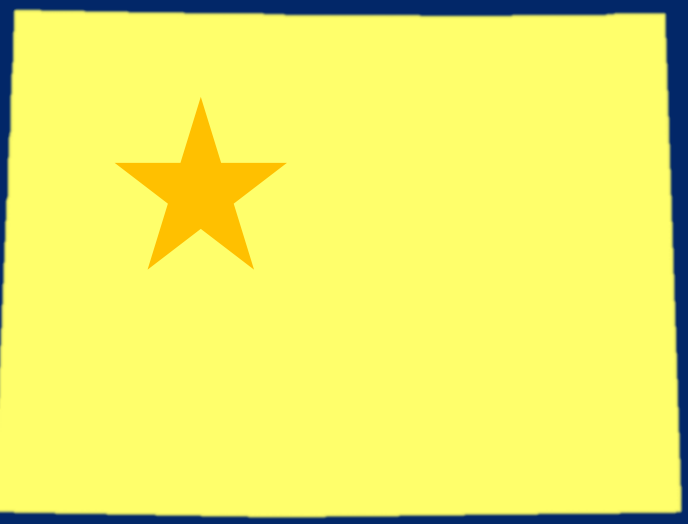

Informing Strategic Enforcement Practices

Minimum Wage Compliance and Complaints in the Denver Area

September 2024

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Executive Summary

In November 2019, the Denver City Council passed Council Bill 19-1237, making Denver the first local government in Colorado to enact a local minimum wage.[1] The Denver ordinance raised the local minimum wage to $12.85/hour on January 1, 2020, with annual scheduled increases thereafter.[2]

This study uses Current Population Survey (CPS) Outgoing Rotation Group data—widely considered the best publicly available survey data on hours and earnings—to estimate the incidence of minimum wage violations in the Denver-Aurora-Lakewood Metropolitan Statistical Area (hereafter "Denver MSA" or "Denver area") over the past fifteen years.[3] The Denver MSA includes the City and County of Denver as well as the counties of Adams, Arapahoe, Broomfield, Clear Creek, Douglas, Elbert, Gilpin, Jefferson, and Park.[4] Between 2007 and 2019, all jurisdictions in the Denver MSA were governed by the Colorado minimum wage. Since 2020, businesses in the City and County of Denver are subject to the Denver minimum wage, while all other jurisdictions in the Denver MSA continue to use the state minimum wage.[5]

Given that the CPS is a household-based survey, we are only able to determine where a respondent lives and not where their place of employment is. As the majority of workers working within the city of Denver commute from outside of the city,[6] data from the broader metropolitan area must be used in order to capture the entire Denver workforce within the analysis. We thus provide two sets of estimates for the years after the Denver minimum wage was passed (i.e., 2020-22), using the (lower) state minimum wage rate and the (higher) Denver minimum wage rate.[7] See **Appendix I** for more on our methodology.

[1] For 20+ years, Colorado law preempted local jurisdictions in the state from enacting minimum wages above the state level. In 2019, Colorado passed House Bill 19-1210, which gave up to ten percent of local governments the authority to establish a local minimum wage above the state's minimum wage. Denver was the first jurisdiction to establish a local minimum wage in 2019, followed by Edgewater and Boulder County in 2023.

[2] The Denver law adjusts the minimum wage rate using the CPI-W, while the Colorado law adjusts the minimum wage rate using the more general CPI-U. See Division of Labor Standards and Statistics, "Local Minimum Wage Report 2023," Department of Labor and Employment, https://cdle.colorado.gov/sites/cdle/files/Local_Min_Wage_Report_2023_1.pdf, pp. 8-9.

[3] In 2023, OMB Bulletin No. 23-01 renamed the Denver-Aurora-Lakewood MSA the Denver-Aurora-Centennial MSA.

[4] See Office of Management and Budget, OMB Bulletin No. 20-01, https://www.whitehouse.gov/wp-content/uploads/2020/03/Bulletin-20-01.pdf, p. 49.

[5] See Appendix II for more information on the applicable minimum wage rates used in this study.

[6] U.S. Census Bureau, 2016-2020 5-Year ACS Commuting Flows, https://www.census.gov/data/tables/2020/demo/metro-micro/commuting-flows-2020.html

[7] Calculations for 2020 to 2022 using the state minimum wage thus include an unknown number of "false negatives," as those working in Denver and making below the Denver rate but above the state rate would not appear as violations. Likewise, calculations for this period using the Denver minimum wage include an unknown number of "false positives," or those working outside of Denver that are paid the appropriate state rate but are paid below the Denver rate.

Based on our analysis of CPS data, we find that:

- At least **45,000 workers a year on average were paid below the applicable state or local minimum wage** within the Denver-Aurora MSA from 2007 to 2022, the period of the study. Given our conservative methodology, we expect the true number to be even higher.
- We estimate that these workers on average **lost at least $136 million annually**, or nearly **$3,000 per worker**.
- The number of **workers paid below the applicable minimum wage has risen** over recent years as the Colorado state and Denver minimum wages have gone up and pay has lagged.
- Minimum wage violation rates are highest in **private households, food services and drinking places, personal and laundry services, and accommodation**.
- **Women, noncitizens, and people of color are more likely to experience minimum wage theft**. Workers identifying with more than one of these groups are particularly likely to experience minimum wage theft. For example, **Black and Latine female noncitizens are roughly four times as likely than white male citizens to be paid below the minimum**.
- **Younger and older workers are more likely** to experience a minimum wage violation than mid-career workers.
- **Part-time workers and those without a high school diploma are more than three times as likely to be paid below the minimum** than full-time workers and high school graduates.

We supplement our study of underlying minimum wage violations in the Denver MSA with an analysis of minimum wage complaints received by Denver Labor since the local minimum wage ordinance went into effect in January 2020.[8] While this type of analysis has been used in the past to suggest initial priorities within proactive, data-driven enforcement strategies in other jurisdictions,[9] Denver Labor already engages in targeted investigations within key sectors such as personal services. One purpose of this report, therefore, is to analyze available data to: a) assess the extent to which Denver Labor's proactive investigations target industries with the highest violation rates; and b) compare enforcement outcomes between proactive and complaint-based cases, with the ultimate goal of informing Denver Labor's efforts to continue to refine and strengthen its enforcement program.

Based on our analysis of Denver Labor complaint data, we find that:

- "Active cases," or those initiated by the office without a complaint, accounted for 32 percent of all cases yet nearly 46 percent of total compensation to workers.
- Active cases averaged $770 in compensation per worker (including back wages, damages, and interest), nearly double the compensation found per worker across all other cases ($408).

[8] Complaint data was provided by Denver Labor to WJL@RU for analysis.
[9] See L.A. County and Oregon studies at https://smlr.rutgers.edu/wjl-ru/beyond-bill-studies

- The four industries where roughly 80 percent of proactive cases were carried out—personal and laundry services, retail trade, food services and drinking places, and administrative and support services—are among the seven highest violating industries, based on our analysis of CPS data.

These statistics suggest that Denver Labor has largely been successful in directing their proactive efforts toward high-impact cases in industries with high rates of underlying wage theft. In other words, the agency has effectively allotted its resources to increase its impact in uncovering minimum wage theft in the majority of the seven highest-violation industries. However, there has been little enforcement to date in the private households and accommodation industries, both of which have unacceptably high violation rates. Thus, as Denver Labor plans future iterations of its proactive enforcement initiative, we recommend that the agency consider expanding its efforts to include these two industries.

Additionally, despite Denver Labor's strategic efforts, tens of thousands of workers continue to be paid millions below the minimum wage each year. The strong correlation of minimum wage rates to violation rates suggests that this problem will continue to get worse as the statutory minimum wage continues to rise in the Denver area. The results of this study suggest it is imperative that enforcement budgets and inspectorate sizes continue to grow to ensure that Denver workers are paid what they are owed.

