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Labor market institutions and the incidence of payroll taxation ☆

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ABSTRACT

Despite the unambiguous predictions of the canonical model of a competitive labor market, empirical studies of the labor market effects of payroll taxation provide conflicting evidence. We estimate the labor market impacts of payroll taxation in Singapore, the country with the most competitive and flexible labor market among the countries investigated in the literature. By exploiting the sharp reduction in payroll tax rate when workers turn 60, we find that the reduced payroll tax rate in Singapore has a large effect on wages without changes in employment. Our meta-analysis shows consistent evidence that varying degrees of labor market competitiveness across places and time could explain the mixed results in the literature. Our findings corroborate the prediction of the canonical model that the welfare costs of social insurance programs financed by payroll taxes can be small in a competitive labor market.

1. Introduction

Most social insurance programs, such as old-age pension and health, disability, and unemployment insurance, are financed by payroll taxes (or social security contributions). These payroll taxes often account for more than 30% of workers' labor income and about a quarter of the total tax revenue of OECD member countries (Saez et al., 2019). Although social insurance programs play an important role in improving social welfare, the payroll taxes levied to finance those programs can distort the labor market.

In the canonical model of a competitive labor market, workers have an incentive to increase (decrease) their labor supply depending on how they value their social insurance benefits when the payroll tax rate increases (decreases). Thus, employers' additional labor costs due to higher payroll taxes can be shifted to workers through reduced wage payments. If workers regard the payroll taxes borne by their employers as their social insurance benefits, the incidence of payroll taxes will fall solely on workers' wages. This leaves employment or work hours unchanged, thereby minimizing deadweight loss in the labor market (Summers, 1989).

Several empirical studies have tested Summers' (1989) insights into the labor market impacts of payroll taxes to finance worker benefits across various countries and time periods and found mixed results. One possible explanation to reconcile the mixed findings in the literature is discrepancies in labor market institutions between the real world and the theoretical model. Although the canonical payroll tax incidence model assumes a perfectly competitive labor market, competitiveness in an actual labor market varies across countries, demographic groups, and time periods.

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To investigate the role of labor market competitiveness, we estimate the labor market impact of a payroll tax rate reduction in Singapore, which has a more competitive and flexible labor market than the other countries investigated in the literature.[1] According to the World Economic Forum's Global Competitiveness Report 2019 (Schwab, 2019), Singapore was ranked first among 141 countries in terms of labor market flexibility. Wage bargaining takes place predominantly at the firm level in Singapore, where the rate of collective bargaining coverage was only 19% in 2015. This is significantly lower than that in European countries such as Finland (91% as of 2016), France (94% as of 2015), and Sweden (90% as of 2015). If labor market competitiveness is an important factor that can reconcile the mixed findings in the literature, we are likely to find a large shift in the payroll tax burden onto workers in Singapore.

To identify the labor market effects of payroll taxes, we exploit the sharp reduction in the payroll tax rate in Singapore when a worker turns 60. We apply a regression discontinuity design (RDD) by comparing the labor market outcomes of workers before and after their 60th birthday. Using a nationally representative sample of monthly panel survey data, we find a 3.1% jump in monthly labor income, but not much discontinuity in labor inputs such as employment and full-time work status at the cutoff age. The results indicate that 77.5% (95% CI: 8.9%–146%) of the labor costs saved through the payroll tax rate reduction are shifted to workers' monthly wages. Thus, the welfare costs of a social insurance program financed by payroll taxation would be small when the labor market is highly competitive.

To further support our claim that labor market competitiveness can play an important role in reconciling the mixed findings of existing studies, we conduct a meta-analysis. We first summarize the results of 22 studies on the wage effects of payroll taxation. The pass-through rate, defined as the percentage change in wages upon a 1 percentage point change in the payroll tax rate, ranges from below 10% (Elias, 2015; Adam et al. 2019) to above 80% (Anderson and Meyer, 2000; Baicker and Chandra, 2006; Gruber, 1994; Kim and Koh, 2022; Komamura and Yamada, 2004; Gruber, 1997). Our meta-analysis results indicate that countries with a more flexible and competitive labor market exhibit a roughly 3.5 times higher pass-through rate of payroll taxation. These results imply that heterogeneity in labor market competitiveness might be one reason for the inconsistent findings on the labor market impacts of payroll taxes.

This study is related to the literature on estimating the labor market consequences of payroll taxes. A growing body of literature has focused on the institutional features of the labor market in particular to better understand the mechanisms through which payroll taxation affects labor market outcomes (Chetty et al., 2009; Saez et al., 2012; Saez et al., 2019; Bozio et al., 2020). For example, Saez et al. (2012) and Saez et al. (2019) show that pay fairness norms can explain why the wage response to payroll taxation deviates from the prediction of the canonical labor market model. Unlike Sweden, where a strong norm for pay equality among workers exists, the unionization rate is not high in Singapore and disclosing a worker's salary to other colleagues is often strictly restricted.[2] These institutional features of Singapore's labor market and social norms may explain the high pass-through rate.

Bozio et al. (2020) investigates the role of tax-benefit linkages in explaining variations in the pass-through rate of payroll taxes, showing that increased payroll taxes financing social security benefits are fully shifted to workers' wages when a strong and salient relationship exists between social security contributions and workers' expected benefits. Our study complements Bozio et al. (2020) by shedding light on the role of market competitiveness. Since the competitive labor market is another important institutional assumption used in the canonical labor market framework, we argue that our results can provide additional insights to reconcile the observed heterogeneity in payroll tax incidence. Both strong tax-benefit linkages and labor market competitiveness under the canonical labor market model are not mutually exclusive explanations: The wage impacts of payroll taxation can differ by the degree of labor market competitiveness, even when there is little heterogeneity across labor markets in terms of tax-benefit linkage, or vice versa.[3] Hence, our study, along with Bozio et al. (2020), can broaden the understanding of the mechanisms through which payroll taxation affects labor market outcomes.

The remainder of this paper is organized as follows. Section 2 discusses the institutional background of the labor market and payroll taxation in Singapore. Sections 3 and 4 describe the data and empirical strategy, respectively. Section 5 presents the empirical results. Section 6 discusses the meta-analysis of existing studies that consider the labor market impact of payroll taxation. Finally, Section 7 concludes the paper.

2. Institutional background

Singapore was ranked first in labor market flexibility out of 141 countries surveyed in the Global Competitiveness Report 2019 (Schwab, 2019). The Institutional Characteristics of Trade Unions, Wage Setting, State Intervention, and Social Pacts (ICTWSS) database indicates that wage bargaining in Singapore was predominantly at the firm level during our sample period. The database also reports that the collective bargaining coverage rate was only 19% in Singapore as of 2015, which is significantly lower than the rates of most countries considered in the literature, such as Argentina (63%, 2013), Greece (24%, 2015), Finland (91%, 2016), France (94%, 2015), Norway (70%, 2016), Spain (70%, 2015), Sweden (90%, 2015), and the United Kingdom (28%, 2015). This implies that Singapore is a good setting to examine whether the estimated pass-through rate is consistent with the prediction of the canonical payroll tax incidence model in a competitive labor market.

Singapore collects payroll taxes from employers and employees to fund its social security savings program, called the Central Provident Fund (CPF). The CPF is a compulsory savings program for local residents. It has features similar to a 401(k) retirement plan in the United States. Thus, there is a strong connection between payroll taxes and the expected benefits. The CPF balance is used to finance four individual savings accounts with distinct purposes: Medisave, Ordinary Account (OA), Special Account (SA), and Retirement Account (RA). Medisave is a savings account for hospitalization and approved health insurance plans. OA is a savings account whose balance can be withdrawn before age 55 to buy a house or pay for children's tuition fees. SA is a savings account for investment in government-approved financial products. RA is opened on the account holder's 55th birthday. The savings in OA and SA

[1] The majority of studies of the labor market impacts of changes in payroll tax rates have focused on European countries such as Sweden (Bohm and Lind, 1993; Bennmarker et al., 2009; Egebark and Kaunitz, 2013; Bennmarker et al., 2013; Skedinger, 2014; Saez et al, 2019), France (Kramarz and Philippon, 2001; Bozio, Breda, and Grenet, 2020; Cahuc, Carcillo, and Le Barbanchon, 2019), Norway (Johansen and Klette, 1997; Gavrilova et al., 2015), Finland (Korkeamäki and Uusitalo, 2009; Huttunenet al., 2013), Spain (Elias, 2015), Greece (Saez, Matsaganis, and Tsakloglou, 2012), and Germany (Müller and Neumann, 2017). Some studies have investigated the labor market impacts of payroll taxations in Argentina (Cruces et al., 2010), Chile (Gruber, 1997), Columbia (Adriana and Kugler, 2009), and the United States (Anderson and Meyer, 2000).

