ISSUE BRIEF

THE IMPORTANCE OF STUDY DESIGN IN THE MINIMUM-WAGE DEBATE

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Executive summary

This paper reviews the empirical literature on the employment effects of increases in the minimum wage. It organizes the most prominent studies in this literature by their use of two different empirical approaches: studies that match labor markets experiencing a minimum-wage increase with an appropriate comparison labor market, and studies that do not. A review of this literature suggests that:

■ The studies that compare labor markets experiencing a minimum-wage increase with a carefully chosen comparison labor market tend to find that minimum-wage increases have little or no effect on employment.

■ The studies that do not match labor markets experiencing a minimum-wage increase with a comparison labor market tend to find that minimum-wage increases reduce employment.

A better understanding of which approach is more rigorous is required to make reliable inferences about the effects of the minimum wage. This paper argues that:

■ Labor market policy analysts strongly prefer studies that match "treatment" with "comparison" cases in a defensible way over studies that simply include controls and fixed effects in a regression model.

■ The studies using the most rigorous research designs generally find that minimum-wage increases have little or no effect on employment.

■ Application of these findings to any particular minimum-wage proposal requires careful consideration of whether the proposal is similar to other minimum-wage policies that have been studied. If a proposal occurs under dramatically different cir-

cumstances, the empirical literature on the minimum wage should be invoked with caution.

Introduction

President Harry Truman famously joked that he wanted to hire a one-armed economist because all of his staff economists would resort to "on the one hand… but on the other hand…" formulations when giving policy advice. Truman just wanted a straight answer. Today, policymakers and the public also seem to want a one-armed economist in discussions of the minimum wage. Minimum-wage policy in the United States is made at the federal, state, and local level. The federal government imposes a minimum wage nationally (currently $7.25 an hour for most workers) that Congress can raise. Many states and even local governments set minimum wages that are higher than the federal minimum. One group of well-regarded economists contends that increases in the minimum wage reduce employment by raising labor costs, while another group insists the evidence shows that minimum-wage increases do not reduce employment, likely due to factors such as reduced turnover, increased productivity, and small price increases. Responsible economists understandably mention both strands of the literature. Nevertheless, it would be helpful if there were some way to determine which side has the more persuasive case, something a little closer to Truman's one-armed economist.

There are many criteria that could be used to make sense of the empirical literature on the employment effects of the minimum wage. This report focuses on the distinction between studies that use what I will refer to as "matched comparison groups" to estimate these effects, and those that do not. The term "matching" is used here in a relatively broad way, to describe a family of methods that identify a comparison group as an appropriate match for a treatment group, thus mimicking a randomized experiment.[1] A matching design is strongly preferred by economists working on a variety of applications because it is often the closest study design to randomized exper-

iments available. Whether or not a study uses matching is a broad criterion, but an important one for discriminating between studies and clarifying who provides more persuasive evidence in the minimum-wage debate.

The first section of this report reviews the two major approaches to studying the minimum wage—studies with and without matched comparison cases—and compares the major findings from these two approaches. The second section makes an argument for preferring studies that use matching over studies that do not. The report concludes with a discussion of the implications of this research for policy.

Two approaches to studying the minimum wage

The empirical literature on the impact of the minimum wage is large, but much of it (and all important recent studies) can be classified into one of two categories: one, studies that match and compare cases involving an increase in the minimum wage with a similar control group, and two, studies that do not match cases of a minimum-wage increase to a similar control group. This distinction is only one of many possible ways of thinking about the empirical literature, but it is critical for answering the question of who is right about the employment effects of the minimum wage.

Matching studies

Analyses of the minimum wage that use matching first received wide attention with David Card and Alan Krueger's 1994 paper on an increase in New Jersey's state minimum wage from $4.25 to $5.05.[2] Card and Krueger were concerned with distinguishing changes in employment at fast food restaurants that would have happened anyway from changes occurring in response to the minimum-wage increase. Their solution was to use comparable restaurants in Pennsylvania immediately across the border from New Jersey as a control group of establishments operating in a similar environment, but not

subject to the minimum-wage increase. These Pennsylvania establishments provided a baseline for determining what would have happened in New Jersey if the minimum wage had remained constant. Deviation from that baseline in the New Jersey restaurants could thus be safely attributed to the minimum wage. A true experimental design would have randomly assigned increases in the minimum wage in order to control for alternative influences, but in the absence of random assignment the authors identified the next best alternative: a close match.