Annual Trends, 2007-2022

Chart 1. Estimated Minimum Wage Violations in Denver-Aurora MSA, 2007-2022

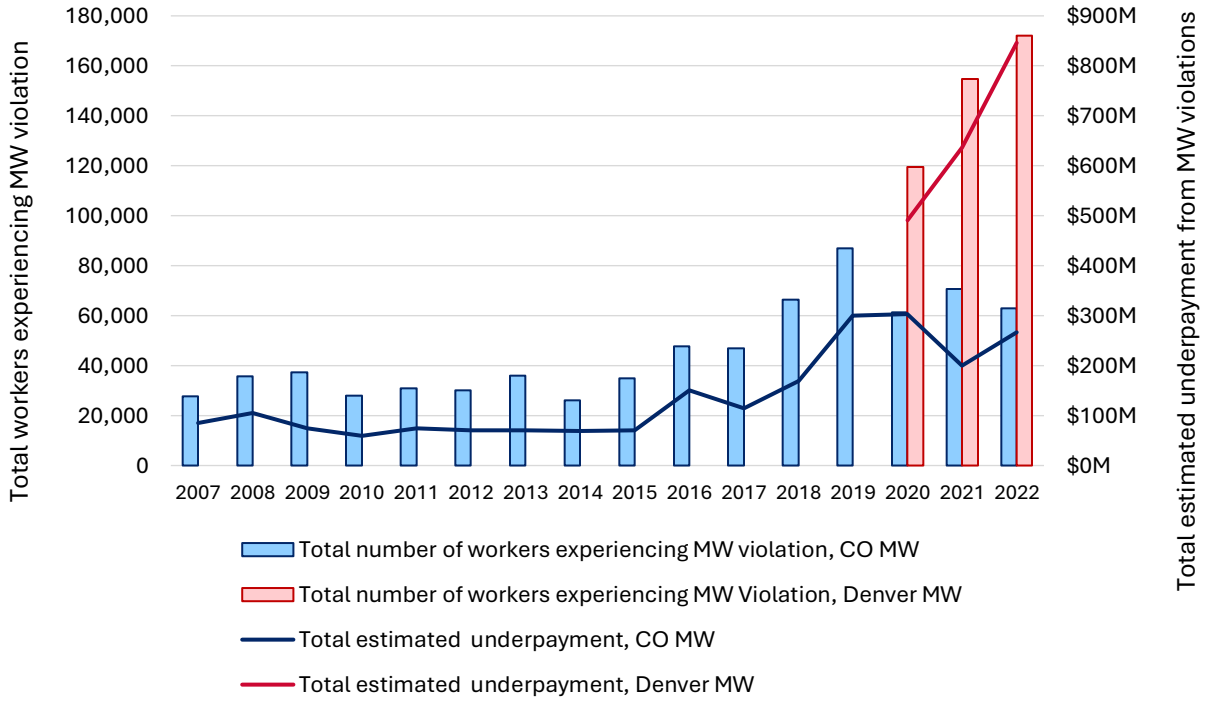


Chart 1 above shows the estimated number of workers in the Denver MSA experiencing a minimum wage violation for each year from 2007 to 2022, as well as the total estimated wages stolen per year. **Table 1** shows the percentage of eligible workers who experienced a minimum wage violation from 2007 to 2022. The change in minimum wage violation rate over time is strikingly similar to the change in the applicable minimum wage rates over time (see **Appendix II**). In the decade from 2007 to 2016—when the state minimum wage was indexed to inflation and grew in relatively small increments annually—we estimate that an average of roughly 33,000 workers a year were paid below the minimum wage in the Denver area. Coloradans voted in 2016 to raise the state minimum wage from $8.31 to $12.00 by 2020.

Table 1. Estimated Minimum Wage Violation Rate by Year, Denver-Aurora MSA, 2007-2022

Year	MWV Rate (CO MW)	Year	MWV Rate (CO MW)	MWV Rate (Denver MW)
2007	2.8%	2015	3.2%	
2008	3.4%	2016	3.9%	
2009	3.6%	2017	3.9%	
2010	2.8%	2018	5.5%	
2011	3.1%	2019	6.7%	
2012	3.0%	2020	4.8%	8.6%
2013	3.4%	2021	6.2%	11.4%
2014	2.3%	2022	4.9%	11.4%

From 2017 to 2019, the three-year period of intense growth in the minimum wage rate, the estimated number of workers experiencing minimum wage violations doubled from the previous decade to over 66,000 a year. When using the state minimum wage for the period from 2020 to 2022—when the state wage went back to being indexed to inflation—the number of workers paid underneath the minimum remains relatively constant at around 65,000 workers a year.

Between 2020 and 2022, over 148,000 workers a year within the Denver MSA were estimated to be paid below the higher Denver minimum wage. While this is almost certainly an overestimate of the true number of violations of the Denver minimum wage law—given that an unknown share of these workers work outside the city of Denver—we can be confident in saying that at least 65,000 workers a year, at a minimum, were paid below the mandated minimum wage in the Denver area (whether state or local) from 2020 to 2022, and that the true number lies somewhere between 65,000 and 148,000 annually.

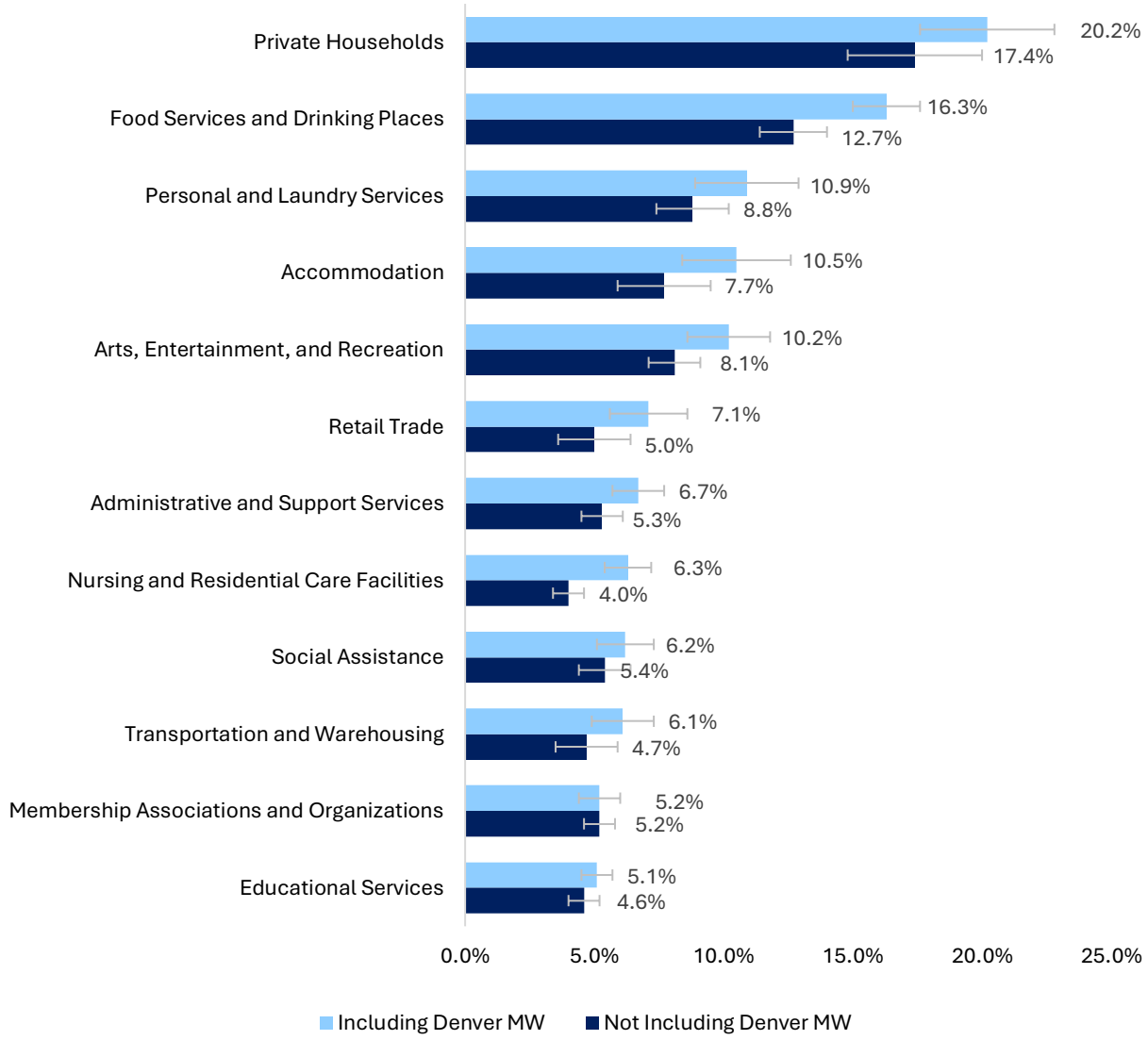
Similar trends can be seen in the amount of back wages owed to workers. Between 2007 and 2016, we estimate that over $83 million in wages were lost by workers in the Denver area due to being paid below the statewide minimum wage. When the state minimum was raised by voters from 2017 to 2019, workers are estimated to have lost nearly $195 million a year. In the three years after the Denver minimum wage went into effect in 2020, the amount lost by workers annually grew even further – to between $256 million and $656 million.