[2] In addition, the 2017–2020 World Values Survey and European Values Survey data indicate that Singaporeans show the highest acceptance level of income inequality among developed countries.

[3] A theoretical exposition of this point is illustrated in Appendix B.

are transferred to RA to form a retirement fund; this can be withdrawn through monthly payouts after the official claiming age (currently 65).[4] Both employers and workers contribute to the CPF, but self-employed individuals are only required to contribute to the Medisave component. Table A1 shows the CPF allocation schedule by age.

The government has increased the payroll tax rates several times over the past decades (for example, in 2014 and 2015) to ensure sufficient retirement savings, but has retained the same rates since January 1, 2016. Table A2 summarizes how the current payroll tax rate (i.e., the CPF contribution rate) varies with workers' age. The tax rate is 37% of the monthly wages of workers aged below 55 (17% levied on employers and 20% on employees) and 26% of the monthly wages of workers aged 55 and above but below 60 (13% on employers and 13% on employees). For those aged 60 and above but below 65, the payroll tax rate is 16.5% of monthly wages (9% on employers and 7.5% on employees). For those aged above 65, it further decreases to 12.5% of monthly wages (7.5% charged on employers and 5% on employees). Monthly income up to S$6,000 is taxable for payroll tax purposes in Singapore. Our main analysis exploits the discontinuous change in the payroll tax rate upon turning 60 to identify the labor market incidence of payroll taxation in Singapore. Hence, if there is a full incidence on workers' net wages, their monthly wages would increase by 4 percentage points.

It is noteworthy that there are simultaneous policy changes at ages 55 and 65. First, upon turning 55, Singaporeans can withdraw a portion of their CPF account balances. Approximately 40%–45% of individuals withdraw about S$33,000–43,000 when they become eligible for withdrawal (Kim and Koh, 2020). Second, the payroll tax rate cut at the age of 65 is accompanied by changes in retirement-related policies. Individuals reaching age 65 can claim public retirement pension benefits (called CPF LIFE), which will relax their liquidity constraints at the age of 65. Individuals aged 65 and above are also eligible for the Silver Support Scheme, a means-tested cash transfer program for the bottom quintile earners. Although these institutional settings deter us from cleanly identifying the causal effects of payroll taxation, we discuss the results of the other cutoff ages in Section 5.4.

3. Data

For our empirical analysis, we use data from the Singapore Life Panel (SLP), a nationally representative longitudinal survey of local residents in Singapore aged between 50 and 70 in July 2015, when it was launched. The SLP surveys about 8,000 individuals each month, mainly through the Internet, collecting rich individual- and household-level information on labor market outcomes, health, and demographic characteristics. As stated above, the payroll tax rates for different age groups have remained unchanged since January 2016. We drop the observations before 2016 and consider 55 monthly waves of the SLP from January 2016 through July 2020 in the baseline analysis to focus on the current payroll tax rate schedule, which has remained unchanged since 2016.

Our primary dependent variables are the binary indicators of employment and full-time work status, and net monthly labor income. The SLP does not ask respondents about their specific work hours. Instead, it surveys whether the respondents work 35 hours or more a week or less than 35 hours a week, or whether their work hours vary. We consider an individual working for more than 35 hours as a full-time worker.[5] Net monthly labor income is defined as the monthly income before taxes and other deductions conditional on employment and after the employer payroll tax contribution.

Singapore's payroll tax rate schedule depends on the worker's age. For an age-based RDD, we consider age in months as the baseline running variable.[6] As control variables, we include years of schooling, with the dummy variables indicating ethnicity (Chinese, Indian, or Malay), marital status, and gender.

Our sample is restricted to Singaporeans with paid jobs, because only they are subject to payroll taxation. As the SLP also collects information on labor market outcomes from self-employed workers and foreigners who are not subject to payroll taxation, we use these individuals to estimate the discontinuities in labor market outcomes at age 60 as a falsification check.

Table 1 provides the summary statistics of labor market outcomes and demographics of individuals aged 59 or 60, excluding foreign or self-employed workers. Workers aged 59 years earn higher monthly wages, are more likely to be employed, and are more likely to be full-time workers than those aged 60, although their demographic characteristics measured by years of education, gender, ethnicity, and marital status are generally similar.

4. Empirical strategy

To identify the labor market impacts of payroll taxation in Singapore, we exploit the sharp reduction in the payroll tax rate when a worker turns 60. We compare the labor market outcomes of workers just before and after turning 60 by applying an RDD. To estimate the discontinuity in labor market outcomes at the cutoff age (i.e., the month of the 60th birthday), we use the following regression specification:.

$$Y_{ia} = \alpha + \beta \hat{A} \cdot 1[age_{ia} > 0] + f(age_{ia}) + \varepsilon_{ia} \quad (1)$$

where Y_{ia} is the labor market outcome variable of interest such as monthly wage and its logarithm value and binary indicators of employment and full-time status for individual i at age in month a; age_{ia} denotes a worker's age in months normalized to zero at the month individual i turns 60; $1[age_{ia} > 0]$ is equal to 1 if individual i is 60 years of age or older and 0 otherwise;[7] $f(\cdot)$ is a smooth function of individual i's age in months, controlling for the age profiles of labor market outcomes; and ε_{ia} is an error term. The parameter of interest is β, representing the discontinuous changes in labor market outcomes at the cutoff age. For statistical inference, we calculate the standard errors clustered at the age-in-month level and corrected for heteroskedasticity.

The key identification assumption for interpreting the estimated discontinuities in labor market outcomes as the causal effects of payroll tax rate reduction is that all factors except for the payroll tax rate change continuously. As an indirect test of this assumption, we examine whether the observable characteristics of workers change smoothly at the cutoff age. Table A3 shows that

[4] The payroll taxes collected for a worker's CPF are allocated across Medisave, OA, and SA at predetermined shares, which vary by age. In general, more savings are allotted to Medisave when the worker is old and to SA when the worker is young. For workers aged between 60 and 65 years, 63.6%, 21.2%, and 15.2% of their total payroll taxes are allocated to the Medisave account, OA, and SA, respectively. For workers aged 35 and below, 22%, 16%, and 62% of their payroll tax payments are allocated to the Medisave account, OA, and SA, respectively.

[5] Although we consider workers' employment and full-time work status as measures of workers' labor inputs, these two variables may not fully capture changes in working hours. However, if the effect of the reduced payroll tax rate on working hours is materialized pervasively over the range of working hours, we could infer the effect on working hours via the effect on full-time work status.

[6] We also use age in weeks as an alternative running variable. The results show noisier patterns of outcome variables probably because we use a running variable with bins finer than a monthly frequency at which our labor market outcome data are measured. The magnitudes of discontinuities in labor market outcomes remain similar.

[7] We do not include the observations in the month of the 60th birthday because some respondents surveyed in that month may not yet be eligible for the payroll tax rate reduction.

Table 1
Summary Statistics.

	Age 59	Age 60
Labor market outcomes		
Monthly wages (S$)	3,989	3,860
Pr(employed)	0.65	0.63
Pr(full-time)	0.50	0.47
Demographics		
Years of education	12.28	12.11
Share of male	0.45	0.45
Share of Chinese	0.86	0.86
Share of Indian	0.05	0.05
Share of Malay	0.07	0.07
Pr(married)	0.80	0.80

Data source: The Singapore Life Panel.
Note: Monetary units are in 2019 Singapore dollar.

the estimated discontinuities are small in magnitude and statistically insignificant except for years of education, which is estimated at 0.054, but statistically significant at the 5% level. However, we argue that this discontinuity does not cause a serious bias in our estimation. First, the estimate is small compared to the average years of education in our sample, which is 12.3 years (see Table 1). Second, some birth cohorts will always be younger or older than 60 years during the sample period, and their educational attainment levels may be different from those of other birth cohorts.[8] As a robustness check, we estimate equation (1) after controlling for these individual characteristics and examine whether the statistically significant discontinuous change in educational attainment is orthogonal to the discontinuities in labor market outcomes.[9]

To minimize the bias in estimating β s, given the bandwidth, we need to choose a correct parametric approximation of unknown labor market age profiles$f(\cdot)$. We restrict the age of the sample respondents in the baseline specification to 59 and 60 (i.e., 12-month bandwidth before and after the month of the 60th birthday). Under the assumption that the baseline bandwidth is reasonably narrow, we approximate the labor market age profiles with a linear function of age in months and the slope differing on each side of the cutoff. As this baseline bandwidth is chosen arbitrarily, we also consider the data-driven optimal bandwidths computed for each dependent variable by adopting the method of Calonico et al. (2014). As an additional robustness check, we use a more flexible parametric approximation of $f(\cdot)$ by adding quadratic terms of age in months and its interaction with$1[age_{ia} > 0]$.