The Card and Krueger study concluded that there was no evidence that the minimum-wage increase in New Jersey reduced employment in that state relative to the comparison group of Pennsylvania restaurants. Criticisms of the quality of the study's phone survey data were raised at the time, which led the authors to analyze more reliable administrative payroll data from New Jersey and Pennsylvania. Card and Krueger (2000) confirmed the original finding that the minimum-wage increase in New Jersey had no discernable employment effect.[3]

The matching approach pioneered by Card and Krueger has been applied with increasing sophistication and stronger data sources than the initial phone survey data in the 20 years since the New Jersey analysis. The most notable advance in matching has been in the work of Arindrajit Dube with several coauthors, which uses counties that neighbor each other across state borders as control cases. Rather than a restricted analysis of one state's minimum-wage increase, Dube, Lester, and Reich (2010) compare every pair of neighboring counties along every state border in the country (similar study designs are used in other papers by Dube and his colleagues).[4] By exploiting variation in the minimum wage across the country and over the course of 16 years, this research estimates minimum-wage effects from a larger sample than earlier matching studies, and produces estimates that are more representative of the typical response to a minimum-wage increase and not the special circumstances of a particular local labor market.

Dube and his colleagues consistently find no evidence for reduced employment as a result of regular increases in the minimum wage using the county pair match. In fact, even before using county pairs, as Dube, Lester, and Reich (2010) add increasingly more precise geographic matching into their models, the negative impact of the minimum-wage increase identified in the nonmatching literature (discussed in more detail below) gradually evaporates. **Table 1** reports Dube, Lester, and Reich's (2010) estimates of the percentage change in employment resulting from a percentage change in earnings as a result of an increase in the minimum wage.[5] The authors analyze two different samples of employment data: one that includes all counties (the first column), and one that includes pairs of neighboring counties (the second column), with county pair matching performed on the latter sample.

The first row in Table 1, which presents results when no matching is done, is representative of most study designs before Dube, Lester, and Reich (2010), and many since. When no matching is done, the minimum-wage increase is estimated to have a negative effect. However, as the comparison is increasingly narrowed to more similar counties, first in the same Census division, then the same state, then the same metropolitan statistical area (MSA), the statistically significant negative effect of the minimum-wage increase is eliminated. In the analysis that uses actual pair-matching of bordering counties to construct a comparison group (the last row), the higher minimum wage has an estimated positive effect on employment. However, because this result is statistically insignificant it cannot be statistically distinguished from a finding that the minimum wage has no effect on employment. In any case, the stronger designs that use matching strategies clearly contradict the theory that minimum-wage increases *reduce* employment. Other examples of this approach include Addison, Blackburn, and Cotti (2009; 2012), which have conclusions that are similar to Dube, Lester, and Reich (2010) and other matching studies.

TABLE 1

Percentage change in employment for each percentage change in earnings due to a change in the minimum wage

	All county sample	County pair sample
No matching	-0.784*	-0.482**
No matching, control for Census division differences	-0.114	–
No matching, control for state differences	0.183	–
No matching, control for MSA differences	0.211	–
County-level matching	–	0.079

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

Source: Estimates drawn from Dube, Lester, and Reich (2010), Table 2 (this is not a reproduction of their Table 2)

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One possible critique is that by over-parameterizing (i.e., adding too many controls to) their models, Dube, Lester, and Reich (2010) are mistakenly attributing true employment-discouraging effects of minimum-wage increases to other variables in their model, or that statistical significance is lost due to the difficulty of estimating such a complex model.[6] However, the authors point out that these fears can be easily dismissed by comparing estimates of the impact of the minimum wage on employment with estimates of the impact on earnings. Only the estimate of the impact on employment becomes positive—and loses statistical significance—as more rigorous matching strategies are introduced. The effect of the minimum wage on earnings stays consistent across these models. Since the same statistical model with the same risks of over-parameterization is being used regardless of the dependent variable (earnings in one case, employment in the other), the case that specification problems are driving the result is harder to justify.[7]