In sum, we estimate that at least 45,000 workers a year on average were paid below the applicable state or local minimum wage within the Denver area from 2007 to 2022, the period of the study. We estimate that these workers on average lost at least $136 million annually, or nearly $3,000 per worker. This number is particularly high in recent years as the minimum wage has continued to rise at both the state and local level.

Industry and Occupation

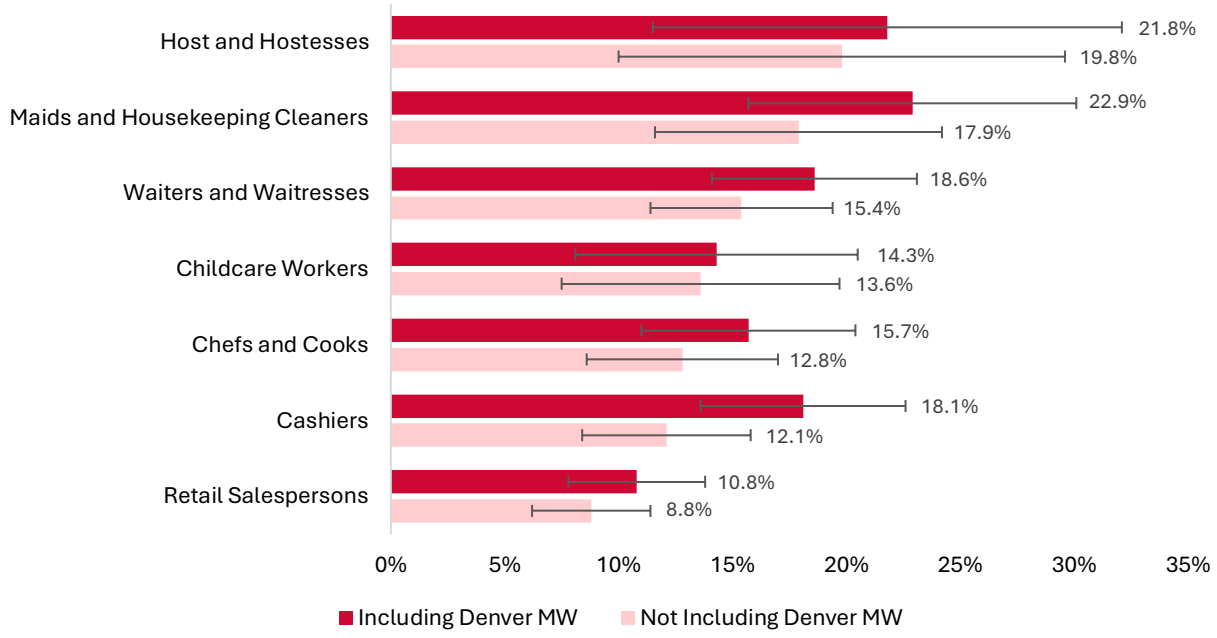
Minimum wage violation rates by industry are shown in **Chart 2** below (full point estimates can be found in **Appendix III**). We estimate that between 17.4 and 20.2 percent of workers employed by private households—including domestic workers, groundskeepers, and the like—are paid below the minimum wage within the Denver area. Between 12.7 percent to 16.3 percent of workers in food services and drinking places are further paid below the minimum wage each year. Other particularly high violation industries in the Denver area include personal and laundry services (8.8-10.9 percent), accommodation (7.7-10.5), and arts, entertainment and recreation (8.1-10.2). Full violation estimates by industry can be found in the appendices, as well as example low-wage occupations by industry.

Chart 2. Estimated Minimum Wage Violation Rate by Industry, Denver-Aurora MSA, 2007-22



The occupational groups for which estimates can be derived add further weight to the above findings (see **Chart 3** below). High-violation occupations for which estimates could be derived include hosts and hostesses (19.8-21.8 percent), maids and housekeeping cleaners (17.9-22.9), waiters and waitresses (15.4-18.6), childcare workers (13.6-14.3), chefs and cooks (12.8-15.7), cashiers (12.1-18.1) and retail salespersons (8.8-10.8).

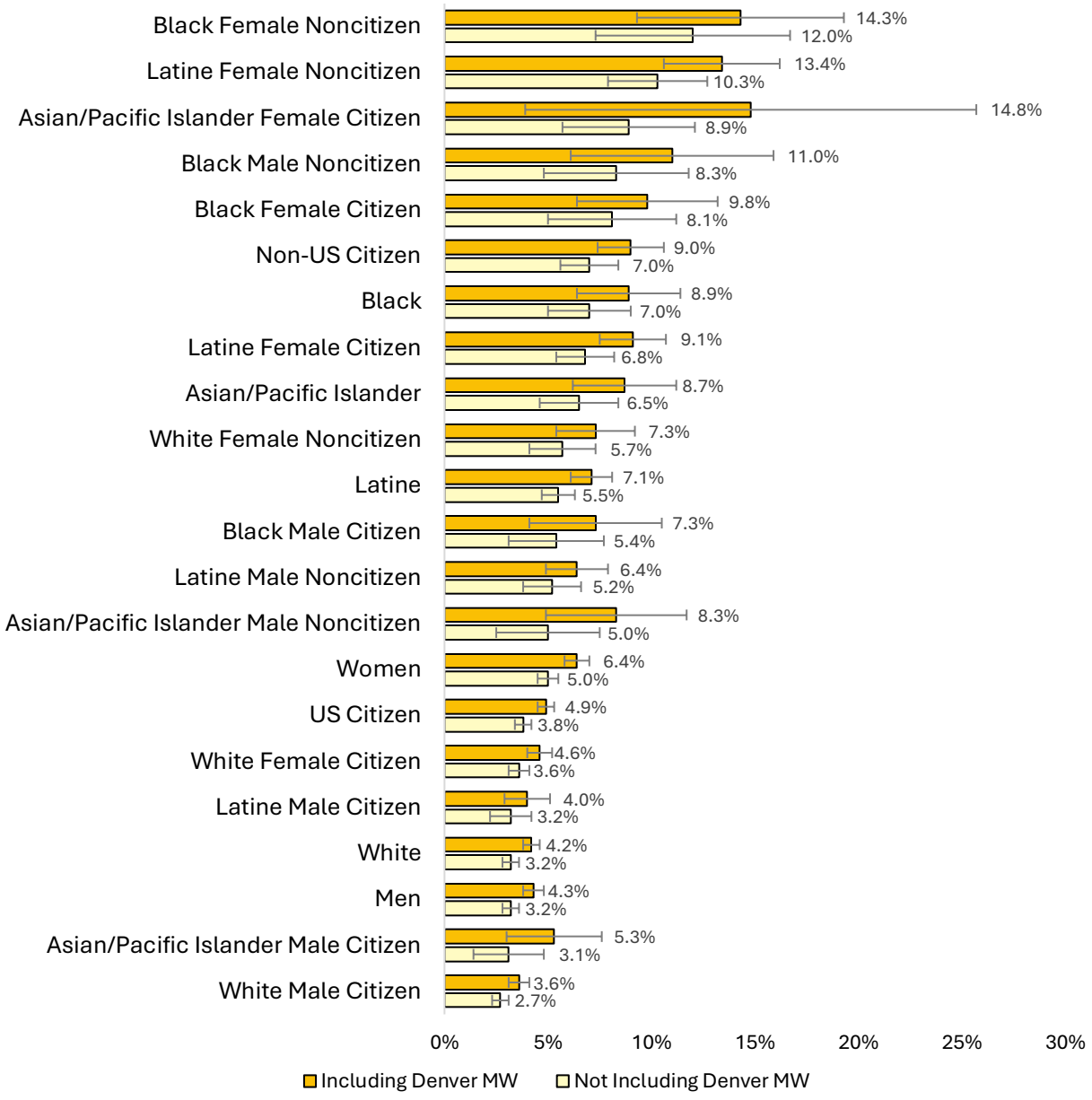
Chart 3. Estimated Minimum Wage Violation Rate by Select Occupation, Denver-Aurora MSA, 2007-22



