# MINIMUM WAGE AND REAL WAGE INEQUALITY: EVIDENCE FROM PASS-THROUGH TO RETAIL PRICES

Justin H. Leung*

*Abstract*—This paper considers the impact of the minimum wage on both labor and product markets using detailed store-level scanner data. I provide empirical evidence that a 10% increase in the minimum wage raises grocery store prices by 0.6% to 0.8% and suggest that the minimum wage not only raises labor costs but also affects product demand, especially in poorer regions. This points to novel channels of heterogeneity in pass-through that have distributional consequences, with key implications for real wage inequality. I also find that price rigidity within retail chains ameliorates these effects, reducing the pass-through elasticity for retail prices by about 60%.

## I. Introduction

MINIMUM wage laws are one of the most frequently used policies to combat poverty around the world. They are a nearly universal policy instrument and applied in around 90% of all countries (ILO, 2006). However, the efficacy of minimum wage laws as an antipoverty tool has been debated for many decades, beginning with Stigler (1946). While the minimum wage raises wages for low-wage workers, less clear are who exactly pays for these increases and how much. There are three main ways through which these higher labor costs are transmitted throughout the economy. First, firms can reduce employment or adjust nonmonetary returns to workers (e.g., fewer fringe benefits such as fewer paid lunch hours and holidays). In this case, low-wage workers pay. Second, firms may reduce profits, which means that owners pay. Third, firms may raise prices, hence consumers also pay. The first mechanism has received much of the attention in the empirical literature, but the magnitude of the disemployment effect is still hotly debated.[1] Significantly less studied are the latter two mechanisms of prices and, in particular, profits.[2]

This paper studies the impact of the minimum wage on retail prices for a wide range of products. To estimate the minimum wage pass-through elasticity, store and product group specific price indices are constructed using retail scanner data. I apply a standard difference-in-differences approach to exploit over 220 federal, state, and city minimum wage law changes in the United States from 2006 to 2015 as sources of variation, covering both changes during the Great Recession and the subsequent recovery. I show that this standard identification strategy generates estimates that can be interpreted as plausibly causal because stores in different states exhibit no differential pretrends. In the labor market, I find that a 10% minimum wage hike raises earnings of grocery store workers up to 1.5%. In the product market, I find that the impact of the minimum wage on retail prices is economically large and statistically significant in grocery stores. A 10% hike in the minimum wage raises grocery store prices by around 0.58%. These estimates are economically significant since both the national CPI and grocery store inflation rates are around 2% annually over the sample period.

Pass-through estimates for other store types such as drug and merchandise stores are statistically insignificant. I provide empirical evidence that most grocery chains either adopt regional pricing or operate only in a few states, while most drug and merchandise chains adopt rigid pricing within retail chains across the nation. Among these store types, grocery stores account for about 60% of consumer expenditures, while drug and merchandise stores account for 40%. I estimate that within-chain price rigidity attenuates the impact of an increase in local minimum wage on retail prices by 58%. These findings suggest that any extrapolations from my data about the impact of a rise in the federal minimum wage on retail prices should be made cautiously, since drug and merchandise stores may also change prices nationally across the entire retail chain in response to federal minimum wage hikes, which could interact with the price effects in grocery stores.

Furthermore, the estimated pass-through elasticity passes a series of robustness checks and exhibits substantial heterogeneity between stores in rich and poor counties. When focusing only on grocery stores in poor counties where the minimum wage is more binding, the estimated pass-through elasticity is larger than predicted by theory if minimum wage hikes are purely labor cost shocks. Interacting the pass-through elasticity with measures of how binding the minimum wage is within counties gives strongly significant

Received for publication November 7, 2018. Revision accepted for publication January 17, 2020. Editor: Olivier Coibion.

*Leung: National University of Singapore Business School.

I am grateful to the editor and anonymous referees for insightful comments. I also thank Marianne Bertrand, Stéphane Bonhomme, José Ignacio Cuesta, Stefano DellaVigna, Sharat Ganapati, Austan Goolsbee, Michael Greenstone, Günter Hitsch, Erik Hurst, Xavier Jaravel, Neale Mahoney, Magne Mogstad, Derek Neal, David Neumark, Krisztina Orbán, Juan Ospina, Canice Prendergast, Hee Kwon Seo, Chad Syverson, Joseph Vavra, Jeff Weaver, Michael Weber, Glen Weyl, Owen Zidar, and seminar participants at the University of Chicago for valuable comments and advice. Researchers' own analyses calculated (or derived) based in part on data from the Nielsen Company (U.S.), LLC and marketing databases provided through the Nielsen data sets at the Kilts Center for Marketing Data Center at the University of Chicago Booth School of Business. The conclusions drawn from the Nielsen data are those of the researchers and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

A supplemental appendix is available online at https://doi.org/10.1162/rest_a_00915.

[1]One side has shown no significant disemployment effect (Allegretto et al., 2017), while the other side has shown significantly negative employment effects (Neumark & Wascher, 2007).

[2]Draca, Machin, and Van Reenen (2011) find that the minimum wage reduces firm profitability in the United Kingdom.

*The Review of Economics and Statistics*, October 2021, 103(4): 754–769

https://doi.org/10.1162/rest_a_00915

coefficients. These results are consistent with theoretical derivations and point to novel channels of spatial heterogeneity in pass-through elasticity that have distributional consequences.

I propose that demand-induced feedback is one mechanism that can explain the large magnitude in pass-through elasticity as well as the dispersion between rich and poor counties. If the minimum wage generates spillover effects, a large number of workers would experience an increase in income and possibly household credit, lowering demand elasticities and raising prices as stores increase markups. This effect would be particularly strong in regions where the minimum wage is more binding. I derive pass-through formulas to predict the magnitude of the pass-through elasticity if the minimum wage only increased demand and show that theoretical calibrations are consistent with the reduced-form estimates. I also provide suggestive evidence that poorer households reduce their shopping intensities when the minimum wage rises.

My paper contributes to several strands of literature in labor economics on the minimum wage. First, I contribute to a literature on the price effects of the minimum wage, as surveyed in Lemos (2008). This literature has focused mostly on prices of food away from home since minimum wage workers are predominantly hired by restaurants, as shown in appendix table K1.[3] I study specifically retail stores for two reasons. First, scanner data for goods sold in retail stores have unparalleled richness, providing information on quantities and prices on a weekly basis for over 2 million goods sold in over 35,000 stores across the entire United States. This overcomes challenges in the previous literature, where prices of goods are sampled from stores and often subject to sampling error. Second, retail stores hire many minimum wage workers, accounting for over 7% of all minimum wage workers, and are a crucial part of the consumption basket, covering around 18% of all expenditures in the CPI.[4] Poorer consumer units spend a larger share of their income on retail goods, which further magnifies the distributional effect of increasing retail prices. To my knowledge, there are two contemporaneous papers that also estimate the minimum wage pass-through elasticity using retail scanner data (Renkin et al., 2017; Ganapati & Weaver, 2017). I describe both of their approaches and reconcile the differences in appendix section A. In particular, the results in Renkin et al. (2017) are complementary to mine. We find broadly similar results using a similar data set with a different sample of stores and time period.

Second, there is a scant but growing literature demonstrating that the minimum wage generates spending responses of considerable magnitude, partly by expanding access to credit (Kennan, 1995; Aaronson, Agarwal, & French, 2012; Alonso, 2016; Dettling & Hsu, 2017). To my knowledge, this is the first paper to demonstrate that minimum wage hikes can increase prices through *both* supply and demand. Third, several recent studies have tried to jointly consider all these mechanisms to understand who pays for the minimum wage (Aaronson & French, 2007; MaCurdy, 2015; Harasztosi & Lindner, 2019). I focus on the impact of the minimum wage on labor costs and the resulting cost pass-through in product markets. Building on cost pass-through formulas derived by Weyl and Fabinger (2013), I find that even the largest spillover estimates in the literature cannot explain the magnitude of the estimated pass-through elasticity. This relates to a vast literature on the drivers of wage inequality in the past four decades, which has often found that declining real minimum wages had major impacts on rising wage inequality (Autor, Manning, & Smith, 2016, hereafter AMS; Dube, 2019). I highlight a mechanism that implies the reduction in real wage inequality caused by a minimum wage hike could be smaller than the reduction in nominal wage inequality.

Fourth, this paper adds to a growing macroeconomic literature on how large demand shocks can affect retail prices procyclically (Stroebel & Vavra, 2018, hereafter, SV; Beraja, Hurst, & Ospina, 2015).[5] I argue that the minimum wage increases retail prices by the same mechanism, providing further evidence on how increased income among consumers may lead to lower household shopping intensities and demand elasticities, generating a procyclical natural markup. I also derive pass-through formulas to shed light on the factors that determine the size of the price response.

Fifth, this paper adds to literature that studies price rigidity within retail chains. DellaVigna and Gentzkow (2019, hereafter DVG) find that most retail chains in the United States implement uniform pricing across stores in the same chain and show that this dampens the overall response of prices to local economic shocks using a calibration. I provide direct empirical evidence to support this claim and find that this has major policy implications, since the local price response to local minimum wage shocks is completely attenuated for stores in rigid chains.

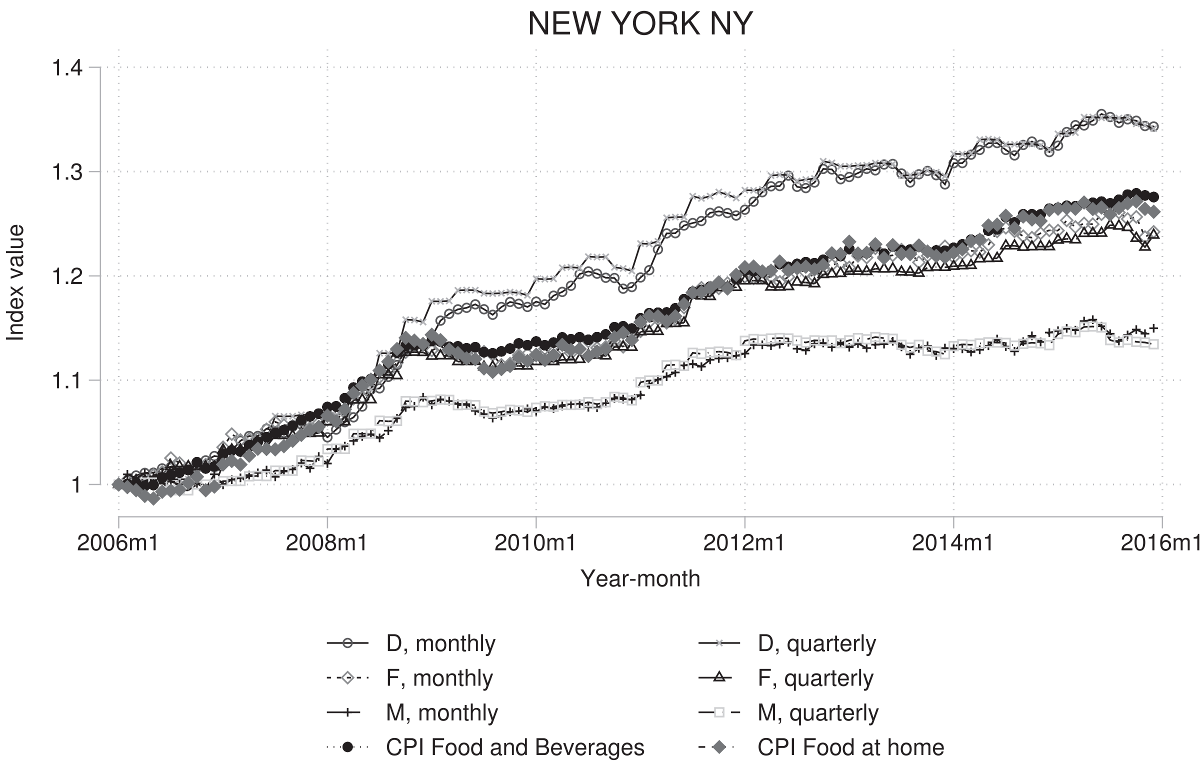
This paper is organized as follows. I first describe the data and how I construct the price indices in section II. Next, I discuss my empirical strategy in section III. Main results are then presented in section IV. Pass-through formulas are derived in section V to shed light on the determinants of the minimum wage pass-through elasticity. Additional results are presented to corroborate the theory. Concluding remarks are offered in section VI.