There are many different explanations for the lack of substantial disemployment effects in matching studies. One suggestion is that employers exercise "monopsony power," or bargaining power associated with being one of a small population of buyers in a market (an analog to the monopoly power exercised by sellers). Just as a monopoly will not reduce its output in response to an imposed price reduction, a monopsonist can absorb a price increase (such as a minimum-wage increase) without reducing demand for workers. Although such theoretical explanations are possible, a more straightforward argument is that an increase in the minimum wage does not have a disemployment effect because the increased labor costs are easily distributed over small price or productivity increases, or because fringe benefits are cut instead of employment levels. Less work has been done on the impact of the minimum wage on these outcomes than on the employment impact. Alternatively, disemployment effects might be avoided due to reduced fixed hiring costs as a result of lower turnover.

The most comprehensive and best known matching studies find that a higher minimum wage does not have a negative impact on employment, but this finding is not unanimous. Some matching studies do find disemployment effects. For example, Sabia, Burkhauser, and Hansen (2012) find negative effects on employment when they compare New York state with several comparison states, and Hoffman and Trace (2009) find that a minimum-wage increase in Pennsylvania reduced the

employment prospects of "at-risk" workers relative to comparable workers in New Jersey. Perhaps the best quality study using matching methods that identifies a disemployment effect is that of Singell and Terborg (2007), who find negative effects associated with much larger increases in the minimum wage in Oregon and Washington. Finally, Neumark, Salas, and Wascher (2013) use a "synthetic control method" and find negative minimum-wage effects. This important contribution to the matching literature is discussed in more detail below.

Each of these studies is open to criticism. Hoffman (2014) shows that rectifying questionable data choices eliminates Sabia, Burkhauser, and Hansen's (2012) negative result. Finally, all of these analyses use state-wide data, which arguably provide a weaker match than Card and Krueger (1994), Dube, Lester, and Reich (2010), and other studies that match neighboring counties rather than states.[8] Even if these negative results are taken at face value, the strongest studies investigating the widest range of minimum-wage increases by Dube and his colleagues find that *on average*, minimum-wage increases have little or no effect on employment.

Studies without matching

The alternative to a matching approach is to run a model using state-level or individual-level panel data (i.e., data collected over time) on employment levels to estimate how employment changes after states enact a higher minimum wage. These models have a number of valuable features, most notably their ability to control for idiosyncratic differences between states or individuals that do not change over time. These stable differences are called "fixed effects," and the models are therefore referred to as fixed-effects models. Regardless of whether fixed-effect models use state or individual-level data, they rely on variations in the minimum wage among states to determine the effect of the policy.

Notably absent from the fixed-effects models is any matching of comparison cases to treatment cases. While

Dube, Lester, and Reich (2010) used counties immediately across a state border as comparison cases, the fixed-effects models implicitly treat *every* state not experiencing a minimum-wage increase as a coequal comparison case to *every* state that does have a minimum-wage increase. This potentially introduces "selection bias" into the results. Minimum-wage laws are not imposed under experimental conditions. This means that states that "select into" higher minimum wages by enacting increases may be systematically different from states that do not. Fixed-effects models can handle this problem if the researcher has data on the factors that are associated with the differential adoption of minimum-wage laws or if these factors do not change over time (in that case, the inclusion of fixed effects controls for the nonrandomness that is introduced due to the lack of a true experiment). However, if factors correlated with the adoption of minimum-wage laws vary over time and across states, fixed-effects models will produce biased estimates of the effect of the minimum wage.