5. Results

5.1. Baseline analysis: Labor market impacts of payroll tax rate reduction at age 60

Fig. 1 shows the age profiles of labor market outcomes of individuals aged between 59 and 60; each dot represents the average value of each age in months along the lines, fitting those dots on each side of the cutoff age. As reference points, the cross marks in the figure correspond to the counterfactual changes in labor market outcomes when the saved labor costs via the payroll tax rate reduction is fully shifted to workers' monthly wages.

All labor market outcomes decrease with age, reflecting the fact that our sample individuals have already passed their peak working age. Panels A and B show discontinuous increases in monthly wage and its logarithm values upon turning 60, with the increases being close to the full-shifting points. However, Panels C and D do not demonstrate discontinuous changes in the probability of employment and full-time work status in the month of the 60th birthday. These results provide graphical evidence that the reduction in the payroll tax rate increases older workers' wages without changes in their labor inputs.

Table 2 reports the estimated discontinuities of labor market outcomes in the month of the 60th birthday using equation (1). Columns (1) and (2) show the estimated discontinuities in monthly wage and its logarithm value at the cutoff age of S$127.5 (or US $73.9) and 3.1%, respectively.[10] These estimates are statistically significant at the 1% and 5% levels, respectively. Columns (3) and (4) provide little evidence of discontinuous changes in the probability of employment and full-time work status. The estimates were small and statistically insignificant.[11]

In sum, the incidence of payroll taxes largely falls on workers' wages, leaving their employment intact. Our implied pass-through rate is 0.775, and its 95% confidence interval is between 0.089 and 1.461. Our findings imply that the efficiency loss of payroll taxation can be small in highly competitive labor markets.

5.2. Robustness checks

We report our robustness check results in Table 3. First, we restrict the sample to workers whose labor market outcomes are observed both before and after the cutoff age (at least within ± 6 months) and re-estimate the effects of payroll tax rate reduction upon turning 60 so that our sample includes individuals who experienced the payroll tax rate reduction. The estimated discontinuities shown in Panel A are similar to the baseline estimates in Table 2. The estimates for monthly wages and its logarithm values are statistically significant at the 1% level.

Second, if the estimated discontinuities reported in Table 2 are due to the payroll tax rate cut, they would be insensitive to the inclusion of control variables. Consistent with the findings reported in Table A3, the estimates in Panel B of Table 3 remain robust when we include covariates such as years of education, gender, ethnicity, and marital status.[12]

Third, we examine the baseline estimates' sensitivity to the choice of age bandwidth. Instead of the 12-month bandwidth used in the baseline analysis, we consider the data-driven optimal bandwidth computed using the methodology of Calonico et al. (2014), assuming that our running variable, age in months, is continuous. Panel C reports that the alternative bandwidths are wider than our baseline 12-month bandwidth, but the estimated discontinuities remain similar to those in Table 2.[13]

[8] To test this conjecture, we restrict the sample to those born between 1957 and 1959 so that our sample constitutes individuals observed both before and after the cutoff age. Consistent with our conjecture, the estimated discontinuity of education attainments becomes smaller in magnitude and statistically insignificant.

[9] Another identification assumption is that individuals cannot manipulate the running variable. This assumption must hold in our case because biological age is impossible to change by nature.

[10] The exchange rate was S$1 = US$0.74 as of March 25, 2021.

[11] If the reduced payroll tax rate increased working hours, we could have overestimated the wage impact of payroll tax rate reduction. However, this is less likely to be the case given the null impact on the probability of full-time work status as reported in column (4). If the payroll tax rate reduction increased working hours, the probability of full-time work status should have increased under the assumption that the effect of the payroll tax rate reduction on working hours is constant over the range of working hours.

[12] The change in educational attainment at the cutoff age is statistically significant at the 5% level, but the magnitude is small. To further examine whether this leads to bias in estimates, we include only education attainments and re-estimate equation (1). The results remain robust.

[13] Since we use the optimal bandwidths, estimation with alternative bandwidths deviating too much from the optimal bandwidths can mechanically cause bias or increase variance (Cattaneo et al., 2019). To avoid this issue, we use bandwidths whose values are up to 3 months different from the optimal bandwidths (deviating 16%–25% from the optimal bandwidths). That is, we investigate whether our RD estimates are robust when inducing small perturbations of the optimal bandwidths. Fig. A1 in the appendix shows that the RD estimates are generally similar to those with the optimal bandwidths.

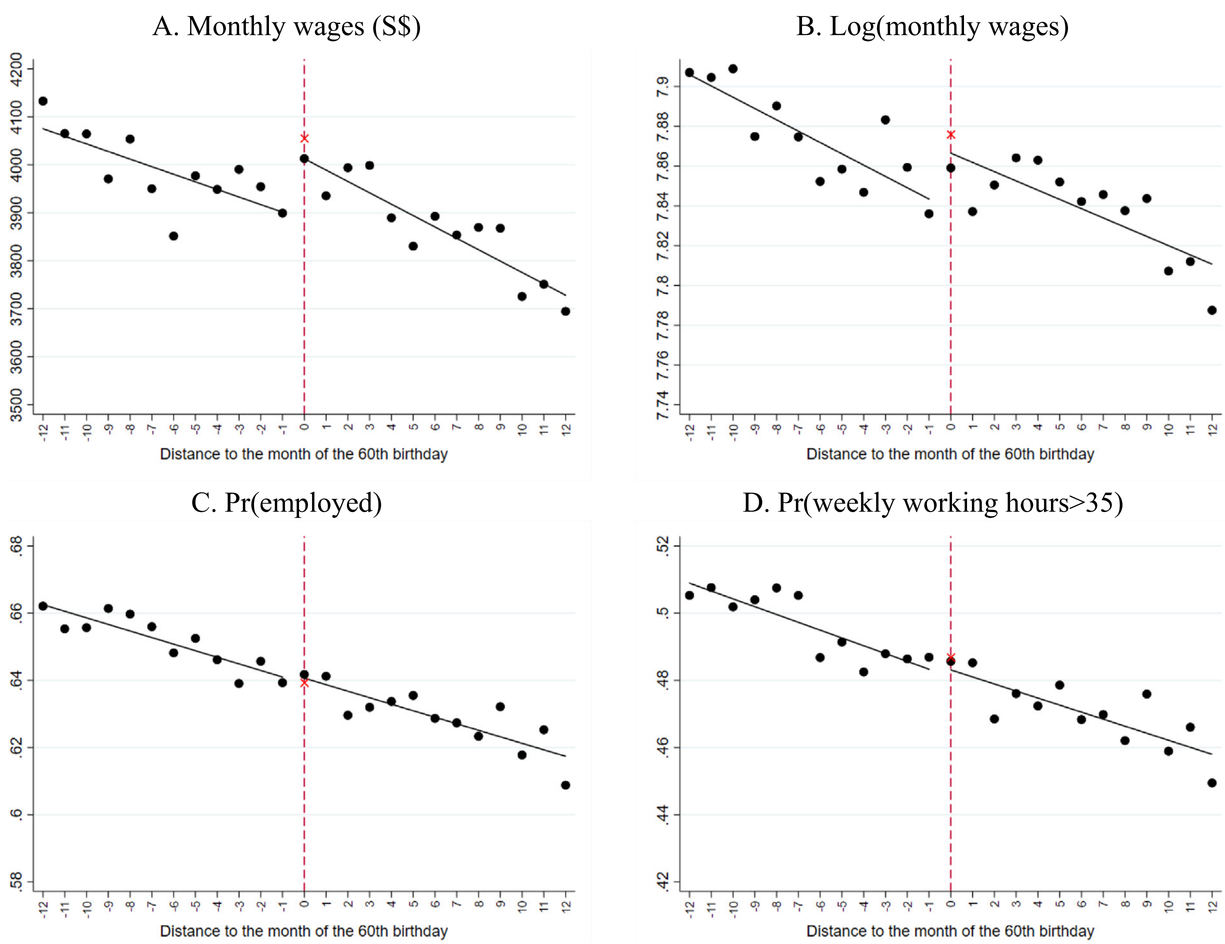

Fig. 1. Age Profiles of Labor Market Outcomes. Data source: The Singapore Life Panel. Notes: We exclude self-employed individuals and foreign citizens from the sample. Each dot represents the average value for each age in months. The cross marks indicate counterfactual changes in labor market outcomes if the payroll tax cut fully shifts to workers' monthly wages.