[3] Aaronson (2001) uses ACCRA price indices and publicly available BLS data, while Aaronson, French, and MacDonald (2008) use restricted CPI data on food away from home but only for a short panel from 1995 to 1997 and 7,500 food items across 1,000 establishments.

[4] This is shown in appendix figure L1. According to the 2015 Consumption Expenditure Survey (CEX) conducted by the BLS, expenditures on food at home exceed those on food away from home, taking up around 60% of food expenditures and 10% of the overall consumer basket.

[5] These papers exploit large, persistent, and unanticipated demand shocks that could potentially shift demand and lower demand elasticities, in contrast to other existing studies that find countercyclical pricing or small price responses such as Chevalier, Kashyap, and Rossi (2003), Gagnon and Lopez-Salido (2014), and Cavallo, Cavallo, and Rigobon (2014), which exploit predictable seasonal holidays and episodic weather events.

FIGURE 1.—COMPARISON OF NIELSEN PRICE INDICES WITH CPI




This figure plots city-level price indices from 2006 to 2015 constructed using Nielsen retail scanner data against those used by the BLS to construct the CPI. D, F, and M correspond to Nielsen price indices for drugstores, grocery stores, and mass merchandise stores, respectively. Nielsen price indices are first constructed at the store level, then aggregated to the city level by taking a sales-weighted average.

## II. Data and Construction of Price Indices

In this section, I give an overview of the data used for analysis and outline the construction of the price indices. I describe the data further in appendix section C.

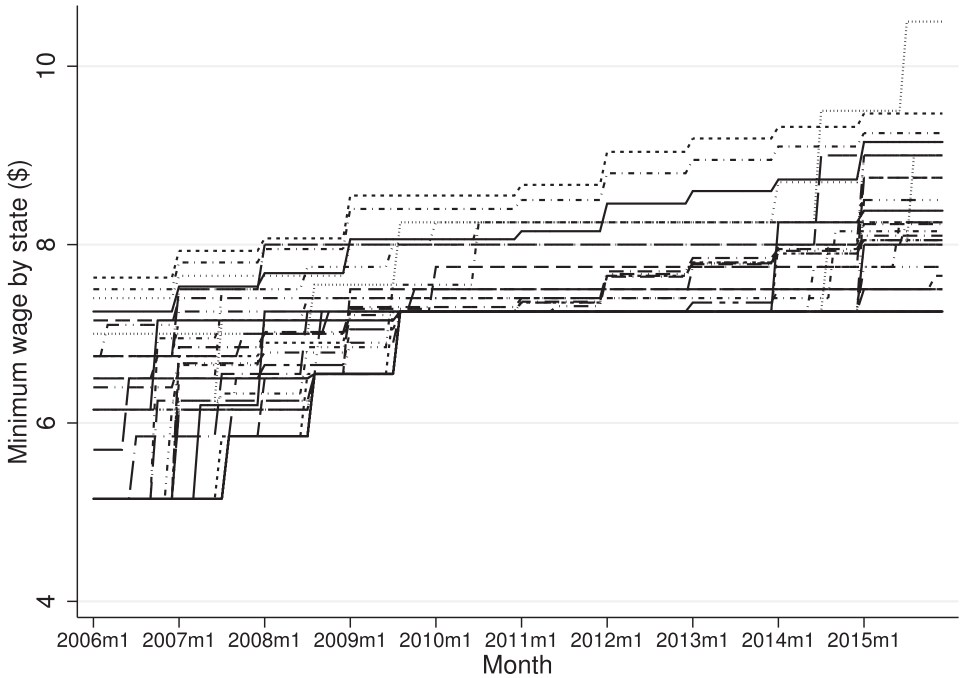
### A. *Price Indices*

*Nielsen Retail Scanner.* I use the Nielsen Retail Scanner Dataset available through a partnership between the Nielsen Company and the James M. Kilts Center for Marketing at the University of Chicago Booth School of Business. The data consist of weekly pricing, volume, and store merchandising conditions generated by participating retail store point-of-sale systems across the United States from 2006 to 2015. Data are included from approximately 35,000 participating stores and include store types such as drug, grocery, and mass merchandise stores, covering around 53% to 55% of national sales in food and drugstores and 32% of national sales in mass merchandise stores. The finest location of each store is given at the county level. I only use stores that appear throughout the entire sample period such that store entry and exit do not affect results. Among the stores in the sample in 2006, 84% remain throughout the entire sample period. Results are robust to using all stores by aggregating prices first to the county level. A huge number of products from all Nielsen-tracked categories are included in the data, with 2.6 million universal product codes (UPCs) in total aggregated into around 1,100 product modules, which are further aggregated up to 125 product groups.

The advantage of using the retail scanner data as opposed to the Nielsen Consumer Panel is that a wider range of goods is observed at higher frequencies and quantities. Scanner price indices are constructed as in Beraja et al. (2015). I briefly describe the approach they adopt in appendix section B and refer interested readers to their paper for details. I also construct a range of different price indices using alternative methods, which give nearly identical results.

To investigate the behavior of the constructed indices, the scanner price index is compared to the publicly available CPI series. Since the BLS only publishes local price indices for around twenty sample areas in the United States, I match the available CPI price indices at the city level with the store price indices constructed by taking a sales-weighted average across stores in each available city. This leaves sixteen cities that can be compared to the scanner price indices, and this is done for food, food at home, and food away from home. The indices exhibit a high correlation of around 0.75 to 0.8. Figure 1 shows the different indices for New York City. Plots for other cities are shown in appendix figure L2. Overall, the Nielsen grocery store price indices track the ones produced

FIGURE 2.—MINIMUM WAGE OVER TIME FOR ALL STATES, 2006–2015




This figure plots the state-effective minimum wage for each state in each month from 2006 to 2015. States that do not have a state minimum wage are bounded by the federal minimum wage.



by the CPI food indices closely. The average annual inflation rates are around 2%, similar to the national CPI inflation over the sample period.

### B. *Nielsen Consumer Panel*

The Nielsen Consumer Panel Dataset represents a longitudinal panel of approximately 40,000 to 60,000 U.S. households from 2004 to 2015 that continually provide information to Nielsen about their households and what products they buy, as well as when and where they make purchases. Panelists use in-home scanners to record all their purchases, from any outlet, intended for personal, in-home use. Products include all Nielsen-tracked categories of food and nonfood items, across all retail outlets in the United States. Nielsen samples all states and major markets. Panelists are geographically dispersed and demographically balanced. Each panelist is assigned a projection factor, which enables purchases to be projectable to the entire United States. I use these data to construct measures of household expenditure and shopping intensities, which include (a) the share of expenditures using coupons (coupon share), (b) the share of expenditures on goods that are on sale (deal share), and (c) the share of expenditures on generic store brands (store brand share).

### C. *Minimum Wage Series in the United States*

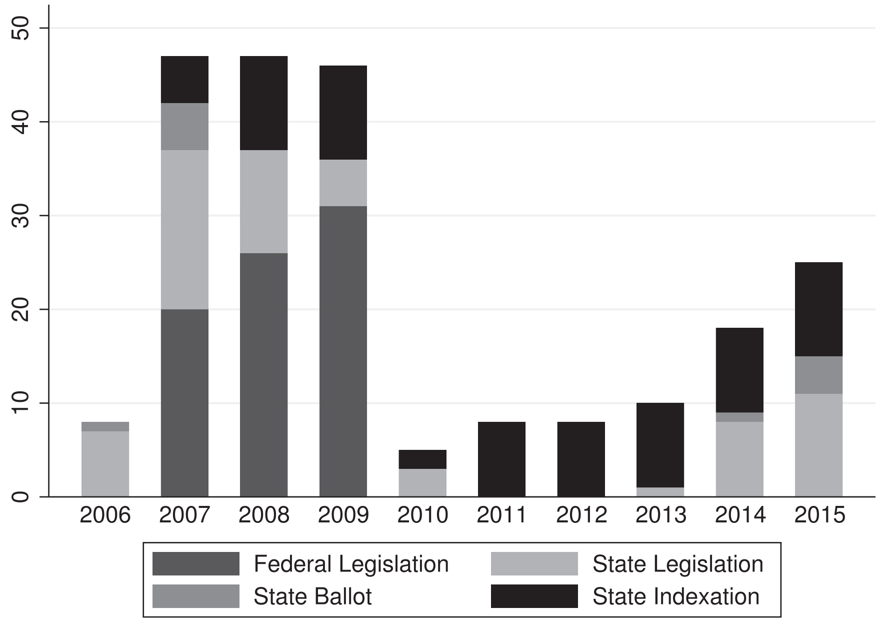
I use the state-by-month or state-by-quarter minimum wage data in the United States from 2006 to 2015. These data are made available by Vaghul and Zipperer (2016) and compiled from a wide variety of primary sources. Results are nearly identical when accounting for local minimum wage ordinances at the city or county level. The minimum wage used is the maximum of the federal and state minimum wage, commonly known as the state effective minimum wage.

I plot the minimum wage over time for all states from 2006 to 2015 in figure 2. Note that there is quite a lot of within-state variation over the period of interest that is staggered across time for different states, providing useful variation for identification. The lower envelope is the federal minimum wage over time, since some states are consistently bound by federal changes. This implies that there is substantial variation beyond the federal changes due to state minimum wage laws. Furthermore, federal changes also provide identifying variation since some states are forced to comply with federal legislation while states with higher minimum wages are unaffected.