Individual and Job Characteristics

Women are roughly 50 to 60 percent more likely than men to experience a minimum wage violation. Black and Asian/Pacific Islander workers are more than twice as likely than white workers to be paid below the minimum wage, while Latine workers are 70 percent more likely to experience a violation. Non-citizens are roughly 80 percent more likely than citizens to be paid below the minimum. It is when these identities intersect that workers become particularly likely to experience minimum wage theft. For example, Black female noncitizens (12.0-14.3 percent violation rate) and Latine female

Chart 4. Minimum Wage Violation Rate by Race/Ethnicity, Denver MSA, 2007-2022

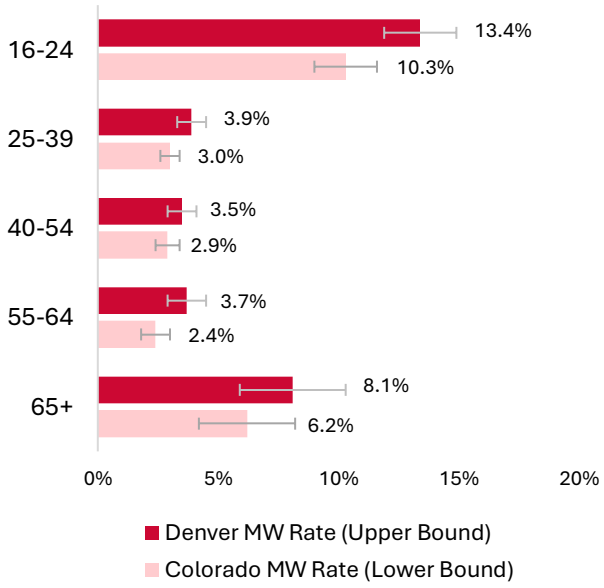


noncitizens (10.3-13.4) are around four times more likely than white male citizens (2.7-3.6) to be paid below the minimum.

Younger and older workers are particularly likely to experience minimum wage violations. We estimate that between 10.3 and 13.4 percent of workers under 25 and between 6.2 and 8.1 percent of workers 65 and older are paid below the minimum wage, compared to roughly 3-4 percent of mid-career workers.

Part-time workers and those without a high school diploma, are both more than three times as likely to be paid below the minimum than their respective full-time and high school graduate counterparts. Contrary to what we have typically found in other studies,[10] those paid by the hour appear to be somewhat more likely to be paid below the minimum wage than those paid on non-hourly bases (e.g. weekly or piece-rate).

Chart 5. Minimum Wage Violation Rate by Age, Denver MSA, 2007-2022



[10] See, e.g., Daniel J. Galvin, Jake Barnes, Janice Fine, and Jenn Round. 2023. "Wage Theft in Texas: Minimum Wage Violations and Payday Law Enforcement, 2009-2022."

Minimum Wage Cases at Denver Labor

Table 2. Minimum Wage Cases Summary, Denver Labor, 2020-2023

MINIMUM WAGE SUMMARY

Type	Cases	Total Compensation	Workers Included
Employee	**98** (49%)	**$1,233,363** (45%)	**3214** (61%)
Active	**64** (32%)	**$1,249,318** (46%)	**1622** (31%)
Third Party	**19** (10%)	**$239,758** (9%)	**343** (6%)
Anonymous	**18** (9%)	**$17,082** (<1%)	**99** (2%)
Grand Total	**199**	**$2,739,521**	**5278**

As shown in **Table 2**, roughly half of minimum wage cases from 2020 to 2023 were started by employee complaints, while around 10 percent each began with either a third party or anonymous tip. "Active cases", those initiated by the office without a complaint, accounted for 32 percent of all cases yet nearly 46 percent of total compensation to workers—including underpayment, damages and interest—suggesting that the office has been successfully targeting violating employers with their proactive efforts. In other words, while over 50 percent more cases were initiated by employee complaints than proactively by the office, "active cases" resulted in $16,000 more in compensation to aggrieved workers. Similarly, active cases averaged $770 in compensation per worker, nearly double the amount found per worker across all other cases ($408) and further indicating that the agency is successfully targeting its proactive efforts towards egregious violations.

Minimum wage complaints submitted to Denver Labor—either by an employee, a third party, or an anonymous tip—have increased over the past four years from 25 in 2020 to 45 in 2023. Total compensation found for workers in complaint-based cases likewise increased from $178,544 in 2020 to $655,187 in 2023. The number of employees involved in these complaint-based cases declined by over half from 1,130 in 2021 to 543 in 2022, increasing to 817 in 2023.

Chart 6a. Minimum Wage Complaints by Year, 2020-2023

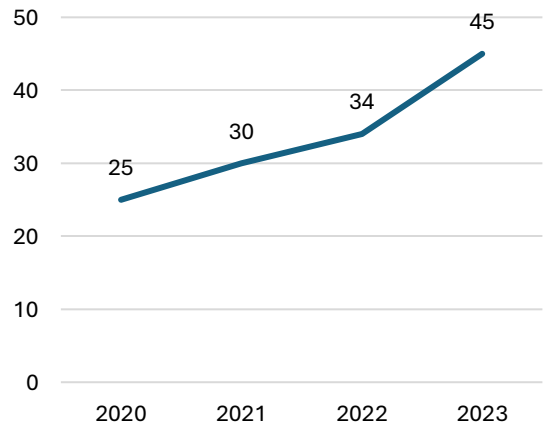
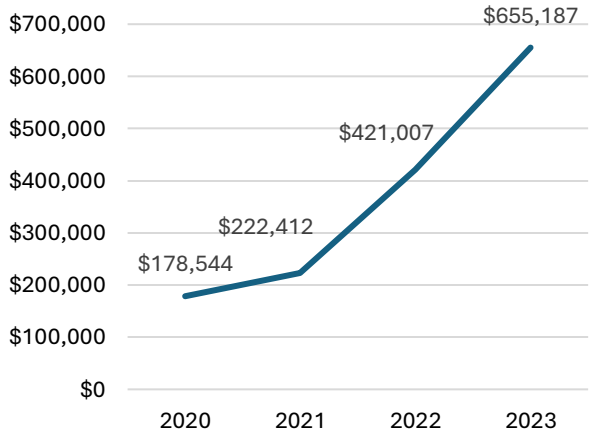