Table 2
Discontinuity in Labor Market Outcomes Upon Turning 60.

Dependent variables:	Monthly wages (1)	Log(monthly wages) (2)	Pr(employed) (3)	Pr(Weekly working hours > 35) (4)
1[Age > 60th Birthday]	127.5***	0.031**	0.001	0.001
	(38.1)	(0.014)	(0.004)	(0.005)
Implied pass-through rate [95% CI]	0.775 [0.089, 1.461]			
Observations	28,453	28,334	44,322	44,322
R-squared	0.001	0.001	0.001	0.001
Mean of control	S$3,899	7.84	0.64	0.49
Bandwidth	12	12	12	12

Data source: The Singapore Life Panel.
Notes: We exclude self-employed individuals and foreign citizens from the sample. We do not include any control variables. Standard errors in parentheses are clustered at the age level and corrected for heteroskedasticity. *** p < 0.01, ** p < 0.05, * p < 0.1.

Fourth, we investigate whether the estimated discontinuities at age 60 remain robust when we approximate $f(\cdot)$ with higher-order polynomials of age in months. As an alternative to the linear approximation of the underlying functions of outcome variables, recent literature recommends the use of a quadratic function (Gelman and Imbens, 2019). We also use the quadratic function of age in months and its interaction with $1[age_{ia} > 0]$ to fit the age profiles of labor market outcomes. As the optimal bandwidth choice can be affected by the functional form of $f(\cdot)$, we re-calculate the data-driven bandwidths following Calonico et al.'s (2014) method. The results shown in Panel D indicate that the estimated discontinuities, with the higher-order polynomials of age in months, are similar to those of the baseline specification in Table 2.

Table 3
Robustness Checks.

Dependent variables:	Monthly wages (1)	Log(monthly wages) (2)	Pr(employed) (3)	Pr(Weekly working hours > 35) (4)
A. Restricting the sample to those whose labor market outcomes are traced before and after 60th birthday				
1[Age > 60th Birthday]	114.1***	0.035***	−0.005	−0.005
	(34.2)	(0.012)	(0.004)	(0.004)
Observations	25,220	25,123	39,059	39,059
R-squared	0.0002	0.0002	0.001	0.001
Mean of control	S$3,893	7.83	0.65	0.49
Bandwidth	12	12	12	12
B. Adding covariates				
1[Age > 60th Birthday]	98.8**	0.024*	0.0003	0.00004
	(38.4)	(0.013)	(0.004)	(0.004)
Observations	28,453	28,334	44,322	44,322
R-squared	0.197	0.277	0.044	0.062
Mean of control	S$3,899	7.84	0.64	0.49
Bandwidth	12	12	12	12
C. Using data-driven optimal bandwidth (linear specification for age profile)				
1[Age > 60th Birthday]	101.8***	0.025**	−0.0002	0.001
	(32.3)	(0.011)	(0.003)	(0.005)
Observations	45,107	37,839	48,036	44,322
R-squared	0.001	0.001	0.001	0.001
Mean of control	S$3,899	7.84	0.64	0.49
Bandwidth	19	16	13	12
D. Adding quadratic specification				
1[Age > 60th Birthday]	173.9***	0.032	0.0005	−0.004
	(48.9)	(0.019)	(0.005)	(0.005)
Observations	52,305	40,212	55,514	92,804
R-squared	0.002	0.001	0.001	0.003
Mean of control	S$3,899	7.84	0.64	0.49
Bandwidth	22	17	15	25

Data source: The Singapore Life Panel.
Notes: We exclude self-employed individuals and foreign citizens from the sample. In Panel A, we include only individuals whose labor market outcomes are observed both before and after the 60th birthday. We do not include any control variables. In Panel B, we include dummy variables for primary education, secondary education, gender, ethnicity (Chinese, Indian, and Malay), marital status, and number of children. Standard errors in parentheses are clustered at the age level and corrected for heteroskedasticity. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Fifth, we examine whether our baseline estimates are driven by few observations close to the cutoff by using a donut-hole approach (Barreca et al., 2011). We excluded observations with respondents' age (in months) being zero to three months away from the 60th birth month while using the baseline bandwidth. As a result, the donut hole size varies from one to seven months. Fig. A2 indicates that the estimated discontinuities in labor market outcomes remain robust under different donut-hole sizes, implying that our baseline estimates are not sensitive to the observations near the cutoff age.[14]

5.3. Falsification checks

In our baseline analysis, we excluded foreigners and self-employed Singaporeans because social security contributions are mandated only for local residents engaged in paid work.[15] If the estimated discontinuities in labor market outcomes at age 60 are due to the payroll tax rate reduction, we do not expect to observe such discontinuities for foreigners or self-employed Singaporeans. Table A4 shows that the estimated discontinuities of labor market outcomes at age 60 are statistically insignificant for this group of people. Although this is a natural falsification check to consider, we acknowledge that the results are imprecisely estimated. As such, this falsification check is limited in providing evidence on the internal validity of our baseline results.

Hence, we conduct an additional falsification check by examining the estimated discontinuities at a hypothetical cutoff age range. We assign each of the 48 months before and after the actual cutoff (the month of the 60th birthday) as a placebo cutoff age. We then estimate the discontinuity of labor market outcomes at each of the 96 cutoffs with a 12-month bandwidth. Fig. 2 plots the distribution of the 96 estimates, with the baseline estimates in Table 2 shown as vertical lines. The probabilities of the placebo estimates being larger in magnitude than the baseline estimate for monthly wages and log monthly wages are 5.2% and 4.7%, respectively, while the corresponding probabilities for employment status and full-time work status are 72.4% and 74.5%, respectively. These results imply that the estimated discontinuities at the placebo cutoffs are less likely to replicate the baseline estimates.

5.4. Additional analyses

5.4.1. Heterogeneity in labor market impacts by sector

We compare the labor market impacts of payroll taxation used to finance pension benefits between the private and public sectors to investigate the extent to which the empirical content of the bargaining institutions hypothesis overlaps with the empirical content of the tax-benefit linkage hypothesis. The ICTWSS database reports that in Singapore, the labor market in the public sector is less competitive than that in the private sector in terms of collective bar-

[14] We find that discontinuities in the logarithm value of monthly wages at the cutoff age become larger when the donut-hole size increases. This may be due to the fact that wages fall faster with age after reaching the peak of an inverted-U-shaped age profile of wages. As the donut-hole size becomes larger, the slope of $f(.)$ after the cutoff age can be estimated steeper.

[15] Self-employed individuals are required to contribute only to the individual medical savings account called Medisave. Their Medisave contribution rates (5.25% to 10% depending on income) do not change once they reach 50.