To get a better understanding of the frequency of minimum wage changes in the sample period, figure 3 plots the number of minimum wage changes by year and type, pooling together all states, from 2006 to 2015. The figure indicates that the sample period contains quite a lot of minimum wage variation that comes in two waves across different phases of the business cycle, with mostly federal changes in the first wave in 2007 to 2009 and only state changes in the second wave in 2014 to 2015.[6] There are four types of minimum

[6]Federal minimum wage changes are defined as those that were binding on states. State minimum wage changes are defined as changes not directly caused by a binding rise in the federal minimum wage.

FIGURE 3.—MINIMUM WAGE CHANGES OVER TIME BY TYPE FOR ALL STATES




This figure plots the total number of changes in the minimum wage across states in each year, segmented by the type of change. There are four types of minimum wage changes: federal legislation, and state legislation, state ballot (where voters decide whether the minimum wage should be increased), and subsequent changes due to indexation to the national CPI (with the exception of Colorado, which indexes their minimum wage to the city-level CPI).

wage changes: federal legislation, state legislation, state ballot (where voters decide whether the minimum wage should be increased), and subsequent changes due to indexation.

I also report additional characteristics of the minimum wage changes in appendix tables K2 and K3. Minimum wages are often implemented after the announcement of the legislation with some time lag. The average implementation lag is around 4.13 quarters in the first wave and 1.80 quarters in the second wave, which is important for understanding the dynamics of price changes in response to minimum wage hikes.

### D. *Labor Market Data*

The Quarterly Workforce Indicators (QWI) data set provides labor market statistics by county, detailed industry, worker demographics, employer age, and size. It was first used in the minimum wage literature by Dube, Lester, and Reich (2016), which I follow closely to provide empirical evidence on labor market impacts of the minimum wage on retail stores. I use five dependent variables for my analysis: earnings, employment, hires, separations, and turnover.

I also use the ACS and CPS Merged Outgoing Rotation Groups (MORG) data due to the availability of information on hourly wages, which is unfortunately not present in the QWI.

## III. Empirical Strategy

To estimate the impact of the minimum wage on prices, I apply typical panel fixed effects approaches as opposed to a pure event study methodology or synthetic control due to numerous overlapping minimum wage events in my sample. This also allows me to take advantage of variation in the magnitudes of minimum wage hikes across events. Price indices are constructed for each store at the quarterly level. Results are robust using observations at the state or monthly level. In my preferred specification, the log of the scanner price index $P_{it}$ for store $i$ in state $s$ and time period $t$ is regressed on log minimum wage $MW_{st}$ for the store-year-quarter panel with store and period fixed effects to control for unobserved store characteristics and common time trends that affect prices, as shown in equation (1):

$$\ln P_{it} = \alpha + \beta \ln MW_{st} + X_{ct}' \gamma + \alpha_i + \alpha_t + \varepsilon_{it}. \quad (1)$$

Since the level of the price index is not interpretable, only relative changes are relevant. The log-log specification gives the interpretation of β as the elasticity of prices with respect to the minimum wage, which is known as the minimum wage pass-through elasticity. I also include control variables $X_{ct}$ matched to the county $c$ the store is located in, such as log housing price, log county unemployment rate, log county average wages, and log county population. These variables have been shown to have impacts on regional prices in SV, Beraja et al. (2015), and Handbury and Weinstein (2015). Results are robust to the exclusion of control variables. Standard errors are clustered by state to allow for autocorrelation in unobservables within states since the identifying variation is at the state level, following Bertrand, Duflo, and Mullainathan (2004).

Equation (1) is a static model that does not capture the posttreatment dynamics of the outcomes, but it is a common way to summarize the effect size (Borusyak & Jaravel, 2017; Freyaldenhoven, Hansen, & Shapiro, 2019) and is commonly used in the pass-through literature. Therefore, I present results using a static model as the baseline specification. I use a distributed lag model as shown in equation (2) to account for dynamics nonparametrically:

$$\ln P_{it} = \alpha + \sum_{j=-k}^{k} \beta_j \ln MW_{s,t-j} + X'_{ct}\gamma + \alpha_i + \alpha_t + \varepsilon_{it}. \quad (2)$$

The cumulative effect is obtained by adding together all the coefficients up to the period of interest. While the standard cumulative effect includes only the sum of the contemporaneous effect and all the lag coefficients, the lead coefficients are added as well because minimum wage changes are often announced ahead of time and there could be anticipatory changes in prices attributable to the minimum wage change, consistent with dynamic models of price setting with menu costs. These leads provide a very useful falsification test that is common in the literature, since the minimum wage is not expected to have effects on variables of interest many quarters before implementation.

I show that results are robust to matching the announcement date as opposed to the implementation date to the minimum wage change. Results are also similar when estimating a specification motivated by a dynamic model of price setting following Glover (2018), who derives a minimum-wage augmented Phillips curve. I adapt his specification to the store-level as shown in equation (3):

$$\pi_{it} = \phi_1 c_{it} + \phi_2 MW^r_{s,t} + \beta \mathbb{E}_t \pi_{i,t+1} + \varepsilon_{it}. \quad (3)$$

$\pi_{it}$ refers to the inflation rate, $c_{it}$ are real unit costs of production for inputs other than workers directly affected by the minimum wage, $MW^r_{s,t}$ is the state-specific real log minimum wage, and $\mathbb{E}_t \pi_{i,t+1}$ is the expected inflation in the next period.[7] However, it is not clear where to obtain data on store-level inflation expectations. Alternatively, I can first solve the equation forward to obtain equation (4) as follows:

$$\pi_{it} = \phi_1 \sum_{k=0}^{\infty} \beta^k \mathbb{E}_t c_{i,t+k} + \phi_2 \sum_{k=0}^{\infty} \beta^k \mathbb{E}_t MW^r_{s,t+k} + \varepsilon_{it}. \quad (4)$$

Several minimum wages are often announced at a single point in time, and firms facing costs of price adjustment are informed of the expected path of minimum wages long before implementation. I assume that the expected minimum wage at time $t+k$ will equal the announced minimum wage for time $t+k$ at time $t$. For simplicity, let firms assume the minimum wage remains constant after announced changes.[8] Assuming a discount rate $\beta$ and normalizing the nominal minimum wage with the CPI, the discounted sum of expected future real log minimum wages $\sum_{k=0}^{\infty} \beta^k \mathbb{E}_t MW^r_{s,t+k}$ can then be calculated. However, it is not clear how to obtain future store-level unit costs of other inputs, so I implement equation (4) as follows in equation (5):

$$\pi_{it} = \phi_2 \sum_{k=0}^{\infty} \beta^k \mathbb{E}_t MW^r_{s,t+k} + X'_{ct}\gamma + \alpha_i + \alpha_t + \varepsilon_{it}. \quad (5)$$

Therefore, I assume that the control variables as well as store and time fixed effects can capture variation in real unit costs of other inputs. $\phi_2$ captures the impact of changes in the discounted sum of expected future minimum wages on inflation rates. I allow this discounted sum to enter the specification both linearly and in logs to allow for easier comparison with the baseline specifications.

In addition, I implement a triple differences approach by interacting the log minimum wage with several determinants of the pass-through elasticity, denoted as $B_{it}$, as shown in equation (6):

$$\ln P_{it} = \alpha + \beta_1 \ln MW_{st} + \beta_2 \ln B_{it} + \beta_3 \ln MW_{st} \times \ln B_{it} + X'_{ct}\gamma + \alpha_i + \alpha_t + \varepsilon_{it}. \quad (6)$$

For example, $B_{it}$ can be measures of how binding the minimum wage is in each county, such that county-level variation in bindingness can be used in addition to state-level variation in the minimum wage. State-period fixed effects $\alpha_{st}$ can also be used in this case to control for heterogeneous trends at the state level, in which case $\beta_1$ will not be identified.

### A. *Threats to Identification*

I implement a variety of empirical approaches to address potential threats to the identification strategy. For example, a natural concern is that policymakers may set state minimum wages according to current economic conditions that correlate with trends in retail prices, leading to reverse causality and a violation of the parallel trends assumption.

First, I test for parallel pretrends using the distributed lag model shown in equation (2). To the extent that policymakers may set state minimum wages according to current economic conditions, they would need to predict breaks in trends precisely during the announcement of the minimum wage for the parallel trends assumption to be violated in this way.

Second, I implement a wide range of alternative empirical specifications and test whether results are similar with or without controlling for a large set of control variables, which include economic and policy variables that policymakers are

[7] In Glover (2018), these would be the wages of high-productivity workers unaffected by the minimum wage. In a retail setting, these would likely include wholesale costs.

[8] For example, consider a state following the federal minimum wage. The federal minimum wage was \$5.15 in 2007q2. An announcement was then made in 2007q2 that the federal minimum wage would be \$5.85 in 2007q3, \$6.55 in 2008q3, and \$7.25 in 2009q3. Therefore at the quarterly level, when $t = 2007q1$, $\mathbb{E}_t MW_{s,t+k}$ remains at the current level of \$5.15 $\forall k \geq 0$, but when $t = 2007q2$, $\mathbb{E}_t MW_{s,t+k} = 5.85$ where $1 \leq k \leq 4$, $\mathbb{E}_t MW_{s,t+k} = 6.55$ where $5 \leq k \leq 8$, and $\mathbb{E}_t MW_{s,t+k} = 7.25 \forall k \geq 9$.

TABLE 1.—EFFECT OF MINIMUM WAGE ON PRICES BY STORE TYPE
VARIABLES: LOG PRICE INDEX

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Store Type | Drug | | Grocery | | Merchandise | |
| Variables | Log price index | | | | | |
| Log MW | −0.0469 | −0.0632 | 0.0605* | 0.0576** | −0.00623 | −0.0121 |
| | (0.0555) | (0.0500) | (0.0311) | (0.0255) | (0.0241) | (0.0214) |
| Log housing price | | 0.0461** | | 0.0181 | | 0.0265** |
| | | (0.0194) | | (0.0140) | | (0.0131) |
| Log unemployment rate | | −0.00828 | | −0.000742 | | 0.00245 |
| | | (0.00858) | | (0.00606) | | (0.00452) |
| Log population | | 0.00427 | | −0.0776*** | | −0.0593*** |
| | | (0.0315) | | (0.0243) | | (0.0212) |
| Log average wage | | −0.0111 | | −0.00676 | | −0.00342 |
| | | (0.00989) | | (0.00867) | | (0.00742) |
| Observations | 354,064 | 353,938 | 287,284 | 287,122 | 282,092 | 282,037 |
| $R$-squared | 0.873 | 0.875 | 0.928 | 0.929 | 0.895 | 0.896 |
| Prob > $F$ | 0.403 | 0.000 | 0.058 | 0.002 | 0.797 | 0.064 |
| Number of units | 8,853 | 8,852 | 7,183 | 7,180 | 7,054 | 7,054 |
| Number of clusters | 48 | 48 | 48 | 48 | 49 | 49 |

Robust standard errors are in parentheses, clustered by state. Store and period fixed effects are included. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

likely to utilize. I also include richer specifications that add store-specific linear trends or use differences in the variables across time rather than their levels.