Chart 6b. Total Compensation (Minimum Wage Complaints) by Year, 2020-2023



Cases by Industry

Chart 7a. Minimum Wage Cases by Industry, 2020-2023

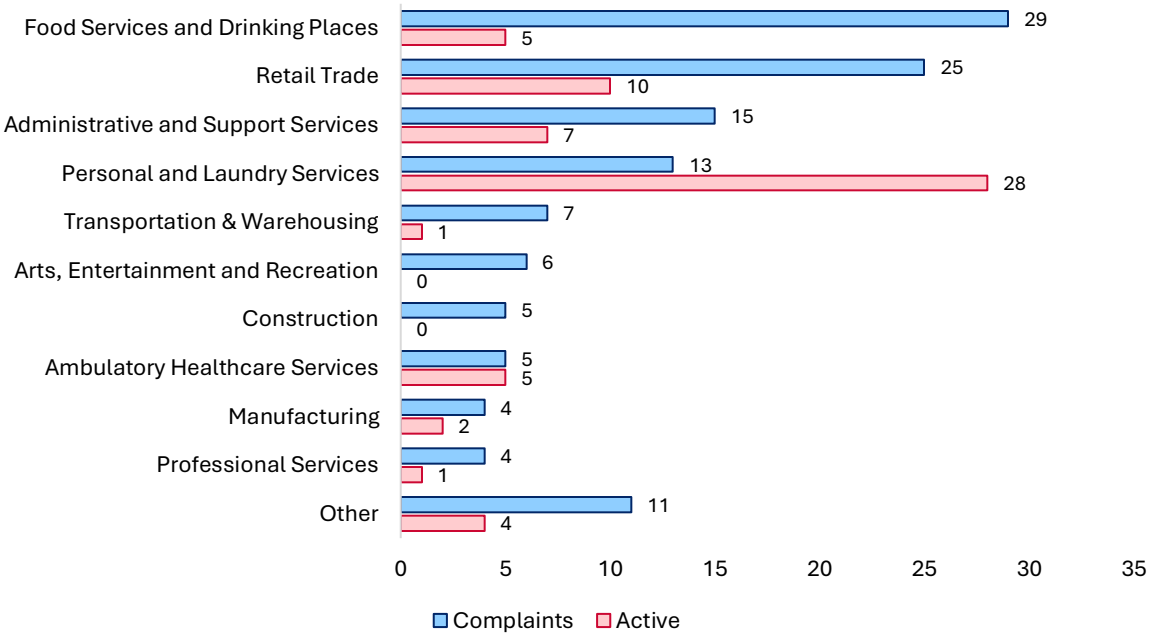
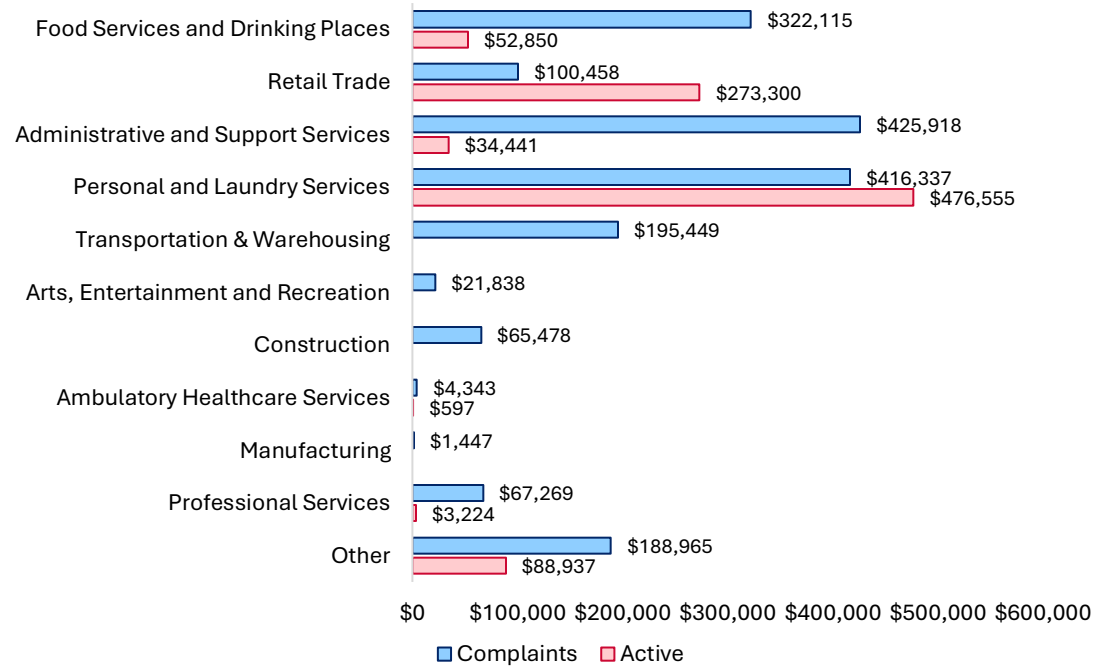


Chart 7b. Total Compensation (Minimum Wage Cases) by Industry, 2020-2023



As shown in **Chart 7a** above, the most complaints were received from the food services (29 complaints) and retail trade (25) industries, followed by administrative and support services (15) and personal and laundry services (13). Nearly 80 percent of active cases were also in these industries, with nearly half of all proactive cases in the personal and laundry services industry.

Comparing Denver Labor's case data with the underlying minimum wage violations found in the Denver MSA shows that **the agency is appropriately targeting most of its proactive investigations toward high-violation industries**. The four industries where roughly 80 percent of proactive cases were carried out are all within the seven highest-violating industries.

However, we also find that Denver Labor's complaint-based and proactive enforcement efforts have largely missed the private households and accommodation industries, industries with the highest and fourth highest violation rates, respectively. To ensure that Denver Labor is working to achieve compliance in all low-wage, high violation industries, we recommend that Denver Labor consider expanding its proactive enforcement initiative to include the private households and accommodation industries.

Conclusion

The findings presented above suggest that minimum wage theft is a growing issue in the Denver area, impacting tens of thousands of workers each year. The highest rates of violations happen in private households, food services and drinking places, personal and laundry services, accommodation, and arts, entertainment and recreation. Women, noncitizens and people of color experience the highest rates of minimum wage theft and are particularly likely to be paid below the minimum wage if identifying with more than one of these groups.

An analysis of minimum wage cases carried out by Denver Labor since the law became effective in 2020 suggests that the agency is successfully targeting high-violation industries—such as personal and laundry services, food services and drinking places, retail trade and administrative and support services—with its proactive cases. These efforts, moreover, have been successful in targeting high-violation cases, recovering nearly double the amount for workers on average than complaint-based cases. However, enforcement in the private households and accommodations industries is needed to reach workers in all of Denver's high violation industries.

Further, our study of underlying minimum wage violation rates suggests that tens of thousands of violations continue to go undetected each year. It is clear that the agency is using its current resources in an efficient and impactful way and making an important difference for Denver workers. In order to more fully address the issue at hand, the agency will require further resources to expand their inspectorate and enhance their enforcement capabilities. This is particularly pressing given that employment in the accommodation and food service industry within the Denver area is projected to grow by 39 percent and personal care and service occupations by nearly 35 percent from 2020 to 2030,

adding over 60,000 jobs between them.[11] Coupled with a continued focus on using agency resources in strategic and innovative ways—such as partnering with worker organizations on identifying violations—[12]additional funds for enforcement would have the potential to increase tax revenue for the city, empower high-road employers throughout the region, and secure millions in necessary income for thousands of low-wage workers and their families in the Denver area.

[11]Analysis of CDLE data by Metro Denver Economic Development Corporation, September 2021, available at https://www.metrodenver.org/do-business/workforce/employment-stats

[12] For more, see WJL@RU's Labor Standards Enforcement Toolbox at https://smlr.rutgers.edu/wjl-ru/beyond-bill/toolbox

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About WJL@RU

The workplace justice lab@RU exists to address economic inequality through supporting and strengthening grassroots organizing and democratic governance. We do this through building dynamic communities of learning and practice, carrying out cutting edge research, and offering specialized training and in-depth one-on-one consultations.