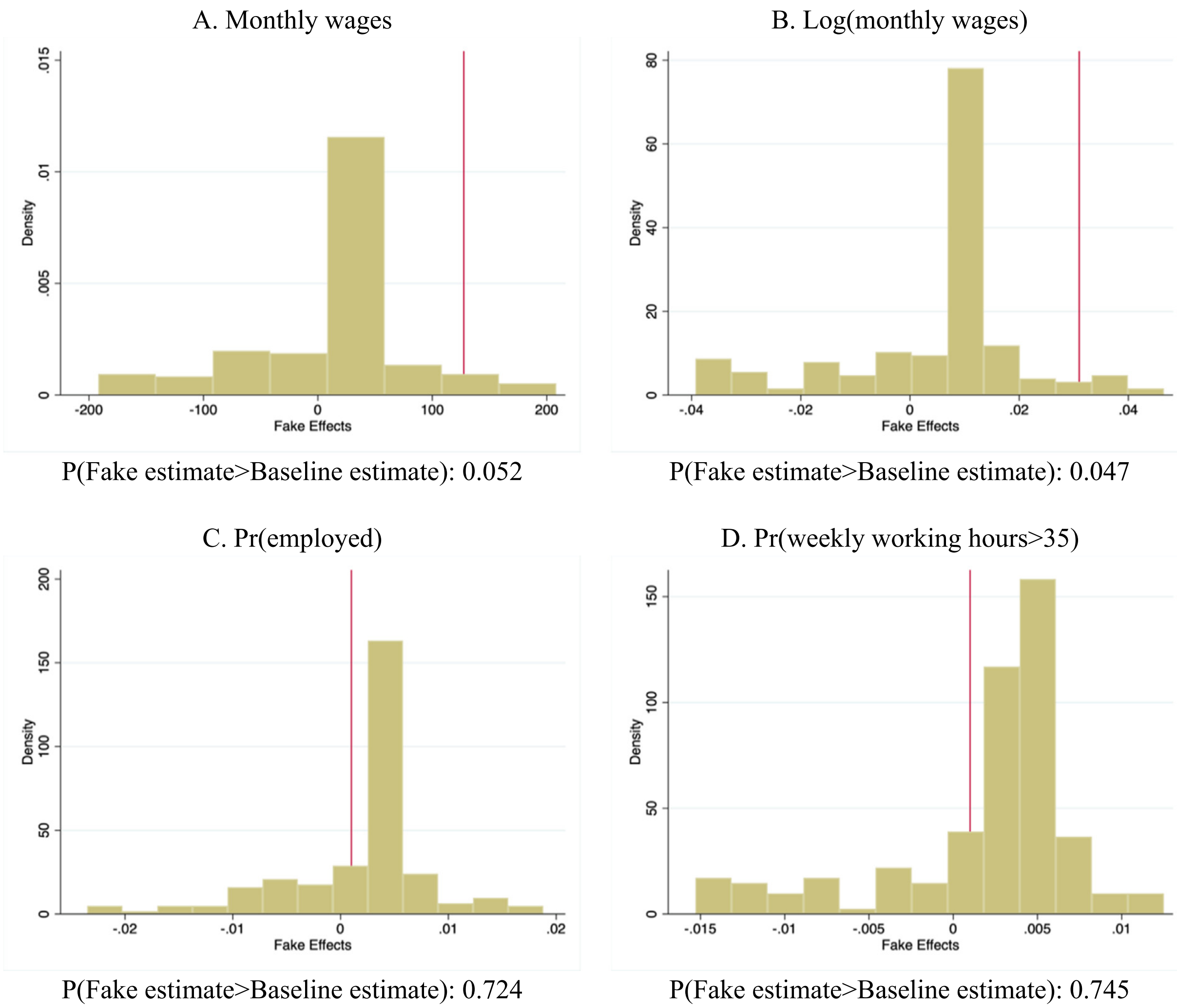

Fig. 2. Distributions of Discontinuities of Labor Market Outcomes at Placebo Age Cutoffs. Data source: The Singapore Life Panel. Note: The red vertical line indicates the baseline RDD estimate reported in Table 2.

gaining and right of association, while we note that workers have strong tax-benefit linkages regardless of sectors because there is no heterogeneity in the degree of tax-benefit linkages across sectors.[16] We estimate the discontinuities in labor market outcomes upon turning 60 in each sector by assuming the same age profiles between the two sectors. To address endogenous selection into different industries based on respondent characteristics, we controlled for respondents' educational attainment, gender, and ethnicity. Panel A of Table 4 indicates that there are discontinuous increases in monthly wages and the logarithm values of monthly wages without significant increases in labor inputs among workers in the private sector. However, there is little evidence that the payroll tax rate reduction increases wages among workers in the public sector. Panel B indicates that the results remain similar when we add control variables in the regression analysis. However, these results should be interpreted with caution because i) the sample size of each group is reduced, as we divide the baseline sample into two sectors, and ii) it is difficult to cleanly identify public sectors because of limited information on the workers' industry.

5.4.2. Heterogeneity in labor market impact by gender and education

We examine whether the labor market impacts of payroll taxes are heterogeneous by workers' characteristics, such as gender and education level. In Table A5, we report the estimated discontinuities in labor market outcomes after splitting the sample by gender and education attainment level. The results indicate that the discontinuous increases in monthly wages and the logarithm value of monthly wages are generally greater among male workers and those with higher education levels (tertiary education). There is little heterogeneity in the probability of employment and full-time status. We conjecture that male or more-educated workers in the later stage of labor market participation may have higher job turnover rates than female or less-educated workers (Eriksson and Lagerström, 2012; Machin et al., 2012; Liu, 2016). We acknowledge that we could not test this conjecture due to the lack of information on employment history or job changes. In addition, the results should be interpreted with caution because of the reduced sample size, as we split the sample into two groups for analysis.

[16] In the analysis, we defined the public sector if a worker's most recent industry is either administrative and support service, public administration and defense, education, health and social services, extra-territorial organizations and bodies according to the Singapore Standard Industry Classification system. We also used a more narrowly defined public sector by only including public administration and national defense for an alternative analysis (the number of observations was 577). The heterogeneity in labor market outcomes between private and public sectors remained similar. However, due to the reduced sample size of the public sector, we present the results using a broader definition of the public sector.

Table 4
Discontinuity in Labor Market Outcomes Upon Turning 60: Sectoral Difference.

Dependent variables:	Monthly wages (1)	Log(monthly wages) (2)	Pr(employed) (3)	Pr(Weekly working hours > 35) (4)
A. Without controls				
1[Age > 60th Birthday]× Private	164.5***	0.036**	0.004	0.005
	(38.2)	(0.013)	(0.003)	(0.005)
1[Age > 60th Birthday]× Public	−18.7	0.014	−0.006	−0.013*
	(63.4)	(0.021)	(0.005)	(0.007)
Observations	28,453	28,334	44,322	44,322
R-squared	0.003	0.004	0.025	0.010
B. With controls				
1[Age > 60th Birthday]× Private	129.1***	0.026**	0.002	0.002
	(36.7)	(0.011)	(0.003)	(0.004)
1[Age > 60th Birthday]× Public	−28.7	0.013	−0.004	−0.010
	(60.4)	(0.020)	(0.005)	(0.006)
Observations	28,453	28,334	44,322	44,322
R-squared	0.200	0.279	0.069	0.071

Data source: The Singapore Life Panel.
Notes: We exclude self-employed individuals and foreign citizens from the sample. We defined the public sector if a worker's most recent industry is either administrative and support service, public administration and defense, education, health and social services, extra-territorial organizations and bodies according to the Singapore Standard Industry Classification system. Standard errors in parentheses are clustered at the age level and corrected for heteroskedasticity. *** p < 0.01, ** p < 0.05, * p < 0.1.

5.4.3. Labor market impacts of payroll tax rate reduction at other ages

We estimate the discontinuities in labor market outcomes at ages 55 and 65 to understand how payroll tax rate reduction and other public policies jointly affect labor market outcomes. The labor market impact of payroll tax rate reduction at 55 and 65 are theoretically analyzed in Appendix B.2 which accounts for the change in the liquidity constraints and the retirement decision induced by the accompanying policy change at the same cutoff age. For our empirical analysis, we employ the same specification as in the baseline analysis. We use a bandwidth of 12 months and a linear function of age in months, normalized to zero at the month individual i turns 55 (or 65), and its interaction term with$1[age_{ia} > 0]$, which is equal to 1 if individual i is 55 (or 65) or over, and 0 otherwise.

Panels A and B of Table 5 report the estimated discontinuities in labor market outcomes at the cutoff ages of 55 and 65, respectively. Panel A indicates that the estimated discontinuities in monthly wages, the logarithm value of monthly wages, and the probabilities of employment are all small and statistically insignificant. However, the estimated discontinuity in full-time work status is 0.012 and statistically significant at the 1 percent level. Panel B shows that the estimated discontinuities in monthly wages and log monthly wages are small and statistically insignificant. However, the estimated discontinuities in the probabilities of employment and full-time status (conditional on being employed) are − 0.018 and − 0.01, and statistically significant at the 1% and 5% levels, respectively. These results, in general, do not support the predicted labor market impact of payroll taxes of the canonical model. We conduct the following additional analyses to better understand the discrepancies between theoretical predictions and empirical results at the cutoff ages of 55 and 65.

First, our theoretical analysis in Appendix B.2 implies that the small and insignificant tax incidence observed at the age 55 threshold could be due to the fact that some 55-year-old workers had binding liquidity constraints. 55-year-old workers are more likely to be subject to binding liquidity constraints than workers aged 60 or 65 years because older workers could have withdrawn part of their CPF pension wealth up to five or ten times if they withdrew once a year after turning 55. As a result, the effects of a reduction in the payroll tax rates on those 55-year-old workers are shown to be ambiguous.

On the other hand, the labor market impacts of the reduced payroll tax rates among 55-year-old workers *without* liquidity constraints will be more likely to be consistent with the predictions under the canonical labor market model.[17] To examine this conjecture, we estimate heterogeneous labor market impacts of the reduced payroll tax rate by household wealth. If wealthier workers are less likely to experience liquidity constraints, our results in Panel A of Table A6 are generally consistent with our conjecture. The panel shows that the reduced payroll tax rate increased workers' wages by S$54.9 or 2.1 percent among workers with household net worth above the median although the estimates are not statistically significant at the 5 percent level.[18] In addition, our estimates on labor inputs are small in magnitude and statistically insignificant. These results are qualitatively similar to the results for 60-year-old workers in Table 2.[19] By contrast, the labor market impacts among less wealthy workers reported in Panel B show insignificant wage impacts with a larger increase in work hours.