This sort of bias is very plausible in practice. Many states in the South and Central United States are experiencing rapid population and economic growth. In contrast, communities in the Midwest and Northeast are already densely populated and in many cases undergoing a structural transition associated with the decline of manufacturing. None of these changes are the result of the minimum-wage policy, but all are correlated with the minimum wage, which tends to be lower in the South and Central United States and higher in the Midwest and Northeast. Other trends specific to states or counties rather than regions are also conceivable. Some of these trends may be controlled for in certain studies, but fixed-effects models are not structured to capture the more comprehensive set of state-specific trends that matching studies can account for. State-specific time trends that are not accounted for will move a fixed-effects model further away from results that would have been estimated by a randomized experiment.

The economists most closely associated with the fixed-effects model approach to studying the minimum wage are David Neumark and William Wascher. In 2007, Neumark and Wascher conducted a thorough review of 102 minimum-wage studies, covering policies implemented both inside and outside the United States, and at the federal and state level. They identified a subset of studies that they deemed "credible," most of which fall into the category of state and individual-level fixed-effects models. This subset of studies, selected for special mention by the most prolific authors who use the fixed-effects method, is therefore an excellent vantage point for understanding the consensus of this literature. Most of the studies mentioned below come from this list. Neumark and Wascher's most recent minimum-wage study with J.M. Salas is not a standard fixed-effects model. This is discussed in more detail in the next section.

A typical state-level fixed-effects approach is offered by Neumark and Wascher (1992), published two years before the great disruption of the Card and Krueger (1994) study. This research estimated that a 10 percent increase in the minimum wage reduced teenage employment by 1 to 2 percent and young adult employment by 1.5 to 2 percent. These findings were notable because they were comparable to earlier estimates from the time series literature, which relied on variation over time rather than across states to estimate employment effects.

Neumark and Wascher (1996), Neumark (2001), and others soon extended the fixed-effects modeling framework to individual-level data to understand the impact of the minimum wage on specific vulnerable groups. The authors find in both cases that increases in the minimum wage reduce employment for the population of interest (typically teenagers or low-skill workers). These studies use the same design as the state-level studies, relying on variation among states and over time to estimate how changes in the minimum wage affect employment. As such, they are vulnerable to the same criticisms outlined above. Individuals in a high-minimum-wage state may experience lower employment rates, but it is difficult to determine whether that is the result of fundamentally different local labor market conditions that are unrelated to the minimum wage.

The most comprehensive exploration of the sensitivity of the fixed-effects model results to their ability to control for differences among states is by Allegretto, Dube, and Reich (2011). This study uses Neumark and Wascher's preferred fixed-effects modeling framework, but includes controls for Census division and state-specific labor market trends that Dube, Lester, and Reich (2010) suggest might be driving the strong negative employment effects in most fixed-effects analyses. After controlling for these trends, the standard disemployment effects become statistically indistinguishable from zero effects. What is notable about Allegretto, Dube, and Reich's (2011) contribution is that the result of little or no disemployment effects of the minimum wage is *not* generated from models related to the matching studies described in the previous section. Instead, the study uses the methods that are usually employed by Neumark and Wascher.

The method has also been extended beyond standard employment outcomes for the United States. Couch and Wittenburg (2001) use a fixed-effects model to assess the impact of the minimum wage on hours worked, while Neumark and Wascher (2004) use these techniques to understand how labor market institutions are relevant for international differences in the effect of the minimum wage. Both studies find the traditional negative impact. Meer and West (2013) use state fixed-effects models and numerical examples to argue that matching studies that include location-specific time trends (discussed in more detail in the next section) may provide inappropriate employment estimates if the principal impact of changes in the minimum wage is on employment growth rates.

Which approach makes more sense?

Matching cases of minimum-wage increases to a control group is essential because it is often the closest social scientists can get to the gold standard of an experiment using random assignment. Although the minimum-wage literature as a whole is divided on the question of the impact of minimum-wage increases, the strongest studies that use matching strategies find little or no evidence that such increases have a negative impact on employment.