At the lab, we go beyond talking about what government should do, to focusing on how government should do it. Through our strengthening labor standards enforcement program, we work to reimagine the public enforcement of workers' rights laws. By proactively targeting the sectors with the worst problems and involving those directly impacted in enforcement, we help agencies realize the intended impact of innovative labor standards legislation.

Appendices

Appendix I. Data & Methodology

Measuring the scope and depth of "wage theft" is difficult. No single data source systematically and reliably tracks the incidence of wage theft and records the precise amounts of money that are not being paid. Early studies of minimum wage compliance used data provided voluntarily by employers to the Bureau of Labor Statistics (e.g., Zucker 1973), but employer-reported data is not reliable, as employers who violate the law cannot be trusted to report that information to government agencies.

Workers can report wage theft by filing lawsuits and/or lodging complaints with federal, state, and local enforcement agencies. But lawsuits are often too expensive for minimum-wage workers and the costs of litigation frequently exceed the amounts of back pay owed. Complaints are also problematic measures because the workers who are more likely to be exploited are also more likely to be unaware of their right to complain (whether due to language barriers, lack of information and knowledge, or fear of retaliation, termination, or deportation). Lawsuits and the complaints government agencies receive thus provide inaccurate and unreliable portraits of the actual number of violations. We must therefore turn to alternative methods to more accurately detect and measure violations. Survey data on hours and earnings are invaluable in this regard, as they enable us to estimate the true underlying incidence wage violations indirectly.

Most useful is the Current Population Survey's Merged Outgoing Rotation Groups (CPS-MORG) data, which the U.S. Department of Labor's Wage and Hour Division uses to identify "priority industries" for investigations and which remains the top choice of every social scientist who has sought to develop national or industry-specific estimates of FLSA noncompliance since the 1970s.[13]

The CPS-MORG data has many advantages: it is gathered via extensive interviews with around 60,000 households per month; it is representative at the state and national levels (unlike other survey data, such as the Survey of Income and Program Participation [SIPP]); and its individual-level responses permit us to estimate earnings and minimum wage violations relatively easily. The biggest downside is measurement error, as with any survey.

The methodological approach employed here is consistent with previous research.[14] A few key points to keep in mind:

Wage variable

For hourly wages, we use variables that include wages earned from overtime, tips, and commissions (OTC) for both hourly and nonhourly workers.[15] Wage estimates are therefore conservative over-estimates that effectively downward-bias the estimated minimum wage violation rates. This is preferable to the alternative, however, which excludes OTC for hourly workers while including it for

[13] Ashenfelter and Smith 1979; Ehrenberg and Schumann 1982; Sellekaerts and Welch 1984; Trejo 1991, 1993; Fry and Lowell 1997; Weil and Pyles 2005; U.S. Department of Labor 2014; ERG 2014; Galvin 2016; Cooper and Kroeger 2017.
[14] In particular, Galvin 2016; U.S. Department of Labor 2014; Cooper and Kroeger 2017.
[15] http://ceprdata.org/cps-uniform-data-extracts/cps-outgoing-rotation-group/.
See also Cooper and Kroeger's 2017 preference for this method of estimating wages.

nonhourly workers (for whom different sources of wages are not distinguished). Efforts to estimate and subtract OTC from nonhourly workers adds unknown quantities of additional measurement error to this key variable, and is not recommended.[16]

To ensure our estimates of wage violations are conservative underestimates, we follow Cooper and Kroeger (2017) in taking the higher of the reported wage (hourly wage or weekly pay divided by hours worked) for hourly workers who reported both hourly and weekly earnings.

Calculating minimum wage violations

Minimum wage violations are dichotomous measures of whether an individual's estimated hourly wage was lower than the applicable legal minimum. We use the applicable statutory minimum wage rate for each respondent as of the date (month) effective.

Given that the CPS is a household-based survey, we are only able to determine where a respondent lives and not where their place of employment is. As the majority of workers working within the city of Denver commute from outside of the city,[17] data from the broader metropolitan area must be used in order to capture the entire Denver workforce within the analysis. We thus provide two sets of estimates for the years after the Denver minimum wage was passed (i.e., 2020-22), using both the (lower) state minimum wage rate and the (higher) Denver minimum wage rate.

"Amount lost" is calculated based on the applicable minimum wage as of the date (month) effective.

Exemptions

We implement (and exclude from the analysis) all respondents who we can identify as exempt from state and local minimum wages. For the Colorado state minimum wage, we exclude salaried administrative, executive and professional employees over the applicable salary each year; outside salespersons; taxi cab drivers; and casual babysitters (i.e., private household workers working less than 8 hours a week). We are unable to remove owners or proprieters; property managers residing on-premises; student residence workers; laundry workers at charitable institutions; field staff of seasonal camps; volunteers; elected officials; or temporary employees of the National Western Stock Show.

The Denver minimum wage applies to all workers performing work after January 1, 2020 within the geographical boundaries of the City and County of Denver. Thus, no respondents were removed in when analyzing the Denver minimum wage during these years.

[16] U.S. Department of Labor 2014.

[17] U.S. Census Bureau, 2016-2020 5-Year ACS Commuting Flows, https://www.census.gov/data/tables/2020/demo/metro-micro/commuting-flows-2020.html

Sample size restrictions

Small sample sizes in some jurisdictions limited the inclusion of certain industries, as there were not sufficient observations to generate reliable estimates. Industries were only included if their point estimates were statistically distinguishable from zero.

Survey weights and standard errors

All analyses, including population estimates, use the survey weights suggested by Davern et. al (2007), which are necessary given the sampling method of the CPS.

Measurement error

There is reason to believe that measurement error in the CPS may downward-bias the estimates of minimum wage violations.[18] First, despite going to great lengths to reach them, both Hispanics (Latinx) and undocumented immigrants are underrepresented in the CPS.[19] Because workers in these groups are at higher risk of experiencing minimum wage violations, the estimates of violations reported here should be considered conservative estimates.[20] Second, in Bollinger's study of measurement error in the CPS, he finds a "high over reporting of income for low-income men" driven by "about 10% of the reporters who grossly over report their income," thus potentially biasing estimates downward even further.[21] Third, CPS data have a shortage of low-wage workers and an excess of high-wage workers relative to comparable survey data like SIPP; one effect of this imbalance could be to underestimate minimum wage violations.[22] Roemer does find that the CPS reaches more "underground" workers than other large-scale surveys and is less biased than alternatives.[23] But given the high rates of violation discovered in the Bernhardt et al. 2009 innovative survey of hard-to-reach workers in the "informal" labor market—higher than the estimates presented here—there is reason to suspect that these findings underestimate the prevalence of minimum wage violations across the board.[24] These considerations notwithstanding, the fact that measurement error surely exists recommends using caution when working with the point estimates reported.

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[18] For an excellent discussion of the advantages and limitations of using the CPS data to estimate minimum wage violations given the existence of measurement error and other issues, see U.S. Department of Labor 2014, Appendix B.
[19] McKay 1992. As Bernhardt et al. 2009 write: "standard surveying techniques—phone interviews or census-style door-to-door interviews—rarely are able to fully capture the population that we are most interested in: low- wage workers who may be hard to identify from official databases, who may be vulnerable because of their immigration status, or who are reluctant to take part in a survey because they fear retaliation from their employers. Trust is also an issue when asking for the details about a worker's job, the wages they receive, whether they are paid off the books or not, and their personal background" (56).

[20] McKay 1992; Bernhardt et al. 2009; U.S. Department of Labor 2014.
[21] Bollinger 1998.
[22] Roemer 2002; U.S. Department of Labor 2014.
[23] Roemer 2002.
[24] Bernhardt et al. 2009.