Third, I estimate effects using only variation in the federal minimum wage by comparing states bound by the federal minimum wage to those that are not. Minimum wages in these states only reflect increases in the federal minimum wage. Thus, any variation in the minimum wage in these states is less likely to be based on local economic conditions and driven by concerns of reverse causality. More precisely, I interact the minimum wage with an indicator for whether states are bound by the federal minimum wage. During the federal minimum wage hikes from 2007 to 2009, these states experienced a larger increase in the minimum wage than states that already had a state minimum wage above the federal one. Thus, the estimated effect on federally bound states is identified using variation in the magnitude of minimum wage changes due to differences in the initial gap between the federal and state minimum wages similar to Clemens and Wither (2019).

Fourth, I estimate effects during both the recessionary period and the recovery period. This robustness check could potentially alleviate concerns that the results are driven by heterogeneous trends during the Great Recession if the results are similar across these two periods.

Fifth, in some states, the state-level minimum wage is often raised automatically since it is linked to price indices, which could create another channel for reverse causality. However, all states, with the exception of Colorado, use the national CPI for indexation. Thus, any variation in minimum wages generated by indexing is absorbed by time fixed effects. I also test whether results are robust to dropping these indexing states.

Sixth, I relax the identifying assumption of parallel trends by estimating equation (6). This specification controls for heterogeneous trends at the state level and relies on variation in the bindingness of the minimum wage across counties. Any shock that might violate the parallel trends assumption would need to further vary with the bindingness of the minimum wage at the county level, which narrows the list of potential concerns.

## IV. Main Results

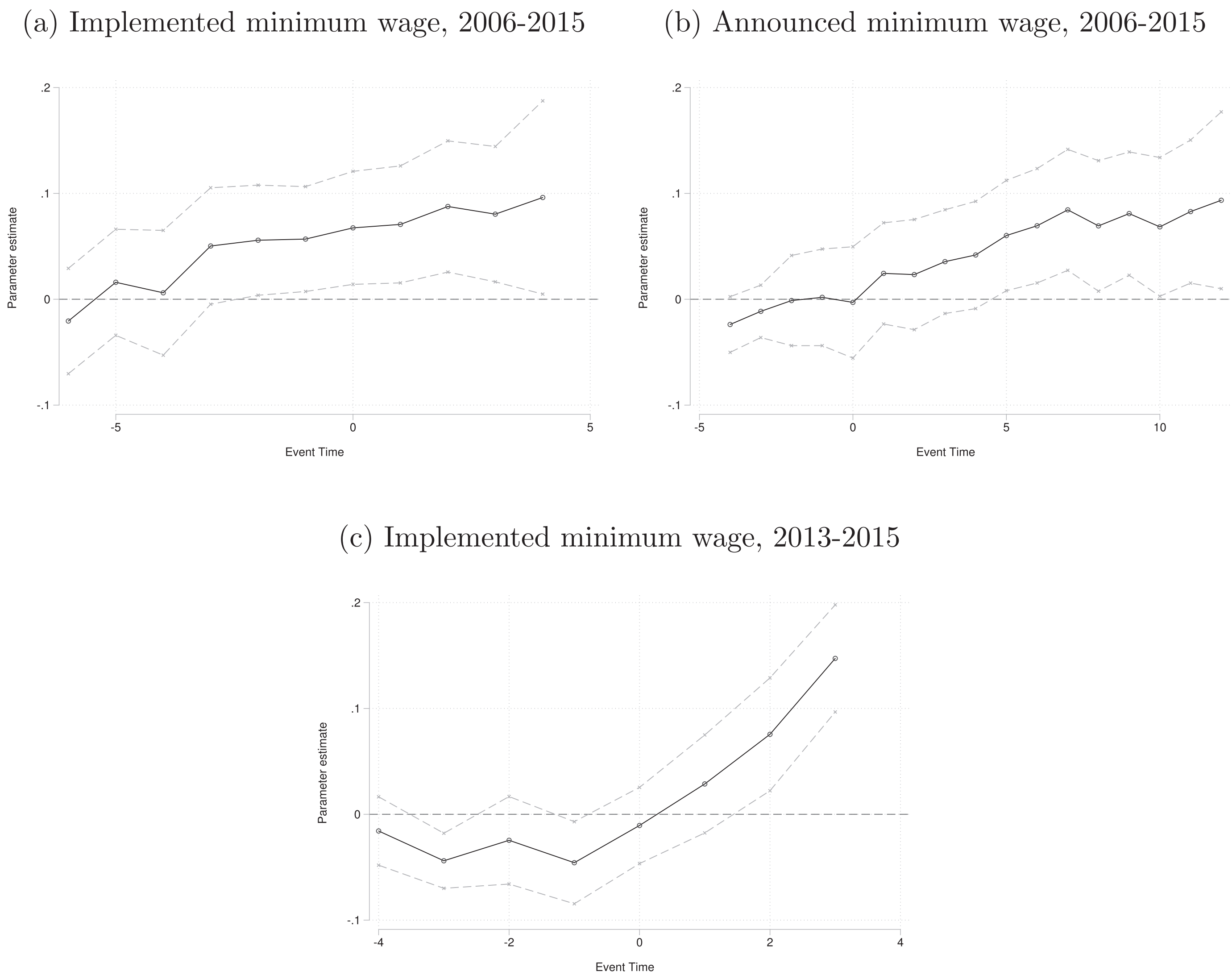
In this section, I present the main empirical evidence on how the minimum wage affected retail stores, first through the product markets, then through the labor markets to explain the product market effects. I give further interpretation of the results and the interaction between these two markets using theory derived in section V.

### A. *Product Markets*

I first estimate the contemporaneous effect of the minimum wage on prices using the standard fixed effects approach and store price indices as shown in equation (1). Table 1 presents the estimated pass-through elasticities for all store types with and without control variables. The point estimates are statistically significant for grocery stores with a pass-through elasticity of 0.058, while the coefficients on the control variables have signs mostly consistent with previous literature. The estimates are not statistically significant for other store types. I explain later in this section why the pass-through elasticity is large and significant in grocery stores but not in other store types.

I test for differential pretrends by estimating a distributed lag model for grocery stores as shown in equation (2). I choose an event window of six quarters before and four quarters after a minimum wage hike and plot both the distributed lag coefficients and the cumulative effects. This event window is long enough to show parallel pretrends and short enough such that little of the minimum wage variation is dropped from the

FIGURE 4.—CUMULATIVE EFFECT OF MINIMUM WAGE ON PRICES FOR GROCERY STORES




This figure plots the sum of estimated coefficients for each period, along with the 95% confidence intervals, from regressions using a distributed lag model, where log price index is regressed on log minimum wage. Control variables as well as store and period fixed effects are included. (a) The effect of the implemented minimum wage is estimated. (b) Estimates of the effect of the announced minimum wage for states that do not index their minimum wage to the national CPI, with the event window shifted to retain observations. When focusing on 2013 to 2015 when implementation lags were much shorter, the timing of the effect is sharper. Event windows are chosen to retain 2015q1 minimum wage variation, since the latest minimum wage data are available until 2016q3.

sample.[9] Given that the mean announcement of a minimum wage hike is around 3.21 quarters before the implementation, figure 4 shows suggestive evidence that prices spike mostly during the announcement of minimum wage hikes and trended slightly upward after these events. Renkin, Montialoux, and Siegenthaler (2017) also found announcement effects, and this is consistent with models of price setting with nominal rigidities as illustrated in Glover (2018). More important, there is no evidence that the positively significant results shown earlier are driven by differential pretrends.[10] Although the timing of the price changes is not extremely sharp, this is consistent with the fact that announcement dates vary for each minimum wage hike and the possibility that menu costs lead to gradual adjustment in prices.

To get a clearer picture of the timing, I first run the distributed lag model using the announced minimum wage instead of the implemented minimum wage as in Renkin et al. (2017). For announcements that cover multiple minimum wage changes, I take the maximum across all changes as the announced minimum wage. I also drop states that index their minimum wage to the national CPI since there is no exact announcement timing for these states. Figure 4b confirms that prices rise right after the announcement of minimum wage.

[9] A lot of the variation is in 2015q1, and the latest available minimum wage data are in 2016q3, which is six quarters after 2015q1.

[10] Appendix figure L4 plots the observations (collapsed into fifty bins) used to estimate the cumulative effect six quarters before a minimum wage change and four quarters after a change, showing that the slope is initially flat but becomes positive.

TABLE 2.—PASS-THROUGH ELASTICITY ESTIMATES INTERACTED WITH DETERMINANTS, GROCERY STORES

| Variables | (1) Kaitz index | (2) Log AW | (3) Fraction below 25K | (4) MW / median | (5) Log sales | (6) Log est. per cap |
|---|---|---|---|---|---|---|
| Interaction coefficient | 0.426*** | −0.124*** | 0.367*** | 0.438*** | −0.0853*** | −0.000954 |
| | (0.0617) | (0.0171) | (0.0526) | (0.0579) | (0.00909) | (0.00971) |
| Observations | 287,122 | 287,122 | 287,122 | 287,122 | 287,122 | 287,117 |
| *R*-squared | 0.949 | 0.949 | 0.949 | 0.949 | 0.951 | 0.948 |
| Prob > *F* | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Number of units | 7,180 | 7,180 | 7,180 | 7,180 | 7,180 | 7,180 |
| Number of clusters | 48 | 48 | 48 | 48 | 48 | 48 |

Robust standard errors are in parentheses, clustered at the state level. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$. The interaction coefficient is obtained from a regression of the log price index on log minimum wage, the variable of interest, and its interaction with the minimum wage, along with control variables as well as state-period fixed effects. The Kaitz index is defined as the ratio of the minimum wage to the average wage in each county. AW refers to average wage. Fraction below 25,000 refers to fraction of households earning below $25,000. Est. per Cap refers to the number of establishments per capita.

To further address concerns of differential pretrends, I argue that it is more reliable to draw inference from minimum wage changes for which the implementation lag is short as well as use variation outside of the recession. Therefore, I run the distributed lag within the sample period of 2013 to 2015, since most of these minimum wage changes have much shorter implementation lags, as shown in table K3. Figure 4c shows sharper timing and parallel trends in the entire preperiod and a similar cumulative effect of around 0.1.