It is difficult to overstate how uncontroversial it is in the field of labor market policy evaluation to assert the superiority of matching methods to the nonmatching approaches described above.[9] The seminal evaluations of the effects of job training programs, work-sharing arrangements, employment tax credits, educational interventions, and housing vouchers all use at least some sort of matching method, if not an actual randomized experiment. In their widely cited survey article on non-experimental evaluation, Blundell and Costa Dias (2000) do not even mention state-level fixed-effects models when they list the five major categories of evaluation methods. In a similar article, Imbens and Wooldridge (2009) do mention fixed-effects models as a tool for policy evaluation, but clarify that these were used before more advanced methods were developed, noting that the modern use of fixed-effects models is typically in combination with other more sophisticated techniques. For example, Dube, Lester, and Reich (2010) also use a fixed-effects model, but more importantly it is a fixed-effects model that utilizes rigorous matching strategy to identify the effect of the minimum wage. Sometimes fixed-effects models are the best available option if no natural experiment or other matching opportunity emerges to provide a more rigorous approach. Well specified fixed-effects models can still be informative. But faced with the choice between a well matched comparison group and a fixed-effects model, the former is unambiguously the stronger study design.

Given the unanimity of the evaluation literature on the importance of these methods, how is it possible that so many minimum-wage studies use only state-level fixed-effects models? One possible answer is that unlike many of the programs studied in the evaluation literature, everyone is subject to the minimum wage. The minimum wage is not like a training program or a tax credit where some people receive it (are treated) and others do not. It is instead just one of many "rules of the game" in the labor market. As such, economists may not think of the minimum wage in the context of the evaluation literature and the methods of that literature.

Potential signs of progress

In the immediate aftermath of the Card and Krueger (1994) study, many critics simply dismissed the finding as an abandonment of sound economic theory.[10] Fortunately, today these reactions are less common (though still not unheard of), and the major voices in the discussion seem to be developing a mutual appreciation for the importance of hammering out credible study designs. An excellent example is the recent exchange between Neumark, Salas, and Wascher (2013) and Allegretto et al. (2013). Instead of advancing new work in the tradition of a state-level fixed-effects model, Neumark, Salas, and Wascher (2013) raise criticisms of the county matching approach of Dube and his colleagues, and then go on to offer an alternative matching approach that they feel to be more appropriate. They suggest that a better method is the "synthetic control" approach of Abadie and Gardeazabal (2003), which generates weights for a number of comparison cases that *together* provide a good match to the treatment case. After running models using the synthetic control method, Neumark, Salas, and Wascher (2013) find evidence for negative effects of a higher minimum wage on employment, consistent with their work with state-level fixed-effects models. Allegretto et al. (2013) responded by defending their county-pair approach and further developing the synthetic control method, including rectifying problems in Neumark, Salas, and Wascher's (2013) work. In a separate paper,

Dube and Zipperer (2013) argue that Neumark, Salas, and Wascher (2013) fail to properly implement the synthetic control method, using an approach that is quite different from the earlier literature in that tradition and much less defensible. Allegretto et al. (2013) and Dube and Zipperer (2013) conclude that across both methods (their contiguous county approach and a properly executed synthetic control method), the minimum wage does not have substantial disemployment effects.

The most important development in this recent work is not that it has resulted in agreement on the impact of the minimum wage. Numerous econometric disagreements remain, and of course Neumark, Wascher, and others continue to defend fixed-effects studies on the grounds that the biases in these analyses are not substantial. The critical advance has been that Neumark, Salas, and Wascher (2013) appear to concede that some sort of modern matching approaches are essential for evaluating the effect of minimum-wage increases in the absence of a randomized experiment. The authors continue to disagree on the best way to implement such a study, but the more recent focus on credible non-experimental designs is a step forward.

What do we need to keep in mind in applying research to policy?

Study design offers a means of arbitrating between studies in the often conflicting minimum-wage literature. The strongest designs seem to consistently find little or no evidence of disemployment effects associated with increases in the minimum wage. However, when applying this research to policymaking, these findings do come with caveats.

