-food restaurants. In the short-run, restaurants might have few options to economize on labor. They have so many tables to serve and the kitchen works in a particular way. At the margin, the restaurant might close earlier or accept larger queues, but those options are limited.

But, in the long-run, restaurant owners can exploit many margins of adjustment. The first margin of adjustment is to reorganize the

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<sup>46</sup> See generally DAVID NEUMARK & WILLIAM L. WASCHER, MINIMUM WAGES (2008).

<sup>47</sup> Sylvia Allegretto, et al., *Credible Research Designs for Minimum Wage Studies* 4 (Inst. for the Study of Lab. (IZA), Discussion Paper No. 7638, 2013).

<sup>48</sup> See generally Card & Krueger, *supra* note 27.

kitchen to use more capital (mechanical food processors instead of manual workers), install more automated services (self-help counters), rearrange the layout of the restaurant, etc. These changes are costly and will only be undertaken the next time the restaurant requires an overhaul (although the overhaul itself may be pushed forward by the desire to lower labor costs). Economists refer to this phenomenon as putty-clay technologies.<sup>49</sup> We say that a production system is ex-ante putty when there is a wide range of choices before the system is installed regarding how it will operate. There are many ways to combine capital and labor to produce a good or a service. We say that a production system is ex-post clay when, once it has been installed, it requires a fixed proportion of capital and labor, with no substitution between the two, and does not have the ability to easily scrap the capital and transform it back into other goods and services.<sup>50</sup>

Putty-clay technologies generate large differences between short- and long-run responses to changes in their relative prices. The importance of this phenomenon has been quantified by Sorkin, who concludes:

As such, the paper suggests that it would be a mistake to infer from existing empirical work on the employment effects of minimum wage increases that the President's 2013 proposal to index minimum wages to inflation would have minimal effects on employment. Taking the model at face value shows how misleading such an inference might be: the results in Table 2 show that a contemporaneous elasticity of -0.002 in response to a temporary increase is consistent with an elasticity after 6 years of -0.252 for a permanent increase.<sup>51</sup>

From a historical perspective, Seltzer has documented how the seamless hosiery industry in the U.S. South substituted capital for labor over the long-run (but not in the short-run) after the passing of the Fair Labor Standards Act of 1938 and its provisions on the minimum wage.<sup>52</sup>

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<sup>49</sup> Isaac Sorkin, *Are There Long-Run Effects of the Minimum Wage?*, 18 REV. ECON. DYNAMICS 306, 307 (2015) (describing putty-clay as the ability to “freely substitute between capital and labor” at the outset of a project, but the firm cannot change the labor scheme once the capital is in place).

<sup>50</sup> The definition in the main text is a simplification of a more formal characterization. For example, we could introduce more input factors (energy, land, etc.).

<sup>51</sup> Sorkin, *supra* note 49, at 322.

<sup>52</sup> Seltzer, *supra* note 1, at 396. Seltzer also shows how in the lumber industry many firms either ignored the provisions of the act or withdrew from interstate commerce (and, thus, were exempted from the minimum wage regulations). *Id.* at 410–13. Seltzer's comparison of the effects across industries reveals the heterogeneity of responses to the same regulation among sectors. *See*



Card and Krueger (1995) dismissed the importance of the short- vs. long-run distinction<sup>53</sup> by arguing that an increase in FTE employment in the short-run seems unlikely to accompany a reduction in long-run employment, that fast-food restaurants have plenty of flexibility in changing their staff levels, and that the high turnover rates of workers in this business make adjustment potentially fast.<sup>54</sup> I find all three responses unconvincing. In the long-run, the production of food can be organized in many ways, but that new structure will not appear until the restaurant has been overhauled (or substituted by a new one). If the monopsony argument proposed by Card and Krueger holds but technology is putty-clay, it is perfectly compatible to have a short-run increase in employment with substantial long-run reductions in labor demand.

The second margin of adjustment is the entry and exit from the restaurant business. Those restaurants that suffer more from the increase in minimum wages (for example, because the preparation of the fast-food they serve is harder to automate) will tend to close faster, while new restaurants that are better at saving labor will enter the market more frequently.