To address measurement error and conduct sensitivity tests, following ERG (2014), Galvin (2016), and Cooper and Kroeger (2017):

- Exclude unemployed and self-employed workers
- Exclude all observations of workers not specifying hourly/nonhourly status
- Exclude observations of nonhourly workers with weekly earnings less than $10
- Exclude observations of workers with hourly wages less than $1
- Exclude respondents with imputed hours
- Exclude proxy respondents (sensitivity test)
- Violation only if less than applicable minimum wage minus $0.25 (sensitivity test)

The relative violation rates remain extremely similar in all sensitivity tests.

Race variable

Racial and ethnic categories are mutually exclusive. We follow CEPR and EPI in the construction of the race variable. "Black" includes those who identify as Black-white; Black-American Indian; Black-Asian; Black-Hawaiian/Pacific Islander; white-Black-American Indian; white-Black-Asian; white-Black-Hawaiian/Pacific Islander; Black-American Indian-Asian; and white-Black-American Indian-Asian. "Asian" includes those who identify as Asian & Hawaiian/Pacific Islander; white-Asian; white-Hawaiian/Pacific Islander; American Indian-Asian; American Indian-Hawaiian/Pacific Islander; Asian-Hawaiian/Pacific Islander; white-American Indian-Asian; white-American Indian-Hawaiian/Pacific Islander; white-Asian-Hawaiian/Pacific Islander; white-American Indian-Asian-Hawaiian/Pacific Islander. "Other" includes American Indian (only); white-American Indian; other 3 races; other 4 and 5 races. "Hispanic" includes those who identify as Mexican, Mexican-American, Mexicano/Mexicana, Chicano/Chicana, Mexican (Mexicano), Mexicano/Chicano, Puerto Rican, Cuban, Dominican, Salvadoran, Other Hispanic, Central/South American, Central American, (excluding Salvadoran), South American, and any of these categories *and* white, Black, Asian, or Other. See: https://microdata.epi.org/variables/demographics/wbhao/

According to the CPS, "noncitizen" includes any person born outside the U.S. who is not a naturalized U.S. citizen (e.g., refugee, asylee, undocumented immigrant legal permanent resident), not born in Puerto Rico, and does not have parents who are U.S. citizens.

Data

We use the IPUMS CPS-MORG abstracts generated by Flood et al. 2020.

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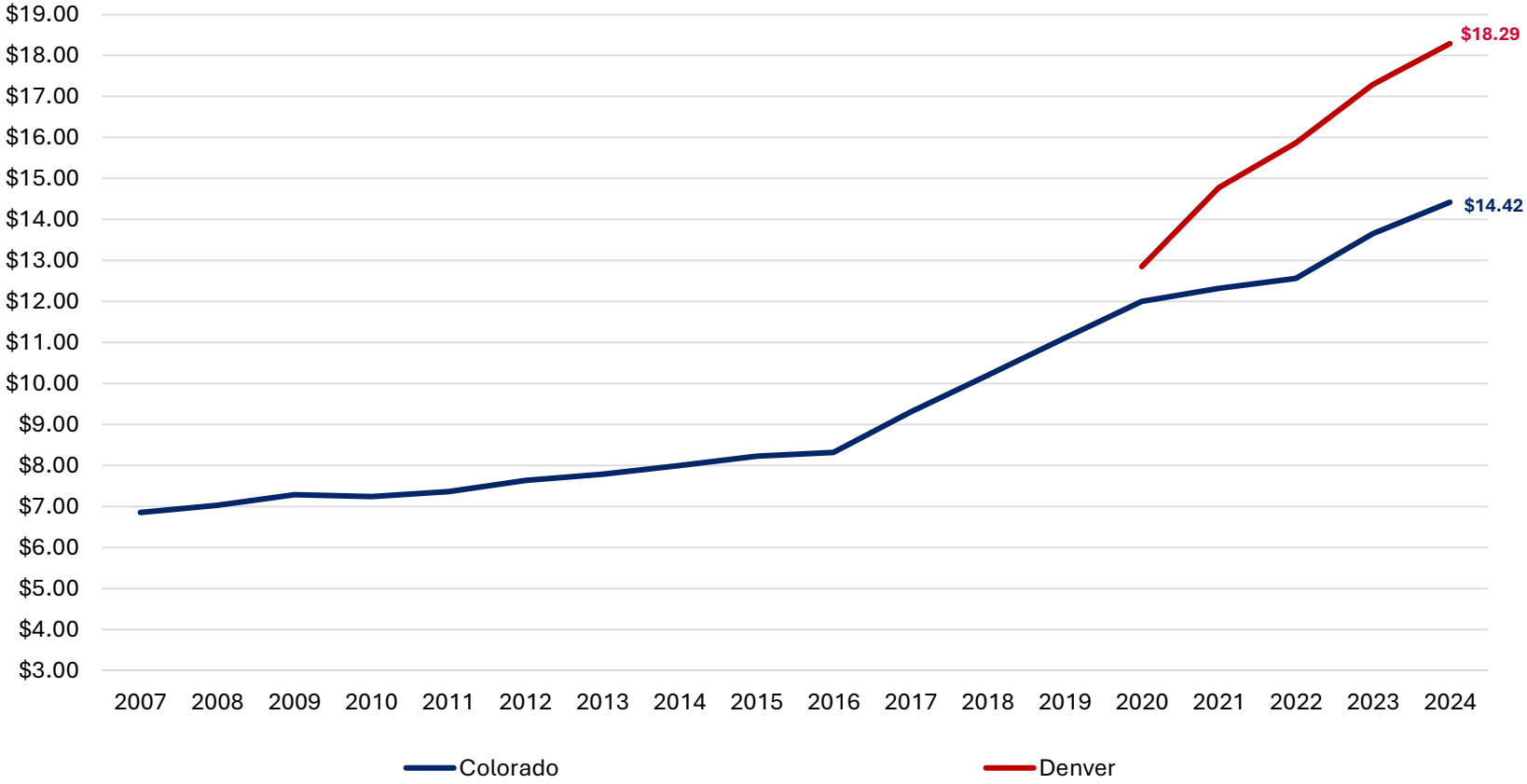
Appendix II. Colorado State and Denver Minimum Wages, 2007-2024



Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
Colorado	$6.85	$7.02	$7.28	$7.24	$7.36	$7.64	$7.78	$8.00	$8.23
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Colorado	$8.31	$9.30	$10.20	$11.10	$12.00	$12.32	$12.56	$13.65	$14.42
Denver					$12.85	$14.77	$15.87	$17.29	$18.29

Appendix III. Minimum Wage Violation Rate by Industry, 2007-2022

	Not including Denver MW			*Including Denver MW*		
Industry	**CI Low**	**MWV Estimate**	**CI High**	**CI Low**	**MWV Estimate**	**CI High**
Private Households	10.5%	**17.4%**	24.4%	12.9%	**20.2%**	27.4%
Food Services and Drinking Places	10.7%	**12.7%**	14.6%	14.1%	**16.3%**	18.6%
Personal and Laundry Services	5.4%	**8.8%**	12.2%	7.0%	**10.9%**	14.8%
Arts, Entertainment, and Recreation	5.2%	**8.1%**	11.1%	7.0%	**10.2%**	13.5%
Accommodation	3.9%	**7.7%**	11.6%	6.0%	**10.5%**	15.0%
Social Assistance	2.5%	**5.4%**	8.3%	3.1%	**6.2%**	9.2%
Administrative and Support Services	3.4%	**5.3%**	7.3%	4.6%	**6.7%**	8.9%
Membership Associations and Organizations	2.6%	**5.2%**	7.8%	2.7%	**5.2%**	7.8%
Retail Trade	4.0%	**5.0%**	6.1%	5.9%	**7.1%**	8.4%
Transportation and Warehousing	2.9%	**4.7%**	6.5%	4.2%	**6.1%**	8.0%
Educational Services	3.4%	**4.6%**	5.9%	3.8%	**5.1%**	6.4%
Nursing and Residential Care Facilities	1.9%	**4.0%**	6.1%	3.8%	**6.3%**	8.8%
Real Estate	1.2%	**3.0%**	4.8%	1.6%	**3.7%**	5.8%
Ambulatory Health Care Services	0.7%	**2.2%**	3.6%	1.2%	**2.8%**	4.3%
Wholesale Trade	0.8%	**2.2%**	3.6%	2.1%	**4.1%**	6.1%
Information	1.0%	**2.0%**	3.0%	1.6%	**3.1%**	4.7%
Hospitals	0.8%	**1.9%**	3.1%	0.7%	**1.8%**	3.0%
Construction	0.9%	**1.6%**	2.4%	1.8%	**2.8%**	3.8%
Professional, Scientific, and Technical Services	0.9%	**1.5%**	2.1%	1.1%	**1.7%**	2.3%
Manufacturing	0.8%	**1.5%**	2.1%	1.4%	**2.2%**	3.1%
Finance and Insurance	0.7%	**1.4%**	2.0%	1.0%	**1.8%**	2.6%
Public Administration	0.4%	**1.3%**	2.3%	0.8%	**2.0%**	3.1%