First, we can only make inferences about the impact of a minimum-wage increase if it is relatively similar to the sorts of minimum-wage increases that have been studied. Dube, Lester, and Reich (2010, 962) caution that their "conclusion is limited by the scope of the actual variation in policy; our results cannot be extrapolated to pre-

dict the impact of a minimum-wage increase that is much larger than what we have experienced over the period under study."

The recent bill introduced by Sen. Tom Harkin (D-Iowa) and Rep. George Miller (D-Calif.) to increase the minimum wage to $10.10 represents a 39.3 percent increase above the current federal minimum wage of $7.25, to be implemented over the course of three years. The typical increase in the legal minimum wage associated with the proposed change to $10.10 is of course lower than 39.3 percent because some states affected by the change at the federal level already have state minimum wages exceeding $7.25. States without a higher minimum than $7.25 would experience the full increase. **Table 2** provides context for this increase by comparing it to prior federal minimum-wage increases.

The increase in Harkin and Miller's proposed Fair Minimum Wage Act of 2013 is typical of the federal minimum-wage increases since the late 1960s. The largest increases during this period (i.e., 1974–1976 and 1978–1981) came at a time of considerable inflation, so their magnitude to a large extent reflects an effort to keep up with consumer prices. However, the 40.8 percent increase between 2007 and 2009 is also larger than the Harkin-Miller proposal, despite the fact that it occurred in an environment of dramatically subdued inflation.

Figure A presents the distribution of all percentage changes in effective minimum wages for all states from 1980 to 2011 using data from the University of Kentucky's Center for Poverty Research.[11] The "effective" minimum wage is defined here as the highest of either the federal or state minimum wage in a given state.[12] Almost all increases were lower than 15 percent. The minimum-wage increase in New Jersey studied by Card and Krueger, at 18.8 percent in one year, was much larger than the average one-year increase during this period. Despite the magnitude of this increase, Card and Krueger found no notable disemployment effects. The proposed federal increase to $10.10 comes in three stages: a 13.1

TABLE 2

Proposed and past federal minimum-wage increases

	Nominal minimum-wage increase
Harkin-Miller proposal	39.3% in three steps
2007–2009	40.8% in three steps
1996–1997	21.2% in two steps
1990–1991	26.9% in two steps
1978–1981	45.7% in four steps
1974–1976	43.8% in three steps
1967–1968	28.0% in two steps

Source: EPI analysis of Fair Labor Standards Act and amendments and the proposed Fair Minimum Wage Act of 2013

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percent nominal increase, followed by an 11.6 percent increase in the first year and a 10.4 percent increase in the second year after the initial increase. These increases are in the upper half of the distribution of changes in the effective minimum wage presented in Figure A, but well within the historical ranges studied by the empirical literature on the minimum wage.

The relative size of any proposed increase does not necessarily imply that the results from the matching literature are irrelevant, but these findings should be invoked with caution in cases that depart from historical norms. Ultimately, what matters is not the absolute increase in the minimum wage, but whether or not the minimum wage is in excess of the value of workers' production to employers.

Finally, policymakers need to remember that even the best national studies, such as Dube, Lester, and Reich (2010) or Allegretto et al. (2013), provide only average effects of the minimum wage across a wide sampling of counties. The effect of a federal minimum-wage increase in any given local labor market is likely to vary with local conditions. This point is made emphatically in Dube, Lester, and Reich (2010, 957); the authors show the variation in minimum-wage effects across different local

labor markets in their sample. These estimates are all heavily concentrated around zero, consistent with their finding of negligible disemployment effects. However, the local labor estimates also show a nontrivial probability of having a considerably more positive or negative employment effect. This suggests that while on average the minimum wage does not have disemployment effects, some localities may exhibit these effects. Dube, Lester, and Reich's (2010) estimates suggest that other localities may experience positive effects from the minimum wage, providing motivation for state or local minimum or living wages in excess of the federal minimum wage.