Aaronson, French, Sorkin, and To have studied the role that the entry and exit of establishments play in the restaurant industry after a minimum wage hike.<sup>55</sup> These researchers used data from the Quarterly Census of Employment and Wages (QCEW) to measure the effects of five hikes in state minimum wages in the early and mid-2000s in fast-food restaurants.<sup>56</sup> They found that a higher minimum wage leads to more restaurants exiting the industry and, conversely, to more new restaurants entering the industry.<sup>57</sup> In concrete terms, after a 10% increase in the minimum wage, the exit rate of fast-food restaurants

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*id.* at 414 (“In both industries the wages of a large proportion of the workforce had to be increased in order to bring firms into compliance with the [Fair Labor Standards Act].”) However, it is important to note that *methods* for adjusting to these changes varied between the seamless hosiery and lumber industries. *Id.* It is entirely possible that the responses of the fast-food industry to changes in the minimum wage are rather different from the responses of other industries or we can even see divergent responses within the fast-food industry (budget fast-food at Burger King vs. premium fast-food at Chipotle).

<sup>53</sup> See CARD & KRUEGER, *supra* note 28, at 67; see also *id.* at 367 (admitting that the distinction between short-run and long-run responses to minimum wage is important, but hard to differentiate between). Card and Krueger find that sunk costs and costly adjustments may mean changes take longer to occur, or the costs will initially be borne by the firm owners, resulting in no short-run price responses to increased wages. *Id.*

<sup>54</sup> *Id.* at 367–69 (concluding that employment effects from changes to minimum wage are close to zero when using the standard model; noting other models that allow firms some discretion in setting their prices have very different effects on employment).

<sup>55</sup> Aaronson et al., *supra* note 4, at 9–13.

<sup>56</sup> *Id.* at 5–6.

<sup>57</sup> *Id.* at 9–13.

increased from 5.7% a year to 7.1%.<sup>58</sup> Employment levels remained roughly the same in continuing restaurants, with only small decreases. These results suggest that the research design in Card and Krueger (1994) and Card and Krueger (1995) may miss a central component of the employment adjustment.

The third margin of adjustment is directed technological change. Many scientific and technical improvements are the result of economic incentives. If there is profit to be gained from a new and better product, inventors and entrepreneurs will spend time and resources developing such a product. The classic illustration of this process is the evolution of the horseshoe.<sup>59</sup> Even if the horseshoe had been around since at least the Early Middle Ages (and one could suspect that such a simple technology had already reached its peak of efficiency), the late nineteenth and early twentieth centuries saw a burst of remarkable advances in horseshoe technology. By that time, the U.S. and other Western countries had become sufficiently affluent as to allow many families to own horses. This phenomenon created a large market for horseshoes that inventors and entrepreneurs rushed to satisfy. Then, when the automobile replaced most horses, the spurt of horseshoe innovations ceased. One could only guess where the horseshoe technology would be today if the market for this product had remained vigorous.

An increase in the minimum wage will, therefore, induce technological change aimed at saving labor. Even if, with today's technology, it may be difficult to run a fast-food restaurant with fewer workers, the situation may radically vary in a few years after a national increase in the minimum wage. Directed technological change confirms, again, that short- and long-run employment responses to changes in labor market regulations can be dramatically different.<sup>60</sup>

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<sup>58</sup> *Id.* at 9. Interestingly, the result is more than twice as strong among fast-food restaurants that belong to chains. The owners of non-chain fast-food restaurants may have limited outside opportunities and have to live with the higher minimum wage.

<sup>59</sup> JACOB SCHMOOKLER, INVENTION AND ECONOMIC GROWTH 91–94 (1966).

<sup>60</sup> I will close this subsection by indulging in some personal recollection. When I arrived in Minnesota, in August 1996, to obtain my Ph.D. in economics, I was surprised at the absence of automatic machines to pay for your ticket at downtown parking lots in Minneapolis. Instead, all parking lots I patronized had an attendant in a booth accepting payment. In Madrid (Spain), automatic payment machines had been in widespread use for many years. The reason, of course, was not the technological superiority of Madrid over Minneapolis, but the higher relative minimum wage in Spain. Given the expensive automatic pay machines of the mid-1990s, it was profitable to substitute labor for capital in Madrid, but not in Minneapolis. Only after the drop in the price of these machines did they become common in the U.S.

## B. Temporary

A striking feature of the evolution of the minimum wage in the U.S. over time has been its “saw-toothed” pattern. The nominal minimum wage has been raised from time to time, but at the federal level (and in most states and cities) without any provision for automatic cost-of-living adjustments.<sup>61</sup> Thus, over time, inflation and increases in productivity have eroded the impact of those increases. In Figure 5, an updated version of Figure 4 in Brown,<sup>62</sup> I plot the minimum wage relative to average hourly earnings in the U.S. private sector.

The “saw-toothed pattern” means that firms are likely to respond much less to increases in the minimum wage if they forecast that the labor cost (nominal wages over nominal productivity) will return, in a short period, to previous levels. By looking at the evolution of the real cost of this minimum wage, the finding that minimum wage increases do not affect employment is not surprising. In terms of the present-discounted value, often there has not been much of an increase.