There is reason to believe that the pass-through elasticity is heterogeneous across counties, since a minimum wage hike should have a larger effect where it is more binding. I employ the triple differences approach shown in equation (6) and examine how the pass-through elasticity changes with the Kaitz index, which is fixed to its value in the first quarter of 2006. I report the results with state-period fixed effects in table 2. The interaction coefficient is large and strongly significant. Raising the Kaitz index by 0.1 increases the pass-through elasticity by about 0.0426. This implies that within the Kaitz index distribution, moving a county from the 25th percentile value of around 0.3 to the 75th percentile of around 0.5 raises the pass-through elasticity by about 0.085. Similar to Alonso (2016), I use alternative measures of how binding the minimum wage is in each county: the log average wage, the fraction of households earning below $25,000 annually (which is the closest bracket available in the ACS to the annual income of an average minimum wage worker), and the minimum wage annual income to median household annual income ratio.[11]

Alternatively, I separate the sample by how binding the minimum wage is for each store using the county-level Kaitz index. I define a store as "rich" or "poor" if it resides in a county with a preperiod Kaitz index below or above median, respectively.[12] I estimate equation (1) separately for both groups of counties by store type and show the results in appendix table K4. The estimated pass-through elasticity for grocery stores in poor counties is statistically significant at the 1% level[13] and economically significant. A 10% increase in the minimum wage raises grocery store prices in those counties by 0.84%.[14]

To examine the large pass-through elasticity for grocery stores, I conduct several robustness checks. First, I provide estimates separately in four periods in appendix table K6, since there may be concern that the results are driven by heterogeneous trends during the Great Recession. Indeed, the results are strong in the 2008–2009 recessionary period but potentially even stronger in the 2014–2015 recovery period. These results indicate that the mechanism inducing a high pass-through persists across different phases of the business cycle.

In appendix table K7, I estimate the pass-through elasticity by using minimum wage levels instead of logs, dropping stores with average price indices below the 5th percentile or above the 95th percentile, monthly instead of quarterly observations, states that do not index the minimum wage to the CPI, counties that are interior or contiguous to state borders, accounting for local minimum wage ordinances, weighting observations by store sales or county population, aggregating store price indices to the county level using store sales before weighting the observations by county sales, adding store-specific time trends, and comparing states bound by the federal minimum wage to those that are not. The point estimates remain roughly similar and statistically significant. In appendix table K10, I construct price indices using alternative methods as illustrated in appendix section B and show that my results are robust. I also show additional results using only city and county level minimum wage variation in appendix section D.

[11] I also find that the pass-through elasticity is larger in stores with lower revenue, since smaller stores are more likely to be located in poorer regions. The interaction coefficient is insignificant using a proxy of grocery market concentration, the number of grocery stores per population in each county. Theoretical derivations in section V show the supply and demand shifts have opposing predictions on how competition affects the pass-through elasticity.

[12] Results are similar using the mean across the sample period instead. Results are robust to dividing counties into four quartiles rather than two quantiles according to their Kaitz index as shown in appendix table K5.

[13] The *p*-value is 0.0002, while the number of clusters remains high at 41. Even if a Bonferroni adjustment is made for multiple hypothesis testing across six independent hypotheses, the result is still statistically significant at the 1% level since $0.01/6 = 0.0017$.

[14] In appendix figure L5, these results are graphically displayed in a plot of the residualized log price index against the residualized log minimum wage with each store-year-quarter observation collapsed into fifty bins. The slope is steeper for poor counties. I also plot similar figures for drug and merchandise stores in appendix figure L6.

TABLE 3.—EFFECT OF MINIMUM WAGE ON REAL AND NOMINAL SALES BY STORE TYPE AND KAITZ INDEX

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Store Type | Drug | | Grocery | | Merchandise | |
| Counties | Rich | Poor | Rich | Poor | Rich | Poor |
| Log real sales | 0.0516 | 0.161 | −0.0147 | 0.0695 | 0.00473 | 0.221** |
| | (0.0707) | (0.134) | (0.0590) | (0.0763) | (0.0425) | (0.0831) |
| Log sales | −0.00614 | 0.0591 | 0.0437 | 0.153* | −0.00761 | 0.218** |
| | (0.0580) | (0.0953) | (0.0551) | (0.0771) | (0.0586) | (0.0946) |
| Observations | 309,002 | 44,936 | 246,966 | 40,156 | 231,709 | 50,328 |
| Number of units | 7,730 | 1,124 | 6,177 | 1,004 | 5,799 | 1,261 |
| Number of clusters | 48 | 40 | 48 | 41 | 48 | 45 |

Coefficients are obtained from twelve separate regressions (by store type and Kaitz index) of the two outcomes, log real sales and log nominal sales, on the minimum wage along with control variables as well as store and period fixed effects. Robust standard errors are in parentheses, clustered at the state level. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$. Real sales are defined as nominal sales divided by the store-specific price index. A county is defined as rich or poor if it has a Kaitz index below median or above median, respectively, relative to all counties.



I also show that my results are robust to using more control variables and additional alternative empirical specifications. Appendix table K8 adds a series of control variables, some of which may be used by policymakers, to the original set of economic variables. These control variables include state-level GDP per capita, state-level tobacco taxes, and state-level personal current transfer receipts from various government policies and other organizations. Although some of these control variables are correlated with minimum wage changes, they have a negligible effect on the magnitude of the estimated pass-through elasticity and actually increase the statistical precision of the estimate.[15] The reason is that based on the standard intuition from the omitted variable bias formula, these control variables are not strongly correlated with the outcome. Appendix table K9 uses specifications with differencing, store, and time fixed effects. Results are smaller with shorter differences but become statistically significant and converge to around 0.06 with longer differences, consistent with dynamic effects. This table also shows results using equation (5), which is based on a dynamic model of price setting. Results are statistically significant and similarly increase with longer differences, although the magnitudes cannot be compared to baseline specifications since the specification is different.

*Sales and results by product department.* Next, I present results on the response of real and nominal sales to the minimum wage. While the theoretical prediction for the sign of the quantity response is ambiguous due to the interaction between supply and demand, an empirical estimate may provide a useful test of whether demand effects are also at work. Alonso (2016) finds that real sales, defined as sales with prices fixed to a particular time period, increase in response to minimum wage hikes. I present alternative results by defining real sales as nominal sales divided by the store-specific price index and using this as a measure of quantities for an additional two years of data.[16] Table 3 shows the effect of the minimum wage on nominal and real sales for all store types, with the sample again segmented by rich and poor counties. While both the nominal and real sales response are positive and higher in poor counties for grocery stores, only the nominal sales response is marginally statistically significant. The nominal and real sales response in poor merchandise stores is large and statistically significant, which is suggestive of demand effects given arguments below in section V. Overall, these coefficients are slightly smaller than those found in Alonso (2016), and the somewhat large standard errors make it difficult to draw any conclusions from these results about the interaction of supply and demand effects.[17]

Furthermore, I also construct price indices by product department as classified by Nielsen to understand how price and real sales responses differ across product departments as shown in appendix table K11, which presents results for grocery stores in poor counties.[18] Most of the results are driven by food, which generates most of the revenue in grocery stores in the sample, as both prices and quantities have positive responses, although the quantity response is marginally insignificant.

*Impact of within-chain price rigidity.* To understand why the pass-through elasticity estimates are heterogeneous across store types, I first show the proportion of revenue generated by each of five product departments across store types in table K12. Drugstores earn most of their revenue from health and beauty care products, while both grocery and merchandise stores earn most of their revenue from food, although grocery stores earn a lot more from food, at around 77%. Combining these facts with the results I have already noted provides a potential explanation for why other store

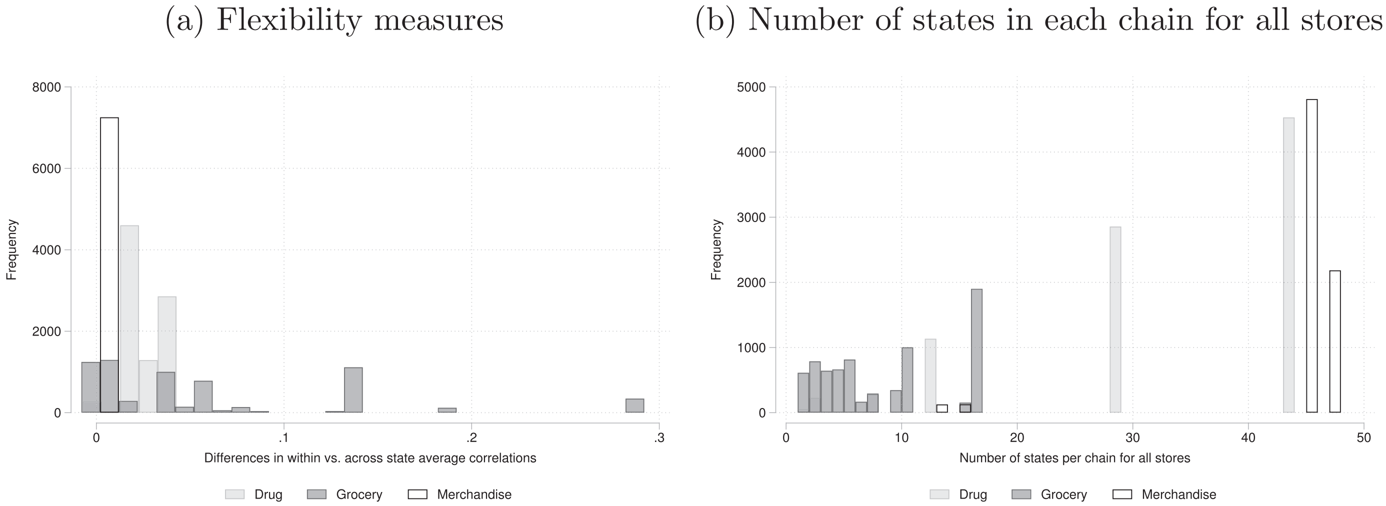
[15] Adding these control variables slightly increases the $R^2$ while having a negligible effect on the point estimate. However, conservatively assuming equal selection on observables and unobservables and a maximum $R^2$ of 1 to calculate a bias-adjusted treatment effect following Oster (2016) gives an estimate of −0.0077, which is still slightly below 0.

[16] Using only sales of the set of goods used to construct the price index gives very similar results.

[17] Deseasonalizing sales (and prices) gives almost identical results. I attempted two methods, using store-quarter-of-the-year fixed effects and the X-13ARIMA-SEATS Seasonal Adjustment Program available through the Census Bureau, both of which give similar results.

[18] I report additional results by store type in appendix tables K13, K14, and K15. There is evidence that prices and quantities increased in certain product departments in mass merchandise stores and the results are statistically significant.

FIGURE 5.—DISTRIBUTION OF FLEXIBILITY MEASURES ACROSS STORE TYPES




This figure plots the chosen flexibility measure, differences in within versus across state average correlations, as illustrated in section IVA, and also the number of states in each chain for all stores. A chain is pricing more rigidly if the flexibility measure is closer to 0.

types have statistically insignificant pass-through elasticities. If consumers respond to income increases mostly by changing demand for products such as food but not other types of products, then there would be smaller price responses in drug and merchandise stores, both of which do not derive the majority of their revenue from selling food.