Ultimately, even skeptics of the matching literature reviewed here need to consider total effects of the minimum wage, and not simply whether or not a disemployment effect can be identified. The disemployment effects identified in the weaker empirical strategies are still small, and the earnings gains for minimum-wage workers keeping their jobs are substantial. The net effect of a minimum-wage increase is therefore likely to be quite positive, even if concerns remain about a small population hurt by the minimum wage and in need of other assistance. Studies with the strongest study designs of

"Effective" one-year minimum-wage increases for all states, by percent change, 1980–2011
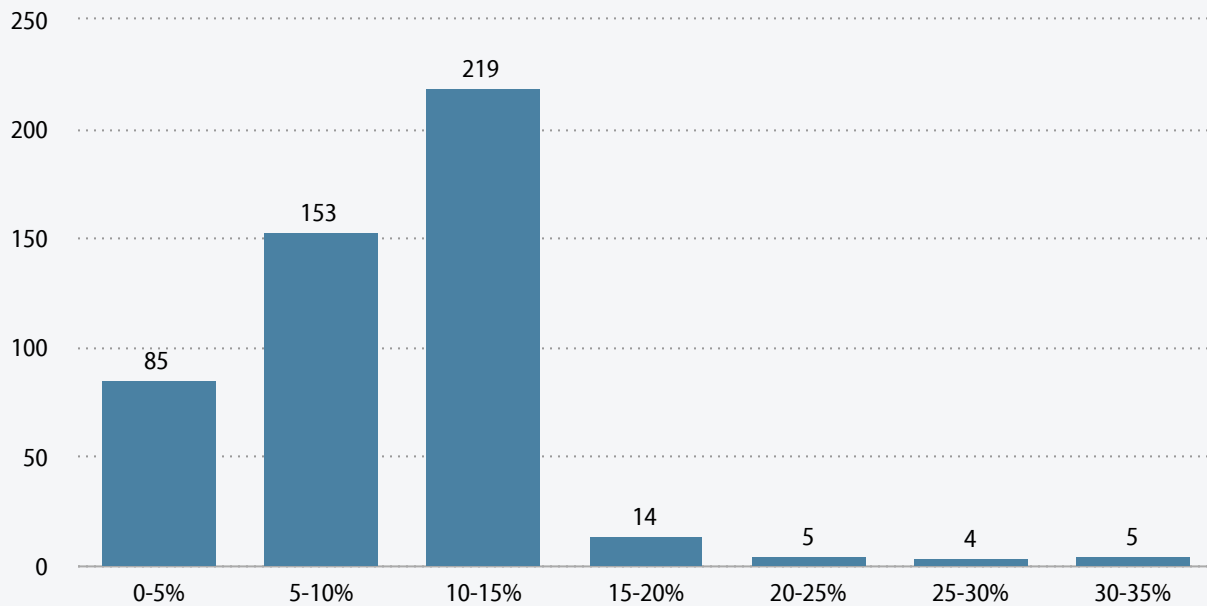
Note: The "effective" minimum wage is defined here as the highest of either the federal or state minimum wage in a given state. Periods with zero percent changes are excluded from Figure A.

Source: Author's calculations from the University of Kentucky Center for Poverty Research's (2012) state-level data of economic, political, and transfer-program information for 1980–2011

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course suggest that this population is extremely small if it exists at all.

Conclusion

Thinking about the designs of the major studies in the minimum-wage literature helps to approach Truman's ideal of a one-armed economist. The best evidence we have comes from studies that try to match treatment cases with appropriate control cases. This research suggests that historically typical minimum-wage increases have no impact on employment, on average. This is valuable information for thinking about policy. It suggests that raising the minimum wage would not have the negative effects attributed to it by critics, but would increase the earnings of low-income families.

Policymakers and the public should demand empirical rigor in research impacting the lives of low-income working families. Minimum-wage research should be conducted with the best feasible study designs, just as federal agencies demand the best designs when they seek out evaluations of other labor market policies.

About the author

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Acknowledgements

Endnotes

1. Within this family of methods, there is an approach to policy evaluation called "propensity score matching" that literally establishes a match between one treatment case and one or several comparison cases using an estimate of the probability of receiving a treatment. This paper, which is targeted to a broader audience, does not use "matching" to refer specifically to propensity scores, and instead uses it to describe any study design that consciously constructs comparison groups for treatment cases (here, cases experiencing an increase in the minimum wage). These include difference in difference models, regression discontinuities, synthetic control models, and other "natural experiments."