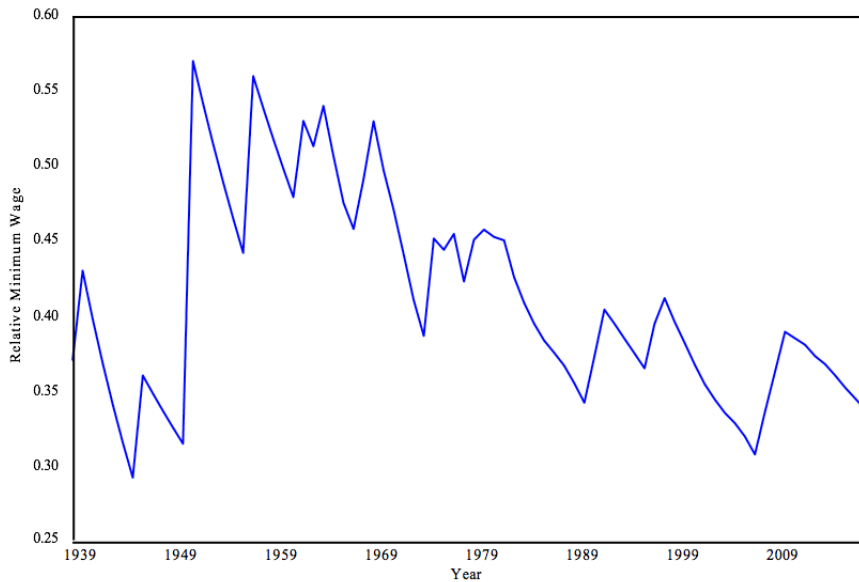


Figure 5: Minimum wage relative to average hourly earnings in the U.S.<sup>63</sup>

<sup>61</sup> Brown, *supra* note 4, at 2111–13.

<sup>62</sup> *Id.* at 2113.

<sup>63</sup> *See id.* (depicting an earlier version of this graph, which is current through the year 2000).

### C. Modest

In 1992, New Jersey increased its minimum hourly wage 18.8%, from \$4.25 to \$5.05.<sup>64</sup> While this increase was not trivial, it was not too large either: given an inflation rate in 1992 of 3.0%,<sup>65</sup> the real increase was only 15.8%.

The way in which firms respond to a 50% change and to a 15.8% real change in minimum wages can be fundamentally different. Economic activity is subject to adjustment costs.<sup>66</sup> I may not change my cell phone provider if it increases my plan price by 15.8% (because the opportunity cost of searching for a new provider is too high), but I may do so if the increase is 50%. Adjustment costs generate non-linearities in behavior: there is no presumption that the response to a 40% increase in minimum wages should be twice as large as the response to a 20% increase. While the evidence of Card and Krueger may be informative for the responses of employment to a 15–25 % change in the minimum wage, it says next to nothing about the responses to increases of 50% or higher, such as those proposed in the recent policy debate. Krueger himself acknowledges “a \$15-an-hour national minimum wage would put us in uncharted waters, and risk undesirable and unintended consequences.”<sup>67</sup>

### D. Other Aspects

The previous paragraphs have omitted many additional aspects of the minimum wage legislation. For completeness, I will briefly comment on three aspects that I find of outmost interest.

First, Card and Krueger (1995) reported a 4% relative increase in the pretax price of a full meal in New Jersey’s fast-food restaurants in comparison with Pennsylvania’s restaurants.<sup>68</sup> This increase in prices is intuitive: restaurants with some market power, since all restaurants engage in monopolistic competition, will pass through some of the higher labor cost to consumers. On the one hand, the higher price paid

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<sup>64</sup> Card & Krueger, *supra* note 27, at 772.

<sup>65</sup> *Consumer Price Index Data from 1913 to 2017*, U.S. INFLATION CALCULATOR (Jan. 18, 2017), <http://www.usinflationcalculator.com/inflation/consumer-price-index-and-annual-percent-change-s-from-1913-to-2008/> [<https://perma.cc/43QF-QA3A>].

<sup>66</sup> Sorkin, *supra* note 49, at 308 (defining adjustment costs as the “significant and lumpy costs” firms experience when adjusting labor, which may be incurred when responding to the number of jobs or changing the identity of workers).

<sup>67</sup> Alan B. Krueger, *The Minimum Wage: How Much Is Too Much?*, N.Y. TIMES (Oct. 9, 2015), [https://www.nytimes.com/2015/10/11/opinion/sunday/the-minimum-wage-how-much-is-too-much.html?\\_r=0](https://www.nytimes.com/2015/10/11/opinion/sunday/the-minimum-wage-how-much-is-too-much.html?_r=0) [<https://perma.cc/WBP2-Q5XA>].