Second, many individuals are likely to retire upon turning 65, which could have confounded the effects of the reduced payroll tax rate. We conjecture that labor market impacts of payroll taxation would be more consistent with the predictions under the canonical model among those who did not plan to retire after reaching 65. To indirectly account for the bias due to individuals' retirement decision, we restrict the sample to those who do not retire immediately after their 65th birthday.[20] Our RD estimates in Table A7 present positive wage impacts without significant changes in labor inputs. The reduced payroll tax rate increases workers' wages by S$121.7 or 2.1 percent, and the effects are statistically significant at the 5 percent level.[21] In the meantime, our estimates on labor inputs are small in magnitude and statistically insignificant. The results suggest that labor market impacts of the reduction in payroll tax rate upon turning 65 become more consistent with the

[17] Workers at age 55 with liquidity constraints will have two additional policy effects in comparison to those without constraints: (i) their liquidity constraints would be relaxed by withdrawing part of their CPF pension wealth upon turning 55, and (ii) the reduced employee contribution to the CPF savings account incentivizes them to increase labor supply. With these additional effects, we argue that changes in labor market outcomes for workers at age 55 with liquidity constraints could be ambiguous.

[18] Table 2 indicates that the 95% confidence intervals of the baseline estimates on monthly wages and log value of monthly wages are 127.5 [52.8, 202.2] and 0.031 [0.004,0.058], respectively. This implies that the differences between estimates on wage variables in Panel A of Table A6 and Table 2 are statistically insignificant.

[19] The implied pass-through rate [95% CI] among relatively wealthy 55-year-old workers is 0.525 [-0.063,1.113].

[20] Specifically, we restricted the sample to individuals who continue to be employed at least until 6 months after their 65th birthday.

[21] The implied pass-through rate [95% CI] is 1.4 [0.224, 2.576].

Table 5
Discontinuity in Labor Market Outcomes at Other Age Cutoffs.

Dependent variables:	Monthly wages (1)	Log(monthly wages) (2)	Pr(employed) (3)	Pr(Weekly working hours > 35) (4)
A. Upon turning 55				
1[Age > 55th birthday]	−41.0	0.009	0.002	0.012***
	(45.8)	(0.006)	(0.004)	(0.004)
Observations	29,456	29,376	40,918	40,918
R-squared	0.0001	0.0001	0.0001	0.0001
Mean of control	S$4,581	8.03	0.73	0.58
Bandwidth	12	12	12	12
B. Upon turning 65				
1[Age > 65th birthday]	10.1	−0.014	−0.018***	−0.010**
	(55.1)	(0.014)	(0.005)	(0.004)
Observations	16,351	16,257	34,144	34,144
R-squared	0.0001	0.002	0.005	0.004
Mean of control	S$3,291	7.63	0.48	0.31
Bandwidth	12	12	12	12

Data source: The Singapore Life Panel.
Notes: We exclude self-employed individuals and foreign citizens from the sample. We do not include any control variables. Standard errors in parentheses are clustered at the age level and corrected for heteroskedasticity. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

predictions under the canonical model when we partially isolate the effects of retirement.

However, we acknowledge that our additional analyses at the other cutoff ages should be interpreted with caution because i) it is difficult to correctly measure workers' liquidity constraint and their incentives to retire[22] and ii) the sample size was reduced, as we conduct subgroup analysis.

6. Meta-Analysis

In this section, we study the heterogeneity of the wage impacts of payroll taxes based on the institutional characteristics of the labor market to further examine the role of labor market competitiveness.

Table 6 reports the estimated pass-through rates of payroll taxes to wages from 22 published studies or working papers covering different countries and time periods. The pass-through rate is equal to 1 when an increase in payroll tax on employers is completely shifted to workers, and 0 when workers do not bear the burden of the increased payroll tax levied on the employer at all.

We first constructed this sample of studies using 16 papers surveyed in Bozio et al. (2020) and reviewed all the papers referenced in each of these papers. We then carried out a Google Scholar search to identify additional studies citing Bozio et al. (2020), the 16 papers, and the papers referenced in them, yielding 34 papers that empirically studied the incidence of payroll taxation. We then excluded 12 papers from the sample because we could not find any estimate of the pass-through rate in them. Three papers in the sample reported more than one pass-through rate estimate. Thus, we obtained 26 estimates.

Pass-through rates vary widely across countries and time periods. For example, Gruber and Krueger (1991), Gruber (1994), Gruber (1997), Anderson and Meyer (2000), and Komamura and Yamada (2004) report a pass-through rate greater than 0.8. In contrast, relatively recent studies such as Lehmann et al. (2013), Skedinger (2014), Elias (2015), Egebark and Kaunitz (2018), Adam et al. (2019), and Saez et al. (2019) find a pass-through rate below 0.2. In particular, Bozio et al. (2020) show that the pass-through rates can range from 0.1 to 1.1, depending on the salience of tax-benefit linkage, even within the same country, using three distinct payroll tax reforms in France.

The last three columns of Table 6 report the degree of labor market flexibility in the wage determination process of the corresponding country in each study. We obtained this information from the ICTWSS database (Visser, 2019). The variable in the fifth column pertains to the predominant level at which wage bargaining takes place in a country each year. It distinguishes five tiers from 1 (wage bargaining takes place predominantly at the local or company level) to 5 (bargaining takes place predominantly at the central or cross-industry level).[23] We presume a more competitive labor market when wage bargaining takes place at the firm level, because the wage determination process is more likely to be flexible.[24] The variable in the sixth column indicates whether the country has a sectoral organization for employment relations. The value 0 stands for weak or no institutions, 1 for intermediate cases (only one side, with no joint institutions), and 2 for strong institutions (both employers and unions, with some joint institutions). The variable in the last column is the collective bargaining coverage rate, which is the population share of employees covered by valid collective wage bargaining agreements. Wage determination can be more flexible if no strong sectoral organization exists, or fewer workers are covered under collective bargaining agreements. The values reported in the last three columns of Table 6 give the average of these variables over the years covered by the data considered in the respective studies.[25]

To formally test whether institutional characteristics of the labor market affect the degree of payroll tax change transferred

[22] The retirement decision is influenced by not just contemporary tax incentives but also life-cycle factors. Moreover, it is often made based on "behavioral" factors such as reference dependence and loss aversion by simply following the official pension claiming age (Behaghel and Blau, 2012).

[23] See the variable description in Table 6 for the details of the five levels.

[24] Three elevating levels are considered in this variable: (i) local or company level, (ii) sector or industry level, and (iii) central or cross-industry level. A level is "predominant" if it accounts for at least two-thirds of the total bargaining coverage rate in a given year. If it accounts for less than two-thirds but more than one-third of the coverage rate, a mixed or intermediate situation exists between levels (i) and (ii) or (ii) and (iii). A mixed situation also occurs when the bargaining levels alternate and/or one cannot assess which of the two levels contributes more to the actual coverage of agreements.

[25] We acknowledge that it is challenging to construct a variable that fully captures the heterogeneity of the wage bargaining processes across countries over time. However, we argue that, given the data availability, the degree of collective bargaining is a reasonable proxy for the labor market competitiveness based on the standard economic theory (McDonald and Solow, 1981; Nickell and Andrews, 1983). Moreover, reduced labor costs due to the payroll tax rate reduction are more likely to be shifted to workers in the form of increased wage payments when the wage bargaining unit on the employer side is smaller (e.g., firm-level bargaining), and this increase in wages is more likely to be concentrated on the target group of the payroll tax rate reduction when the wage bargaining unit on the employee side is smaller (e.g., non-unionized workers). Therefore, the size of wage bargaining units used in our meta-analysis could approximate market competitiveness and be related with the degree of tax incidence.

Table 6
Summary of Empirical Studies of Payroll Tax Incidence.