2. David Card published a study two years earlier, in 1992, examining the impact of a minimum-wage increase in California. This paper also used a matching strategy, even before the celebrated 1994 paper. However, the match in this paper was between California and a set of comparison states that roughly reproduced the demographic and labor market characteristics of California. This is not as clear of a match as the cross-border match in Card and Krueger (1994) nor does it set the same kind of precedent for future work by Arindrajit Dube and his colleagues, but Card (1992) should also be counted as an early example of the matching literature on the minimum wage. The author found no evidence of a decline in teenage employment or employment in retail.

3. See Card and Krueger (2000). In their reanalysis of administrative payroll data, Card and Krueger (2000) also provide evidence of selection bias problems associated with data on New Jersey and Pennsylvania restaurants provided to Neumark and Wascher (2000) by Richard Berman, a public affairs executive who advocates on behalf of the food and beverage industry. Neumark and Wascher's (2000) analysis of the Berman dataset finds that the minimum-wage increase reduced employment in New Jersey, although this finding is not consistent with the administrative payroll data.

4. A detailed discussion of all of Dube's work on the minimum wage is excluded in the interest of briefly outlining the differences between matching and nonmatching studies. Another critical contribution of Dube and his colleagues, Allegretto et al. (2013), is discussed below. Also of note are Dube (2013), which looks at minimum-wage effects by industry; and Dube, Naidu, and Reich (2007), which looks specifically at San Francisco. Recent work by Giuliano (2013) controls for unobserved heterogeneity by restricting the analysis to stores within a single firm. Giuliano also finds no evidence of disemployment effects from the minimum wage.

5. This elasticity is estimated as the ratio of the minimum-wage coefficients in the employment and earnings regressions in Dube, Lester, and Reich (2010).

6. In models that match counties that straddle a state border, additional "fixed effect" variables must be added indicating that a given county in the dataset is a member of a county pair. The inclusion of these fixed effects dramatically increases the size of the model that must be estimated.

7. Notably, the standard errors of the estimates of the minimum-wage effect increase more substantially from the baseline model for the earnings regressions than they do for the employment regressions. The source of the difference between the earnings and employment regressions is thus driven by the change in the point estimates themselves, and not the precision of the estimates.

8. For example, by using the entire state of Pennsylvania, Hoffman and Trace (2009) are comparing employment outcomes in Pittsburgh and rural western Pennsylvania with those in New Jersey. These communities are quite different and they are experiencing different types of economic change. In contrast, the original Card and Krueger (1994) study, which focused on border establishments, and Dube's work with border counties compare far more similar local labor markets.

9. Recall once again that "matching methods" is used here to describe a range of quasi-experimental methods that try to construct a comparison group that is a good match to the treatment group.

10. See for example Leonard's (2000) discussion of the reaction to Card and Krueger (1994). A particularly questionable and combative example is the case of the late Nobel laureate James Buchanan, who wrote in the *Wall Street Journal* in 1996, "Just as no physicist would claim that 'water runs uphill,' no self-respecting economist would claim that increases in the minimum wage increase employment. Such a claim, if seriously advanced, becomes equivalent to a denial that there is even minimal scientific content in economics, and that, in consequence, economists can do nothing but write as advocates for ideological interests. Fortunately, only a handful of economists are willing to throw over the teaching of two centuries; we have not yet become a bevy of camp-following whores."

11. The University of Kentucky dataset begins in 1980, in the middle of a three stage increase in the federal minimum wage. The first two stages, which are not in the data, were larger than the third.

12. Some localities have implemented "living wages" that are higher than minimum wages and therefore may be associated with greater percentage changes in the minimum wage at the time of their implementation. These are not considered here, nor are they studied in the minimum-wage literature discussed above. See Holzer (2008) for a review of the literature on living wage laws.

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