Appendix IV. Minimum Wage Violation Rate by Individual Characteristics, 2007-2022

	Not Including Denver MW			*Including Denver MW*		
	CI Low	MWV Estimate	CI High	CI Low	MWV Estimate	CI High
Men	2.8%	**3.2%**	3.6%	3.8%	**4.3%**	4.7%
Women	4.5%	**5.0%**	5.5%	5.8%	**6.4%**	7.0%
White	2.8%	**3.2%**	3.5%	3.8%	**4.2%**	4.6%
Black	5.0%	**7.0%**	9.0%	6.4%	**8.9%**	11.4%
Latine	4.7%	**5.5%**	6.3%	6.1%	**7.1%**	8.1%
Asian/Pacific Islander	4.6%	**6.5%**	8.4%	6.2%	**8.7%**	11.2%
US Citizen	3.4%	**3.8%**	4.1%	4.5%	**4.9%**	5.3%
Non-US Citizen	5.6%	**7.0%**	8.4%	7.4%	**9.0%**	10.7%
Black Male Noncitizen	4.8%	**8.3%**	11.9%	6.1%	**11.0%**	16.0%
Latine Male Noncitizen	3.8%	**5.2%**	6.6%	4.9%	**6.4%**	8.0%
Asian/Pacific Islander Male Noncitizen	2.5%	**5.0%**	7.6%	4.9%	**8.3%**	11.7%
White Female Noncitizen	4.1%	**5.7%**	7.4%	5.4%	**7.3%**	9.2%
Black Female Noncitizen	7.3%	**12.0%**	16.7%	9.3%	**14.3%**	19.4%
Latine Female Noncitizen	7.9%	**10.3%**	12.7%	10.6%	**13.4%**	16.3%
White Male Citizen	2.3%	**2.7%**	3.1%	3.1%	**3.6%**	4.1%
Black Male Citizen	3.1%	**5.4%**	7.7%	4.1%	**7.3%**	10.5%
Latine Male Citizen	2.2%	**3.2%**	4.1%	2.9%	**4.0%**	5.1%
Asian/Pacific Islander Male Citizen	1.4%	**3.1%**	4.7%	3.0%	**5.3%**	7.6%
White Female Citizen	3.1%	**3.6%**	4.1%	4.0%	**4.6%**	5.2%
Black Female Citizen	5.0%	**8.1%**	11.1%	6.4%	**9.8%**	13.2%
Latine Female Citizen	5.4%	**6.8%**	8.1%	7.5%	**9.1%**	10.7%
Asian/Pacific Islander Female Citizen	5.7%	**8.9%**	12.0%	3.9%	**14.8%**	25.8%
16-24	8.9%	**10.3%**	11.6%	11.9%	**13.4%**	14.9%
25-39	2.5%	**3.0%**	3.4%	3.4%	**3.9%**	4.5%
40-54	2.4%	**2.9%**	3.4%	3.0%	**3.5%**	4.1%
55-64	1.7%	**2.4%**	3.0%	2.8%	**3.7%**	4.5%
65+	4.3%	**6.2%**	8.2%	6.0%	**8.1%**	10.3%
Paid by the Hour	3.8%	**4.3%**	4.7%	5.5%	**6.1%**	6.7%
Not Paid by the Hour	3.3%	**3.8%**	4.2%	3.8%	**4.3%**	4.8%
Full-Time	2.4%	**2.7%**	3.0%	3.0%	**3.4%**	3.8%
Part-Time	7.5%	**8.5%**	9.5%	10.4%	**11.5%**	12.7%
No High School Diploma	10.3%	**12.0%**	13.8%	14.2%	**16.4%**	18.6%
High School Diploma or Better	3.0%	**3.3%**	3.6%	3.9%	**4.2%**	4.6%

Appendix V. Highly Represented Occupations in High-Violation Industries[i]

Industry	Occupation examples (Occupation code)
Retail trade (NAICS 44-45)	Retail salespersons (41-2031) Cashiers (41-2010) Laborers and material movers (53-7060) Stockers and order fillers (53-7065) Driver/sales workers and truck drivers (53-3030) Counter/rental clerks/parts salespersons (41-2020) Customer service representatives (43-4051)
Administrative and support services (NAICS 561)	Janitors and cleaners, except maids and housekeeping cleaners (37-2011) Security guards (33-9032) Laborers and freight, stock, and material movers, hand (53-7062) Landscaping and groundskeeping workers (37-3011) Customer service representatives (43-4051) Office clerks (43-9061) Packers and packagers (53-7064)
Social assistance (NAICS 624)	Home health and personal care aides (31-1120) Preschool teachers (25-2011) Childcare workers (39-9011) Social and human service assistants (21-1093) Teaching assistants, except postsecondary (25-9045) Child, family, and school social workers (21-1021)
Arts, entertainment, and recreation (NAICS 71)	Amusement and recreation attendants (39-3091) Exercise trainers and group fitness instructors (39-9031) Food preparation and serving related occupations (30000) Office and administrative support occupations (43-0000) Arts, design, entertainment, sports, and media occupations (27-0000) Building and grounds cleaning and maintenance occupations (37-0000)

Accommodation (NAICS 721)	Maids and housekeeping cleaners (37-2012) Hotel, motel, and resort desk clerks (43-4081) Waiters and waitresses (35-3031) Maintenance and repair workers, general (49-9071) Cooks (35-2014) Gambling dealers (39-3011)
Food services and drinking places (NAICS 722)	Fast food and counter workers (35-3023) Waiters and waitresses (35-3031) Cooks (35-2014) Food preparation workers (35-2021) Bartenders (35-3011) Dishwashers (35-9021) Hosts and hostesses (35-9031) Cashiers (41-2011) Dining room and cafeteria attendants and bartender helpers (35-9011) Driver/sales workers (53-3031)
Personal and laundry services (NAICS 812)	Hairdressers, hairstylists, and cosmetologists (39-5012) Manicurists and pedicurists (39-5092) Laundry and dry-cleaning workers (51-6011) Animal caretakers (39-2021) Parking attendants (53-6021) Receptionists and information clerks (43-4171) Massage therapists (31-9011) Counter and rental clerks (41-2021) Skincare specialists (39-5094) Funeral attendants (39-4021) Morticians, undertakers, and funeral arrangers (39-4031)
Membership associations and organizations (NAICS 813)	Labor relations specialists (13-1075) Secretaries and administrative assistants, except legal, medical, and executive (43-6014) Office clerks (43-9061) General and operations managers (11-1021)

[i] Information obtained from the U.S. Bureau of Labor Statistics Occupational Employment and Wage Statistics database, accessible at: https://www.bls.gov/oes/current/oessrci.htm.