Authors (pub. Year)	Country of study	Years of study	Pass-through rate (std. err.)	Wage bargaining level	Sectoral organization	Collective bargaining coverage rate
Gruber and Krueger (1991)	U.S.	1979–81, 87, 88	0.865 (0.184) [Table 5, col. 7]	1	0	22.36
Gruber (1994)[1]	U.S.	1977, 78	1.56 [Table 5, col. (iii)]	1	0	25.45
Gruber (1997)	Chile	1984, 85	1.022 (0.180) [Table 3, col. 1]	1	0	10
Anderson and Meyer (1997)	U.S.	1978–84	0.715 (0.292) [Table 3, col. 1]	1	0	23.82
Johansen and Klette (1997)	Norway	1983–93	0.80 (0.15) [Table 6, col. 2]	4.55	2	75.00
Anderson and Meyer (2000)	U.S.	1985	1.427 (1.191) [Table 3, col. 1]	1	0	19.87
Komamura & Yamada (2004) (i) Health insurance	Japan	1995–2001	1.20 (0.2) [Table 1, FE model]	1	0	22.20
Komamura & Yamada (2004) (ii) Long-term care insurance	Japan	2000–01	0.20 (0.2) [Table 2, FE model]	1	0	21.10
Baicker and Chandra (2006)	U.S.	1996–2002	1.00 (0.20) [Table 4, col. 1]	1	0	14.65
Murphy (2007)	U.S.	1992–2002	0.23 (1.01) [Table 6, panel A, col. 3]	1	0	15.41
Kugler and Kugler (2009)[2]	Colombia	1994–1996	0.2346 (0.0883) [Table 3, col. 1]	.	.	.
Korkeamaki and Uusitalo (2009)	Finland	2003	0.49 (0.24) [Table 7, col. 2]	4	2	86.20
Bennmarker et al. (2009)	Sweden	2002–04	0.23 (0.08) [Table 4, col. 3]	3	2	94.00
Cruces et al. (2010)	Argentina	1995–2001	0.501 (0.192) [Table 4, col. 2]	2	2	72.90
Saez et al. (2012)	Greece	2004–09	0.295 (0.182) [Table 5, col. 1]	4	0	100.00
Lehmann et al. (2013)	France	2003–06	0.134 (0.260) [Table 2, col. 3]	3	1	98.00
Skedinger (2014)	Sweden	2007, 08	0.036 (0.027) [Table 2, col. 5]	3	2	90.25
Gavrilova et al. (2015)	Norway	1996–2012	0.666 (0.154) [Table 2, col. 1]	3.47	2	73.80
Elias (2015)	Spain	1997, 98	0.0009 (0.0059) [Table 4, col. 6]	3	2	83.18
Egebark and Kaunitz (2018) (i) 2007 reform	Sweden	2007	0.012 (0.002) [Table 6, col. 2]	3	2	90.50
Egebark and Kaunitz (2018) (ii) 2009 reform	Sweden	2009	0.010 (0.003) [Table 6, col. 3]	3	2	90.00
Adam et al. (2019)	U.K.	1982–2015	−0.009 (0.109) [Table 3, col. 6]	1.5	0.05	38.90
Saez et al. (2019)	Sweden	2009–13	0.085 (0.046) [Table 1, panel A]	3	2	89.40
Bozio et al. (2020) Early 1980 s	France	1988	0.209 (0.133) [Table 3, col. 4]	3	1	94.58
Bozio et al. (2020) Late 1980 s	France	1996	0.100 (0.224) [Table 3, col. 3]	3	1	96.00
Bozio et al. (2020) Early 2000 s	France	2007	1.077 (0.318) [Table 3, col. 2]	3	1	95.00

Notes: 1. Gruber (1994) does not report the standard error for the estimated pass-through rate. 2. The ICTWSS database does not provide information on Columbia over the period 1994–96.
Variable description: (1) Wage bargaining level: predominant level at which wage bargaining takes place (in terms of employee coverage). A level is "predominant" if it accounts for at least two-thirds of the total bargaining coverage rate in a given year. If it accounts for less, but for more than one-third of the coverage rate, a mixed or intermediate situation occurs between the two levels. A mixed situation also occurs when bargaining levels alternate and/or one cannot assess which of the two contributes more to the actual coverage of agreements. There are five categories:
5 = bargaining predominantly takes place at the central or cross-industry level negotiated at lower levels.
4 = intermediate or alternating between central and industry bargaining.
3 = bargaining predominantly takes place at the sector or industry level.
2 = intermediate or alternating between sector and company bargaining.
1 = bargaining predominantly takes place at the local or company level.
(2) Sectoral organization: sectoral organization of employment relations There are 3 categories:
2 = strong institutions (both employers and unions, some joint institutions).
1 = medium (only one side, no joint institutions).
0 = weak, or none.
(3) Collective bargaining coverage rate: employees covered by valid collective (wage) bargaining agreements as a proportion of all wage and salary earners in employment with the right to bargaining, expressed as a percentage (0–100), adjusted for the possibility that some sectors or occupations are excluded from the right to bargain.

to wages, we conduct a subgroup meta-analysis of the equality of the pass-through rates between the cases with more and less competitive labor markets based on the three aforementioned measures in Table 6 (Card et al., 2018; Bozio et al., 2020). Our subgroup meta-analysis excludes Gruber (1994) and Kugler and Kugler (2009) because the former does not report the standard error of the estimated pass-through rate and the latter has missing labor market flexibility information for Colombia from the ICTWSS database over the study period. Therefore, we consider 24 estimates.

Panel A of Table 7 reports the weighted average of the pass-through rate from the 24 estimates, with more precise estimates having larger weights. We use a random-effects meta-analysis model to calculate the weights.[26] The average pass-through rate is significantly positive (0.406), and its 95% confidence interval is strictly above zero.

Panel B shows the pass-through rate estimates by the wage bargaining levels. The weighted average pass-through rate is 0.838 for studies conducted in countries where wage bargaining predominantly takes place at the local or firm level (8 observations), and 0.234 for studies conducted in countries where wage bargaining generally takes place at a more aggregate level (16 observations). The group mean difference is statistically significant, with a *p*-value less than 0.001. This implies that the employer's burden of payroll taxes is easily shifted to workers when wages are determined at a more flexible level, as predicted by the canonical competitive labor market model. We find a similar finding in Panel C, where we report the average pass-through rates for groups by sectoral organization. The payroll tax burden is more easily shifted to workers when there is no or only a weak institution of employment relations than when there is a medium or strong sectoral organization.[27]

Since the collective bargaining coverage rate is a continuous variable, ranging from 0 to 100, we plot the relationship between the collective bargaining coverage rate and the pass-through rate in Panel C of Fig. A3. The figure indicates that the two variables are negatively correlated. We then employ the meta-analysis

[26] A random-effects meta-analysis model assumes that variations in the pass-through rate across studies result from both the between-study and sampling variability. In this model, the weight is the inverse of the sum of the two variance estimates.

[27] Graphical presentations of these subgroup meta-analyses, also known as forest plots, are shown in Panels A and B of Fig. A3.

Table 7
Meta-Analysis of Pass-through Rate by Groups of Wage Determination Flexibility.

Group	Number of studies	Weighted Average	95% confidence interval	p-value for homogeneity
A. Overall	24	0.406	(0.239, 0.574)	<0.001
B. By Wage bargaining levels				
Wage bargaining predominantly takes place beyond the company level (>1)	16	0.234	(0.096, 0.372)	<0.001
Wage bargaining predominantly takes place at the local or company level (=1)	8	0.838	(0.560, 1.117)	0.030
[Test of group mean differences]	χ^2 (d.f.) = 14.54 (1), p-value < 0.001			
C. By Sectoral organization				
Medium or strong sectoral organization of employment relations (>0)	15	0.234	(0.087, 0.380)	<0.001
No or weak sectoral organization of employment relations (=0)	9	0.757	(0.477, 1.037)	0.003
[Test of group mean differences]	χ^2 (d.f.) = 10.51 (1), p-value = 0.001			

Table 8
Meta-Analysis Regression: Collective Bargaining Coverage Rate and Pass-through Rate.

	Baseline	Additional regressors
Dep. Var: Pass-through rate	(1)	(2)
Collective bargaining coverage rate (0–100)	−0.00762***	−0.00591***
	(−3.49)	(−2.59)
Cyclical environment		
GDP growth rate		0.0294
		(0.820)
Unemployment rate		−0.0145
		(−0.770)
Unit of observation (omitted = workers)		
Firm observations		0.232
		(1.48)
Regional observations		0.405
		(1.06)
Constant	0.911***	0.762***
	(5.51)	(2.99)
Observation	24	24
R-squared	0.430	0.478

Notes: t-values are given in parentheses. *** significant at 1%; ** significant at 5%; * significant at 10%. Data on annual GDP growth rates were extracted on April 5, 2021, from the World Bank national accounts data and OECD National Accounts data files. Data on unemployment rates were extracted on April 5, 2021, from the OECD data, except for Chile, Colombia, Argentina, Norway, and the United Kingdom; the data for these countries extracted are from the IMF database.

regression method with random effects, which is a linear regression of the estimated pass-through rates on study-level covariates (or moderators). Column (1) of Table 8 shows the regression results with the collective bargaining coverage rate as a single moderator. We find that the pass-through rate is significantly smaller with a higher coverage rate, and the incidence of payroll taxes financing worker benefits is therefore less likely to fall on workers' wages in a country that determines wages in a more collective manner. This is in line with our earlier finding that the employer's burden of payroll taxes is easily shifted to workers when the labor market is more flexible.