<sup>68</sup> CARD & KRUEGER, *supra* note 28, at 54.

by consumers generates a lower demand for other goods and services. On the other hand, there is also a higher demand from workers who have seen their wages increase. How these two mechanisms balance in the aggregate economy is hard to predict. This difficulty tells us that the overall effects on employment at the aggregate level of a change in the minimum wage can be different from the results at the industry level. Firms can also adjust other margins, such as lowering on-the-job training and fringe benefits, changing their recruitment policies (for example, being more reluctant to hire workers without experience), or worsening job conditions (for instance, more inconvenient and irregular work shifts). Unfortunately, there is little research quantifying these additional margins.

Second, a higher minimum wage can have a perverse impact on human capital accumulation.<sup>69</sup> By increasing the relative wage of low-skill work, young people will face a lower incentive to go to school or acquire new skills, lowering aggregate productivity. The counterargument that a higher wage for younger workers may help them finance further education runs against the evidence that borrowing constraints do not seem to matter much for educational attainment.<sup>70</sup>

Third, a higher minimum wage has important redistribution aspects.<sup>71</sup> Some workers (those who see their wages increase and retain their jobs) will be better off, while others (those who lose their jobs or those who must pay for more expensive fast-food meals) will be worse off. Similarly, some business owners will be better off (those having restaurants near establishments that exit the market because of the higher minimum wage or the sellers of machinery that substitutes for labor) and others will lose (the no-chain restaurant owners whose profit margins drop). An analysis of this redistribution is, hence, crucial to assess the efficacy of changes to the minimum wage. MaCurdy has recently attempted such a calculation, with an overall negative assessment of the minimum wage as an antipoverty policy tool.<sup>72</sup>

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<sup>69</sup> Brown, *supra* note 4, at 2145–46.

<sup>70</sup> Stephen V. Cameron & Christopher Taber, *Estimation of Educational Borrowing Constraints Using Returns to Schooling*, 112 J. POL. ECON. 132, 132 (2004).

<sup>71</sup> Thomas MaCurdy, *How Effective Is the Minimum Wage at Supporting the Poor?*, 123 J. POL. ECON. 497, 498 (2015) (“[A] number of studies have documented [benefits from higher earnings,] . . . [b]ut someone must pay for the higher earnings received by the low-wage workers.”).

<sup>72</sup> *Id.* at 536 (“Far more poor families suffer reductions in resources than those who gain, and as many rich families gain as poor families. These income transfer properties of the minimum wage reveal it to be an ineffectual antipoverty policy.”).

## VI. CONCLUDING REMARKS

The previous section illustrates how little evidence there actually is to overturn our old understanding in Figure 3, reinforced by centuries of historical experience, on the effect of minimum wages.

What the last two decades of research on minimum wages have taught us beyond Figure 3 is very limited. As I summarized above, the short-run employment effects of temporary, modest minimum wage increases are probably negative, but small. But, in some sense, we already knew that. A small temporary treatment is likely to have, most of the time, a small effect. Despite the enormous amount of brain power and high-tech econometrics displayed by the participants in the debate, we have likely ended where we started. I do not say this is as a criticism of the different authors cited in this paper, but as a recognition of the tremendous hurdles that empirical work faces.

First, the data are limited and subject to measurement error. We would need to know many more details about the different establishments in the U.S. economy than those we can find in BED or JOLTS. Second, we would need long samples of data to measure both the short- and long-run effects of changes in minimum wages. Third, we would need accurate information about workers and consumers and how they respond to changes in wages and prices. Fourth, we would need good economic models to trace the aggregate effects of these changes. All this is well beyond our current capability.<sup>73</sup>

But this also means that the current empirical work is next-to-useless in evaluating the employment and welfare effects of the current efforts by many cities and states to move to a \$15 minimum hourly wage (indexed, also, to inflation). A candid assessment of the literature can only reach the conclusion that those politicians and activists claiming that academic research supports their “fight for \$15” may not be considering all relevant factors.

We will need to wait many years before the effects of the “fight for \$15” become clearer. Some preliminary estimates at Seattle are not encouraging.<sup>74</sup> Personally, coming from Europe and having experienced

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<sup>73</sup> A researcher would need to use a general equilibrium model to trace aggregate effects. For example, if you increase the minimum wage, firms will move toward more capital-intensive technologies, which will have an impact on the rate of return on capital and, therefore, on savings by households. These effects require extremely complicated models that we do not have the capability to build, solve, or estimate.