The pass-through elasticity estimated from state minimum wage shocks should be affected by the extent to which chains are pricing rigidly. Chains that are located primarily in one state should also exhibit local pricing and react to local shocks, while chains that price rigidly and locate across many states should exhibit national pricing and will not react to local shocks. I follow DVG to measure the extent of price rigidity for each of the retail chains in the data and lay out the details in appendix section C. I plot the distribution of flexibility measures as well as number of states each chain is in across stores by store type in figure 5. A chain is pricing more rigidly if the flexibility measure is closer to 0. Both drug and merchandise stores belong to a few large chains that price rigidly, while a large number of grocery stores belong to chains that price flexibly or chains that are located in only a few states. There are over fifty grocery chains, while both drug and merchandise stores come from around five retail chains each.[19] This implies that most grocery stores are engaging in local pricing while drug and merchandise stores are not.

In appendix table K16, I show that the estimated pass-through elasticity decreases with the number of states the chain is in and increases for more flexible chains by interacting the minimum wage with these two variables in a sample with all store types. This is consistent with the previous finding that pass-through elasticity is small and insignificant in drug and merchandise stores but large and significant in grocery stores. Furthermore, I divide the grocery store sample into stores with local pricing and those without.[20] I define stores as local pricing if it has a flexibility measure above or at the median or belongs to a chain located in one or two states. I include chains with two states because almost all such chains earn over 90% of their revenue from one state. The minimum wage pass-through elasticity increases from 0.058 in the full sample to 0.083 in the flexible sample, and the 95% confidence interval rules out estimates below 0.03. The estimate in the rigid sample is small, insignificant, and statistically different from the estimate in the flexible sample. This further substantiates the claim that price rigidity, rather than difference in the type of goods sold, completely attenuates the effect of the minimum wage on prices for stores in rigid chains.

Overall, I conclude that a 10% increase in the minimum wage raises prices in grocery stores by about 0.6% to 0.8% but not in other types of stores because of within-chain price rigidity, and the response is statistically significant and larger in poorer counties. There is mixed evidence for increases in quantities sold. Results are not driven by differential pretrends and pass a variety of robustness checks.

### B. *Labor Markets*

I first apply standard fixed effects as in equation (1) to estimate the minimum wage effects on earnings and employment from 2006 to 2015. Results are presented for four types

[19]Data from the Economic Census also show that the grocery store industry is much less concentrated and less dominated by chains than the drug and merchandise store industries. For example, market share of the four largest firms is 30.7%, 54.4%, and 73.2% for grocery stores, drugstores, and merchandise stores, respectively, in 2007.

[20]Ideally, this empirical exercise could also be performed on drug and merchandise stores. However, unfortunately, there is basically no variation in price rigidity for these type of stores, which all price very rigidly, as shown in figure 5.

TABLE 4.—MINIMUM WAGE IMPACT ON LABOR MARKETS BY INDUSTRY

| Industry | (1) Drug | (2) Grocery | (3) Department | (4) Merchandise | (5) Restaurant |
|---|---|---|---|---|---|
| Earnings | 0.0638 | 0.146*** | 0.0323 | 0.157*** | 0.252*** |
| | (0.0390) | (0.0420) | (0.0466) | (0.0568) | (0.0341) |
| | 115,663 | 122,081 | 66,330 | 115,499 | 122,698 |
| Employment | 0.0880 | 0.00491 | −0.135 | −0.245 | −0.0755 |
| | (0.0604) | (0.0955) | (0.178) | (0.184) | (0.0551) |
| | 87,483 | 101,726 | 35,355 | 93,439 | 118,609 |

Data from the QWI, 2006–2015. Coefficients are obtained from ten separate regressions of the outcomes on the minimum wage under different specifications. Robust standard errors are in parentheses, clustered by state. Number of observations are given below the standard errors. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$. Log county population is added as a control variable along with county and period fixed effects. Industries include drugstores, grocery stores, department stores, other merchandise stores, and restaurants as classified by four-digit NAICS (4461, 4451, 4521, 4529, and 7225).

of retail stores that are present in scanner data that can be matched to four-digit NAICS industries: drugstores, grocery stores, department stores, and merchandise stores. Restaurants are also included for comparison. Table 4 reports estimates of contemporaneous minimum wage effects from ten separate regressions, with five industries and two outcomes. A 10% minimum wage hike raises earnings of grocery store workers by around 1.5%, while effects are also present for restaurants as in previous literature and also for merchandise stores. I show that the results are not driven by differential pretrends in appendix figure L7. Estimates for employment are statistically insignificant.

In addition, I show in appendix table K18 that the earnings effect is indeed stronger in poor counties.[21] I also follow Dube et al. (2016) and use a contiguous county sample to estimate the impact of the minimum wage on earnings, employment, hires, separations, and turnover in appendix table K17.[22] In addition to replicating their results on restaurants, I also find similar results for grocery stores, although the contiguous county-pair period fixed effects attenuates the earnings effect for both grocery and merchandise stores.

Overall, these results provide suggestive evidence that the minimum wage increases labor costs in grocery and merchandise stores, providing a range of estimates for the minimum wage impact on labor costs. This effect is also stronger in regions where the minimum wage is more binding. I interpret the implications of these results for product markets in the next section.

## V. Theory

To understand the determinants of the minimum wage pass-through elasticity and provide estimates based on theory to compare with the reduced-form empirical estimates, I first derive the *cost* pass-through elasticity under a range of assumptions about the degree of competition in the product market. This framework holds the demand side *fixed* and assumes the minimum wage only raises labor costs. I show that cost pass-through theory cannot fully explain my empirical findings, suggesting that demand-side effects are also needed to explain the results. I then derive the *demand* pass-through elasticity under a range of assumptions about the degree of competition in the product market, holding the supply side *fixed* and assuming that the minimum wage only raises household income. I show that the theoretically calibrated magnitude of the demand pass-through elasticity using this sufficient-statistic approach is consistent with my reduced-form estimate. I show further details on the theory in appendix section F.

### A. *Cost Pass-Through Elasticity*

I first assume that the minimum wage only affects labor costs. I use unit-tax pass-through derivations from Weyl and Fabinger (2013) and convert them to minimum wage pass-through elasticities. I lay out the full derivations in appendix section E.1, which shows that multiplying the pass-through rate $\frac{dp}{dt}$ by the cost share of minimum wage labor $s_{L_1}$ gives the minimum wage pass-through elasticity $\frac{d\ln p}{d\ln w_1}$:

$$\frac{d\ln p}{d\ln w_1} = \frac{dp}{dt} s_{L_1}. \tag{7}$$

The pass-through rate $\frac{dp}{dt}$ varies under different assumptions about the market structure and depends on the supply and demand elasticities, the curvature of demand, and the market-conduct parameter, which is the elasticity-adjusted Lerner index as shown in appendix section E.1. These formulas have several interesting empirical implications. First, store types that have higher minimum wage labor cost share should have higher pass-through elasticities. Second, product groups with lower elasticities of demand should have higher pass-through elasticities. Third, pass-through elasticity should vary across locations with different degrees of competition, holding store type and product group constant. Fourth, how income relates to the pass-through elasticity is ambiguous. On the one hand, individuals in poorer locations would probably face higher pass-through elasticities because more minimum-wage workers live there, but on the other

[21] Using triple differences instead implies nearly identical point estimates.

[22] One problem with the local controls approach to study product markets is that if consumers travel across state borders to contiguous county stores due to the price rises from a minimum wage increase in their state, using contiguous county stores would attenuate the estimated pass-through elasticity due to price rises in those counties as well from substitution. In other words, consumers are likely more mobile than workers, which makes the local controls approach more suitable to study labor markets rather than product markets.

TABLE 5.—THEORETICAL ESTIMATES OF MINIMUM WAGE PASS-THROUGH ELASTICITY

A. Labor cost effect

| | Weighted share of wages earned by MW affected workers | | | Cost pass-through elasticity | | |
|---|---|---|---|---|---|---|
| Spillover adjustment | Poor counties | Rich counties | All | Poor counties | Rich counties | All |
| Earnings elasticity | 0.184 | 0.117 | 0.146 | 0.0186 | 0.0118 | 0.0147 |
| None | 0.084 | 0.073 | 0.081 | 0.0085 | 0.0074 | 0.0082 |
| AMS | 0.162 | 0.164 | 0.181 | 0.0163 | 0.0165 | 0.0181 |
| Lee | 0.210 | 0.207 | 0.228 | 0.0211 | 0.0208 | 0.0229 |

B. Demand effect

| | Income elasticity of MW | | | Demand pass-through elasticity | | |
|---|---|---|---|---|---|---|
| Income elasticity of demand | Poor counties | Rich counties | All | Poor counties | Rich counties | All |
| 0.3 | 0.0254 | 0.0114 | 0.0170 | 0.0054 | 0.0024 | 0.0036 |
| 0.65 | 0.0254 | 0.0114 | 0.0170 | 0.0116 | 0.0052 | 0.0078 |
| 1 | 0.0254 | 0.0114 | 0.0170 | 0.0179 | 0.0080 | 0.0120 |

For the labor cost effect, I use pooled data from ACS, 2006–2015. Industries are classified according to the NAICS. Labor cost shares are from 2007 and 2012 SUSB, which give an average of 10.1% for grocery stores. Shares are constructed using ACS sample person weights. Earnings elasticities are estimated in this paper. Spillover adjustments are made based on theoretical derivations and using spillover elasticity estimates from AMS and Lee, normalized by the maximum percentile. Pass-through rates are taken from estimates in previous literature and assumed to be 1 as an upper bound. The minimum-wage pass-through elasticity is a multiple of the labor cost share, the weighted share of wages earned by MW affected workers, and the pass-through rate as shown by theory. For the demand effect, MPC estimates are collected from the previous literature. Income elasticities of demand are calculated from the MPC estimates assuming an expenditure share of 0.1 for food at home. Demand elasticity of −0.709 and pass-through rate of 0.5 are estimated in Leung and Seo (2018) and consistent with the previous literature. Income elasticity of minimum wage is calculated from estimates from Dube (2019) and further derivations.

hand, the lower income of most customers could possibly raise elasticities of demand, lowering the pass-through elasticity. MaCurdy's (2015) result that the minimum wage is a regressive tax is driven by the fact that low-income workers tend to consume a higher share of goods produced by minimum wage labor. These formulas point to several additional determinants of the pass-through elasticity that drive distributional effects: which type of store a consumer shops in, the demographic characteristics of the consumers who shop there, and the competitive environment the store faces are all important factors to consider.