<sup>74</sup> THE SEATTLE MINIMUM WAGE STUDY TEAM, UNIV. WASH. REPORT ON THE IMPACT OF SEATTLE'S MINIMUM WAGE ORDINANCE ON WAGES, WORKERS, JOBS, AND ESTABLISHMENTS THROUGH 2015 3 (2016) (“Seattle’s low-wage workers show some preliminary signs of lagging behind similar workers in comparison regions. . . . It appears that the *Minimum Wage Ordinance* modestly held back Seattle’s employment of low-wage workers relative to the level we could have

what high minimum wages and strict labor market regulations do (which looks much closer to the straightforward intuition in Figure 3 than to Card and Krueger’s findings), I have a tight negative prior about the outcome of the experiment, but only time will tell.

In this paper, I have argued that we know very little about how the U.S. job market works and that we cannot even answer simple questions (what is the effect on employment of a change in the minimum wage?) with enough confidence to overturn the crushing, deductive logic of traditional economics.

Furthermore, we are observing several worrisome developments that may be related to growing and uncertain regulations such as the “fight for \$15.” In Figure 1 and Figure 2 we saw how the levels of job creation and job destruction are now considerably lower than in the recent past. The sum of both gives us a measure of resource reallocation in the U.S. economy. The negative trend in such reallocation is likely to be a harbinger of bad times for growth.

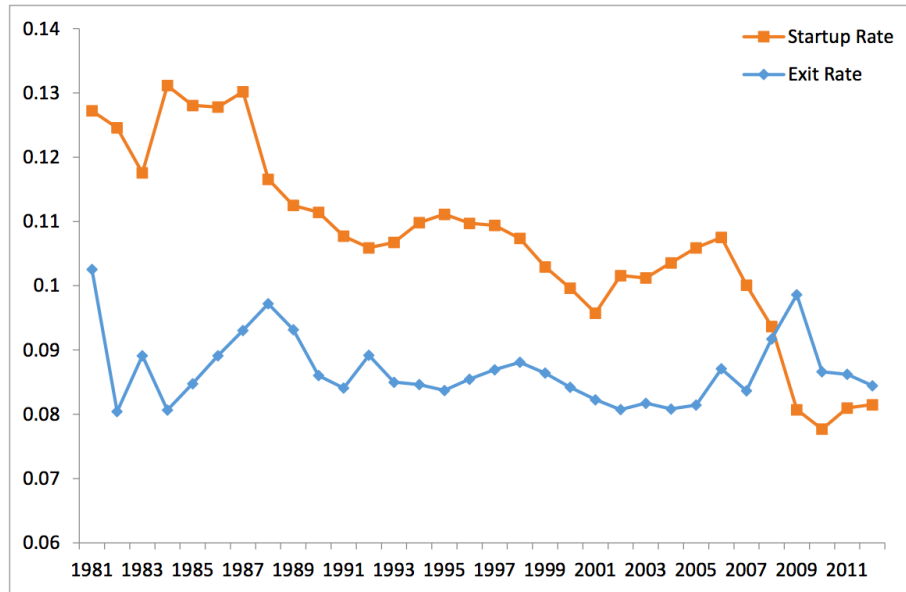


Figure 6: Startup and exit rates for firms in the U.S. non-farm sector<sup>75</sup>

Even clearer is Figure 6, where Professor Haltiwanger plots the annual startup and exit rate of firms and establishments in the U.S. private non-farm sector from the Business Employment Dynamic

expected.”).

<sup>75</sup> Haltiwanger, *supra* note 1, at 16.

dataset of the Bureau of Labor Statistics. The declining trend of startups is alarming. The Microsofts, Googles, and Amazons of the future are not being created today. We are moving to an economy of consolidated firms with fewer new entrants and lower productivity growth.<sup>76</sup> In a couple of decades, this lower productivity growth will translate into much larger welfare losses for workers than anything that can be gained today from a higher minimum wage. Let us concentrate on what matters.

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<sup>76</sup> According to the Penn World Table 9.0, *Penn World Table Version 9.0*, UNIVERSITY OF GRONINGEN, <http://www.rug.nl/ggdc/productivity/pwt/> [<https://perma.cc/WH7S-SGKM>]), a standard source among economists for growth and productivity data the United States total factor productivity grew, between 1950 and 2004, at a 1.0% annual rate. Between 2004 and 2014, total factor productivity grew at a 0.4% annual rate. At a 1.0% annual growth rate, total factor productivity doubles every 70 years. At a 0.4% annual rate, it doubles every 173.