I discuss various estimates of the pass-through rate in the previous literature in appendix section F. To obtain an upper bound for the pass-through elasticity, I assume complete pass-through. I show the theoretical estimates of pass-through elasticity for grocery stores in panel A of table 5 under different assumptions using data from the ACS. First, I assume no spillover effects. In this case, the minimum wage pass-through elasticity equals the minimum wage cost share, which is obtained by multiplying the pass-through rate with the payroll ratio (labor cost share) and the proportion of wages paid to minimum wage workers. The labor cost share is relatively low for retail stores at around 10%. Since the proportion of wages paid to minimum wage workers is around 8%, the estimated pass-through elasticity is 0.0082 for grocery stores.

Second, the minimum wage could raise wages for workers earning above the minimum wage. Previous literature has often accounted for spillovers in an ad hoc manner by including the earnings of workers with wages some percentage above the minimum wage into the minimum wage labor cost share. I derive a reduced-form way of incorporating existing estimates of spillover into the pass-through elasticity formula in appendix section E.2 (AMS; Lee, 1999, hereafter Lee). The relevant formula is

$$\begin{aligned}\frac{d\ln p}{d\ln w_1} &= \frac{dp}{dt}\frac{\sum_{i=1}^{n} w_i L_i}{pY}\sum_{i=1}^{n} s_i \varepsilon_{w_i,w_1}\\ &= \frac{dp}{dt}\frac{\sum_{i=1}^{n} w_i L_i}{pY}\varepsilon_{\overline{wh},w_1}. \end{aligned} \tag{8}$$

There are $n$ types of workers, and minimum wage workers are denoted as $i = 1$. The minimum wage pass-through elasticity $\frac{d\ln p}{d\ln w_1}$ equals the pass-through rate $\frac{dp}{dt}$ multiplied by the payroll ratio $\frac{\sum_{i=1}^{n} w_i L_i}{pY}$ and a weighted sum of the shares of wages earned by workers affected by the minimum wage $s_i$, where the weights are given by the spillover elasticities $\varepsilon_{w_i,w_1}$ for each type of worker. Under certain assumptions shown in appendix section E, this weighted share of wages earned by workers affected by the minimum wage is equal to the earnings elasticity $\varepsilon_{\overline{wh},w_1}$ estimated in section IVB.

The earnings elasticity estimate using standard fixed effects is 0.117 and 0.184 for rich and poor counties, respectively, and the 95% upper confidence bounds do not exceed 0.28. Theoretically, together with the fact that the labor cost share is 10%, this implies a pass-through elasticity of 0.028, smaller than the 95% lower confidence bound of 0.044 for the reduced-form estimate for poor counties in section IVA. The main estimate using all counties, however, has only a 95% lower confidence bound of 0.008, so I can only conclude that cost pass-through theory does not seem to explain the large magnitude of the minimum wage pass-through elasticity estimate in poor counties if we use the 95% lower confidence bound, although the point estimate of 0.058 using all counties is much greater than 0.028. In addition, the difference in the calibrated cost pass-through elasticity between rich and poor counties is only 0.0068, which is much smaller than the reduced-form estimate of 0.0253. Therefore, the labor cost effect alone is unable to explain the dispersion in the point estimates between rich and poor counties.

As an alternative to using the earnings elasticity, I use spillover estimates from AMS and Lee.[23] Using the procedure described above with details in appendix section F, even if I use the largest estimates of spillover effects estimated in Lee, the calculated pass-through elasticity is much smaller than the empirical estimate I obtain for grocery stores in poor counties. The smallest lower bound of the 95% confidence interval of my reduced-form estimates for poor counties is around 0.044, whereas the largest estimate of cost pass-through elasticity is 0.024.

Therefore, cost pass-through theory does not seem to explain the large magnitude of the minimum wage pass-through elasticity estimate in poor counties or the dispersion in the estimate between rich and poor counties, suggesting that demand-side effects could play an important role.

### B. *Demand Pass-Through Elasticity*

I now assume that the minimum wage only affects household income. In appendix section E.4, I show that under symmetric imperfect competition, the demand pass-through elasticity can be written as

$$\frac{d\ln p}{d\ln w_1} = \left(1 - \frac{dp}{dt}\right)\frac{\varepsilon_{Q^D,I}}{-\varepsilon_D}\varepsilon_{I,w_1} + \left(\frac{dp}{dt}\right)\frac{\theta}{-\varepsilon_D}\varepsilon_{p',I}\varepsilon_{I,w_1}. \tag{9}$$

There are two terms through which demand-side effects could raise prices. First, if the minimum wage increases product demand among consumers due to increased income, a demand shift could raise prices if the cost pass-through rate $\frac{dp}{dt}$ is below 1. This first term, which I denote as the shift effect, is equal to 1 minus the cost pass-through rate, multiplied by the income elasticity of demand $\varepsilon_{Q^D,I}$, the inverse demand elasticity, and the income elasticity with respect to the minimum wage $\varepsilon_{I,w_1}$. Second, income could have a direct effect on demand elasticity. I denote this second term as the slope effect. These two terms imply that retailers could raise prices by raising markups even if marginal costs are flat. According to SV, marginal costs of retailers are not very responsive to local demand shocks. Around 75% of costs in a retail store are wholesale costs, which exhibit little geographic variation due to the tradable nature of retail goods as well as restrictions imposed by the Robinson-Patman Act. Almost all remaining costs are retail rents and labor costs, and SV show that these two components do not respond strongly to local demand shocks. Therefore, if the supply elasticity is large, the pass-through rate would be incomplete and hence below 1 if the market-conduct parameter is positive and demand is log-concave.

[23] I represent each worker type by each percentile on the national wage distribution.

In panel B of table 5, I theoretically calibrate the magnitude of the minimum wage pass-through elasticity assuming only demand effects using equation (9). I focus on the shift effect because the slope effect requires an estimate of the superelasticity that is rarely estimated in the previous literature. I focus on food at home for these estimates since grocery stores derive over 75% of their revenue from food at home, and estimates of marginal propensity to consume (MPC) for food at home are most readily available.[24] The calibrated magnitudes show that the shift term of the demand effect alone can generate pass-through elasticities of about 0.02. Given differences in the income elasticity of the minimum wage across rich and poor counties, the magnitude of heterogeneity in my reduced-form estimates of pass-through elasticities is also in line with the heterogeneity in these theoretical calibrations.

I also provide suggestive empirical evidence of a demand effect. First, I show that poorer households decrease shopping intensities when the minimum wage rises in appendix section G. Second, I find that product groups with lower demand elasticities have higher pass-through elasticities as consistent with the theory in appendix section H. I also show in appendix section I that organic food, which is much more likely to be consumed by high-income households, has a negligible price and real sales response relative to nonorganic food.

### C. *Mechanisms*

Overall, there are three mechanisms through which the minimum wage could affect prices and quantities sold in product markets. First, labor cost increases and shifts the supply curve upward, raising prices and decreasing quantities sold. Second, consumer demand could shift outward and raise quantities sold. Third, consumer demand elasticities could drop, leading retailers to mark up retail prices and decrease quantities sold. The combined effects of these three mechanisms raise retail prices, while the impact on quantities sold is ambiguous. The fact that the effect of the minimum wage on real sales in merchandise stores is positively significant, as shown in table 3, is suggestive of demand effects. Since merchandise stores price nationally, quantities will not decrease as much as grocery stores as a result of increased markups, while many of the products sold in merchandise stores, in particular food, are also sold in grocery stores. Out of the three mechanisms described above, only a demand shift can raise quantities sold.

[24] As summarized in Hoynes and Schanzenbach (2009), MPC estimates for food at home are around 0.03 to 0.17. I use the lower range of these estimates to calculate the income elasticities of demand for food at home, which are around 0.03 to 0.1 given an expenditure share of 0.1 for food at home. The demand elasticity estimate is obtained from Leung and Seo (2018) and consistent with Andreyeva, Long, and Brownell (2010). The pass-through rate estimate is also estimated in Leung and Seo (2018) and is slightly higher than those in Besanko, Dubé, and Gupta (2005) due to a high estimated curvature of demand. The income elasticity of minimum wage is calculated using derivations in section E.3 and estimates from Dube (2019).

However, it is important to note that demand-induced feedback is only one of several mechanisms that could potentially increase prices beyond the magnitude predicted under complete labor cost pass-through. First, minimum wage increases could also increase the labor costs of manufacturing goods sold in the retail sector. Renkin et al. (2017) show that this mechanism could boost the pass-through elasticity by about 0.02. Another mechanism is that consumers could be substituting to food at home as prices for food away from home rises, increasing the demand for groceries and possibly lowering the demand elasticity as well. The results illustrated are also consistent with this mechanism. Quantifying the magnitude of this mechanism would require estimates of the cross-price elasticity of food at home with respect to food away from home. Although there is no clear consensus on the magnitude of this elasticity, Richards and Mancino (2014) estimate a cross-price elasticity of food at home with respect to fast food prices at around only 0.06. Given that existing estimates of the minimum wage pass-through to restaurant prices are around 0.07, a cross-price elasticity at least an order of magnitude larger would be needed to explain the real sales responses I find.

## VI. Discussion and Conclusion

In this paper, I find evidence that the minimum wage increases prices in grocery stores but not in other store types because of rigid pricing within retail chains. A 10% minimum wage hike raises grocery store prices by about 0.58%. This finding holds across different phases of the business cycle and passes a variety of robustness checks. Furthermore, the pass-through elasticity is stronger in regions where the minimum wage is more binding. I present evidence that the minimum wage increases earnings of grocery store workers, but based on cost pass-through theory, this labor cost increase is not large enough to fully explain the rise in prices.

I propose that demand-induced feedback leads to a larger pass-through elasticity by increasing income, lowering demand elasticities, and increasing retail markups. I support this claim with four pieces of evidence. First, I derive pass-through formulas for calibrations to show that demand effects can account for the size of the reduced-form estimate. Second, I find that merchandise stores, which do not raise their prices in response to local minimum wage shocks due to within-chain price rigidity, exhibit large nominal and real sales responses to minimum wage increases. Third, I find suggestive evidence that poorer households lower shopping intensities when the minimum wage rises, consistent with lower price sensitivities. Fourth, I provide evidence that multiproduct retailers raise prices for more demand-inelastic product groups, consistent with retail markups.

Overall, these results have several interesting and important implications. First, while the existing literature has found that the minimum wage reduces nominal wage inequality, the reduction in real wage inequality is less substantial. For example, AMS find that for a 10% increase in the minimum wage, a worker earning the 10th percentile of the national wage distribution experiences around a 1.6% increase in wages relative to the median. Extrapolating earlier findings to the entire consumer basket, with caveats that other products may have smaller responses due to smaller MPCs and rigid pricing in national chains, the increase in real wages would be smaller by 0.3% to 0.9% in poor counties, which brings the increase in real wages relative to the median down to about 0.7% to 1.3%. Furthermore, the poor who are not working would only bear the higher costs of living without increases in income.

Second, within-chain price rigidity can substantially lower the impact of local minimum wage shocks on local prices. In stores that belong to chains that practice rigid pricing and locate in states across the United States, the estimated pass-through elasticity is indistinguishable from 0. This also attenuates the increase in real wage inequality by negating demand feedbacks. Since grocery stores have an expenditure share of about 60% in the consumer panel, this implies that chain rigidity lowers the pass-through elasticity to about 0.035 from 0.083 using only flexible pricing stores, a 58% decrease. However, stores that price nationally are still likely to react to national shocks, such as a rise in the federal minimum wage.

Third, these results imply that looking only at the nominal spending response of the minimum wage hike would hugely overstate its benefits for low-wage workers, as the response in real spending is around half of the response in nominal spending.

Fourth, increasing residential segregation would magnify the regressive nature of the minimum wage tax, since low-wage workers will be more likely to shop at the same stores and experience bigger rises in cost of living. This mechanism should also apply to local goods and services with sufficiently high demand responses to income and could arise even within counties if shopping locations are strongly segregated by the income of consumers. While there are no good data on the demographic characteristics of customers in each store, I provide suggestive evidence that income segregation does magnify this mechanism in appendix section J.

Fifth, there has been a global movement to increase the minimum wage to unprecedented levels in both Europe and the United States. These results imply that the pass-through elasticity will become correspondingly larger and each minimum wage hike will have increasing effects on inflation. For example, if the national minimum wage in the United States increases from \$7.25 to \$15, the national Kaitz index would be raised from around 0.3 to 0.6, assuming the average wage increases only slightly. Extrapolating out-of-sample subject to caveats with the triple difference results above, this implies that the pass-through elasticity would increase from 0.06 to roughly 0.19. The effect of each minimum wage hike is progressively stronger due to the nonlinearity in the price response. A further 10% increase in minimum wage would raise grocery store prices by 1.9%.

As movements to increase the minimum wage to historic levels gain traction around the world, the impact of the minimum wage on the cost of living becomes more crucial. Better data on both prices and quantities of goods and services in other industries and countries are needed to inform the policy debate.

REFERENCES


Aaronson, Daniel, "Price Pass-Through and the Minimum Wage," this REVIEW 83 (2001), 158–169. 10.1162/003465301750160126

Aaronson, Daniel, Sumit Agarwal, and Eric French, "The Spending and Debt Response to Minimum Wage Hikes," *American Economic Review* 102 (2012), 3111–3139. https://doi.org/10.1257/aer.102.7.3111

Aaronson, Daniel, and Eric French, "Product Market Evidence on the Employment Effects of the Minimum Wage," *Journal of Labor Economics* 25:1 (2007), 167–200. https://doi.org/10.1086/508734

Aaronson, Daniel, Eric French, and James MacDonald, "The Minimum Wage, Restaurant Prices, and Labor Market Structure," *Journal of Human Resources* 43 (2008), 688–720. https://doi.org/10.2139/ssrn.630515

Allegretto, Sylvia, Arindrajit Dube, Michael Reich, and Ben Zipperer, "Credible Research Designs for Minimum Wage Studies: A Response to Neumark, Salas, and Wascher," *ILR Review* 70 (2017), 559–592. https://doi.org/10.1177/0019793917692788

Alonso, Cristian, "Beyond Labor Market Outcomes: The Impact of the Minimum Wage on Nondurable Consumption," Princeton University working paper (2016). https://doi.org/10.2139/ssrn.2818623

Andreyeva, Tatiana, Michael W. Long, and Kelly D. Brownell, "The Impact of Food Prices on Consumption: A Systematic Review of Research on the Price Elasticity of Demand for Food," *American Journal of Public Health* 100 (2010), 216–222. https://doi.org/10.2105/AJPH.2008.151415, PubMed: 20019319

Autor, David H., Alan Manning, and Christopher L. Smith, "The Contribution of the Minimum Wage to US Wage Inequality over Three Decades: A Reassessment," *American Economic Journal: Applied Economics* 8 (2016), 58–99. https://doi.org/10.3386/w16533

Beraja, Martin, Erik Hurst, and Juan Ospina, "The Aggregate Implications of Regional Business Cycles," *Econometrica* 87 (2015), 1789–1833. https://doi.org/10.3982/ECTA14243

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan, "How Much Should We Trust Differences-in-Differences Estimates?" *Quarterly Journal of Economics* 119 (2004), 249–275. http://www.nber.org/papers/w8841

Besanko, David, Jean-Pierre Dubé, and Sachin Gupta, "Own-Brand and Cross-Brand Retail Pass-Through," *Marketing Science* 24 (2005), 123–137. https://doi.org/10.1287/mksc.1030.0043

Borusyak, Kirill, and Xavier Jaravel, "Revisiting Event Study Designs," working paper (2017). https://ssrn.com/abstract=2826228

Cavallo, Alberto, Eduardo Cavallo, and Roberto Rigobon, "Prices and Supply Disruptions during Natural Disasters," *Review of Income and Wealth* 60 (2014), S449–S471. https://doi.org/10.3386/w19474

Chevalier, Judith A., Anil K. Kashyap, and Peter E. Rossi, "Why Don't Prices Rise during Periods of Peak Demand? Evidence from Scanner Data," *American Economic Review* 93 (2003), 15–37. https://doi.org/10.1257/000282803321455142

Clemens, Jeffrey, and Michael Wither, "The Minimum Wage and the Great Recession: Evidence of Effects on the Employment and Income Trajectories of Low-Skilled Workers," *Journal of Public Economics* 170 (2019), 53–67. https://doi.org/10.3386/w20724

DellaVigna, Stefano, and Matthew Gentzkow, "Uniform Pricing in U.S. Retail Chains," *Quarterly Journal of Economics* 134 (2019), 2011–2084. https://doi.org/10.3386/w23996

Dettling, Lisa, and Joanne Hsu, "Minimum Wages and Consumer Credit: Impacts on Access to Credit and Traditional and High-Cost Borrowing," SSRN scholarly paper 2911761 (2017). https://doi.org/10.17016/FEDS.2017.010

Draca, Mirko, Stephen Machin, and John Van Reenen, "Minimum Wages and Firm Profitability," *American Economic Journal: Applied Economics* 3 (2011), 129–151. https://doi.org/10.1257/app.3.1.129

Dube, Arindrajit, "Minimum Wages and the Distribution of Family Incomes," *American Economic Journal: Applied Economics* 11 (2019), 268–304. https://doi.org/10.1257/app.20170085

Dube, Arindrajit, T. William Lester, and Michael Reich, "Minimum Wage Shocks, Employment Flows and Labor Market Frictions," *Journal of Labor Economics* 34 (2016). https://doi.org/10.1086/685449

Freyaldenhoven, Simon, Christian Hansen, and Jesse M. Shapiro, "Pre-Event Trends in the Panel Event-Study Design," *American Economic Review* 109 (2019), 3307–3338. https://doi.org/10.1257/aer.20180609

Gagnon, Etienne, and David Lopez-Salido, "Small Price Responses to Large Demand Shocks," SSRN scholarly paper 2405101 (2014). https://doi.org/10.1093/jeea/jvz002

Ganapati, Sharat, and Jeff Weaver, "Minimum Wage and Retail Price Pass-Through: Evidence and Estimates from Consumption Data," Yale University working paper (2017). https://doi.org/10.2139/ssrn.2968143

Glover, Andrew, "Aggregate Effects of Minimum Wage Regulation at the Zero Lower Bound," *SSRN Electronic Journal* (2018). https://doi.org/10.1016/J.JMONECO.2018.11.001

Handbury, Jessie, and David E. Weinstein, "Goods Prices and Availability in Cities," *Review of Economic Studies* 82:1 (2015), 258–296. https://doi.org/10.1093/restud/rdu033

Harasztosi, Peter, and Attila Lindner, "Who Pays for the Minimum Wage?" *American Economic Review* 109 (2019), 2693–2727. https://doi.org/10.1257/aer.20171445

Hoynes, Hilary W., and Diane Whitmore Schanzenbach, "Consumption Responses to In-Kind Transfers: Evidence from the Introduction of the Food Stamp Program," *American Economic Journal: Applied Economics* 1 (2009), 109–139. https://doi.org/10.1257/app.1.4.109

ILO, *Minimum Wages Policy* (Geneva: International Labour Office, 2006).

Kennan, John, "The Elusive Effects of Minimum Wages," *Journal of Economic Literature* 33(4), 1950–1965. https://doi.org/10.1257/jep.35.1.3

Lee, David S., "Wage Inequality in the United States during the 1980s: Rising Dispersion or Falling Minimum Wage?" *Quarterly Journal of Economics* 114 (1999), 977–1023. https://www.jstor.org/stable/2586889

Lemos, Sara, "A Survey of the Effects of the Minimum Wage on Prices," *Journal of Economic Surveys* 22 (2008), 187–212. https://doi.org/10.1111/j.1467-6419.2007.00532.x

Leung, Justin H., and Hee Kwon Seo, "How Do Government Transfer Payments Affect Retail Prices and Welfare? Evidence from SNAP," National University of Singapore working paper (2018).

MaCurdy, Thomas, "How Effective Is the Minimum Wage at Supporting the Poor?" *Journal of Political Economy* 123 (2015), 497–545. https://doi.org/10.1086/679626

Neumark, David, and William L. Wascher, "Minimum Wages and Employment," *Foundations and Trends in Microeconomics* 3:1–2 (2007), 1–182. https://doi.org/10.3386/w4509

Oster, Emily, "Unobservable Selection and Coefficient Stability: Theory and Evidence," *Journal of Business and Economic Statistics* 37 (2016), 1–18. https://doi.org/10.1080/07350015.2016.1227711

Renkin, Tobias, Claire Montialoux, and Michael Siegenthaler, "The Pass-Through of Minimum Wages into US Retail Prices: Evidence from Supermarket Scanner Data," working paper (2017).

Richards, Timothy J., and Lisa Mancino, "Demand for Food-away-from-Home: A Multiple-Discrete–Continuous Extreme Value Model," *European Review of Agricultural Economics* 41 (2014), 111–133. https://doi.org/10.1093/erae/jbt008

Stigler, George J., "The Economics of Minimum Wage Legislation," *American Economic Review* 36 (1946), 358–365. https://www.jstor.org/stable/1801842

Stroebel, Johannes, and Joseph Vavra, "House Prices, Local Demand, and Retail Prices," *Journal of Political Economy* 127 (2018), 1391–1436. https://doi.org/10.1086/701422

Vaghul, Kavya, and Ben Zipperer, "Historical State and Sub-State Minimum Wage Data, technical report (2016).

Weyl, E. Glen, and Michal Fabinger, "Pass-Through as an Economic Tool: Principles of Incidence under Imperfect Competition," *Journal of Political Economy* 121 (2013), 528–583. https://doi.org/10.1086/670401