The specification in column (2) additionally controls for the average GDP growth and unemployment rate to capture the fluctuations in macroeconomic conditions over the study years (Card et al., 2018). We also add controls for the observation units in the study (workers, firms, and regions). None of these moderators shows a statistically significant association with the pass-through rate, whereas the collective bargaining coverage rate shows robust effects. The coefficient estimate is not only statistically significant at the 1% level but also economically meaningful. For example, the coefficient value of −0.006 in column (2) of Table 8 implies that the pass-through rate will be lower by 0.21 percentage points if the collective bargaining coverage rate increases by one standard deviation (34.6). This change in the pass-through rate is large in magnitude, equivalent to 52% of the mean pass-through rate of 0.406 (Panel A of Table 7).

Our meta-analysis indicates that the institutional characteristics of the labor market can play a significant role in explaining the heterogeneity in tax incidence. Wages are more likely to respond to payroll taxation when the labor market is more competitive and flexible.

7. Conclusion

Despite clear predictions under the canonical model of a competitive labor market, existing empirical studies have provided mixed evidence on how much a payroll tax change is shifted to workers' wages. One possible explanation for this discrepancy is the heterogeneity in labor market flexibility across countries and time. To better understand the role of market flexibility or competitiveness, we investigate the labor market impact of payroll taxation in Singapore, where the labor market is considered more competitive and flexible than in any other country investigated in the literature. We document that saved labor costs via the reduced payroll tax rate largely shifts to workers' wages. The estimated pass-through rate in Singapore is 77.5%, which is similar to the weighted average pass-through rate of the studied countries where wage bargaining predominantly takes place at the local or firm level, as in Singapore. These findings indicate that labor market competitiveness can play a significant role in determining the labor market impact of payroll taxation. A policy implication is that labor market distortion due to payroll taxation would be small when the labor market is competitive.

Our findings can also provide implications for the heterogeneous effects of payroll taxes on firms' input choices and business activities. Previous studies have examined how variations in payroll tax rates across demographic groups or firms affect firms' investment, sales, and profits through capital-labor complementarity or an imperfect capital market (Saez et al., 2019; Benzarti and Harju, 2021a, 2021b). We infer from our findings that the magnitude of these effects may vary by the degree of labor market competitiveness. Firms' production inputs and net labor costs, and thus sales and profits, are unlikely to be affected by payroll taxes in a competitive labor market.

This study has some limitations. First, due to the lack of information in our data, we do not provide empirical evidence on the mechanisms through which a reduction in the payroll tax rate increased wages upon turning 60. If workers in Singapore share a strong norm

[27] Graphical presentations of these subgroup meta-analyses, also known as forest plots, are shown in Panels A and B of Fig. A3.

regarding pay equality and are well-unionized, as in Sweden (Saez et al., 2019), the estimated wage increase at age 60 could have come from job mobility. However, we find little evidence of a positive employment impact of the payroll tax rate reduction. Consistent with the results, anecdotal evidence indicates that there is a weak pay equality norm in Singapore. It is reported that Singaporeans are more accepting of income differences than any other developed country, and there is a common workplace requirement not to share salary information with other colleagues.

As an alternative mechanism, the payroll tax rate reduction might have increased workers' monthly wages through a salary adjustment within the same employment. According to our informal survey described in Appendix C, Table A8 shows that 6 out of 12 workers surveyed experienced upward adjustments in their base salary upon turning the CPF cutoff ages when the employer-borne payroll tax rates are downward-adjusted. Moreover, our informal communication with the HR personnel staff of a multinational company operating in the travel industry in Singapore reveals that the salaries of workers are adjusted upward when they turn 60. Since a seniority-based wage increase is not a standard practice in Singapore, the anecdotal evidence provides supportive evidence of a within-firm wage adjustment.

Second, as in other studies exploiting age-based discontinuities, our findings cannot be directly extrapolated to other ages or other countries. However, given the fact that our empirical evidence is consistent with predictions under the theoretical framework in Appendix B and the meta-analysis results, we believe that our findings might be replicable for other age groups and countries to the extent that the institutional features of the labor market are similar to those of Singapore. We leave these unanswered questions for future research.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

A.1. Appendix Figures and Tables

See Figs. A1-A4 and Tables A1 –A8.

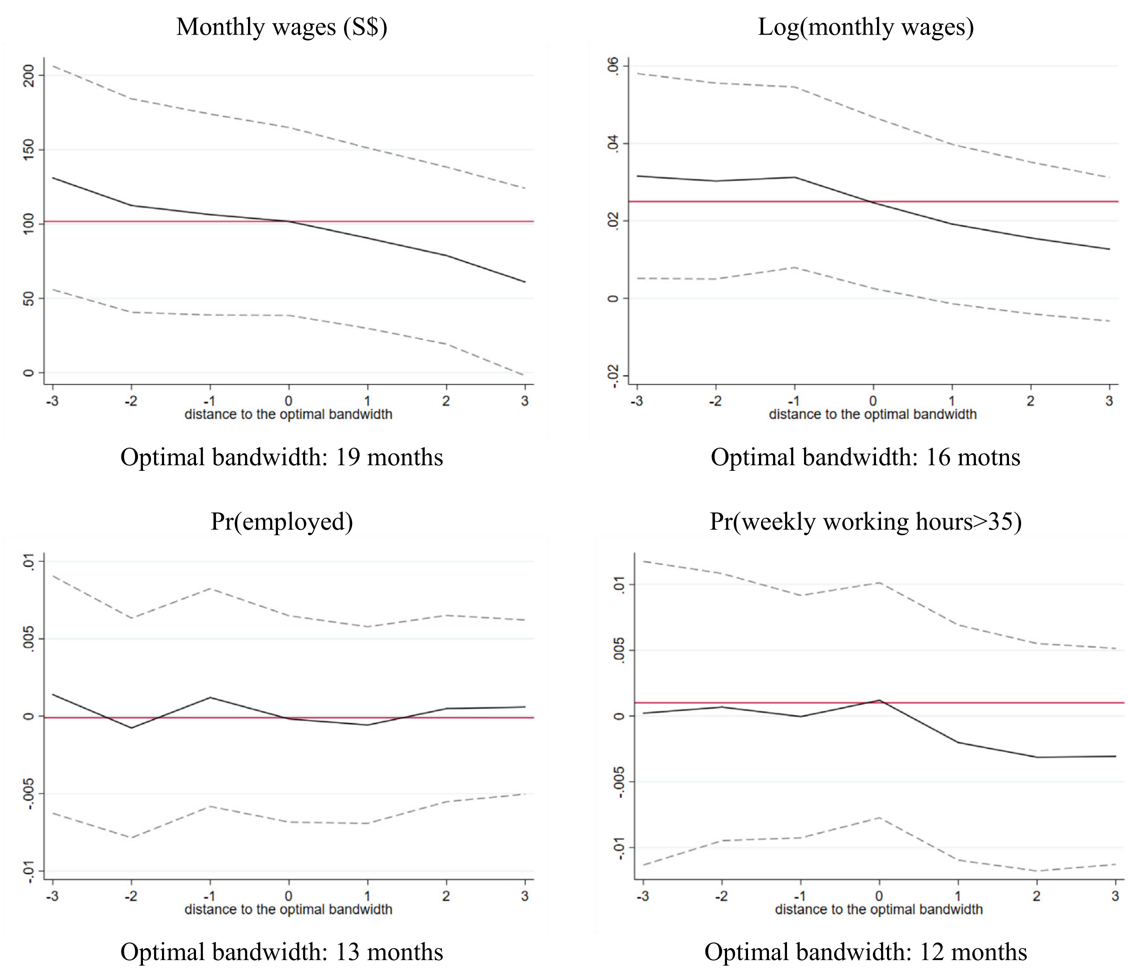

Fig. A1. Discontinuities in Labor Market Outcomes using Alternative Bandwidths. Data source: The Singapore Life Panel. Notes: We exclude self-employed individuals and foreign citizens from the sample. Solid lines indicate the estimated discontinuities in labor market outcomes with alternative bandwidths. We consider bandwidths that deviate from the optimal bandwidth up to six months. The dashed lines indicate the 95% confidence intervals. The red horizontal line represents the RD estimates with the optimal bandwidths.

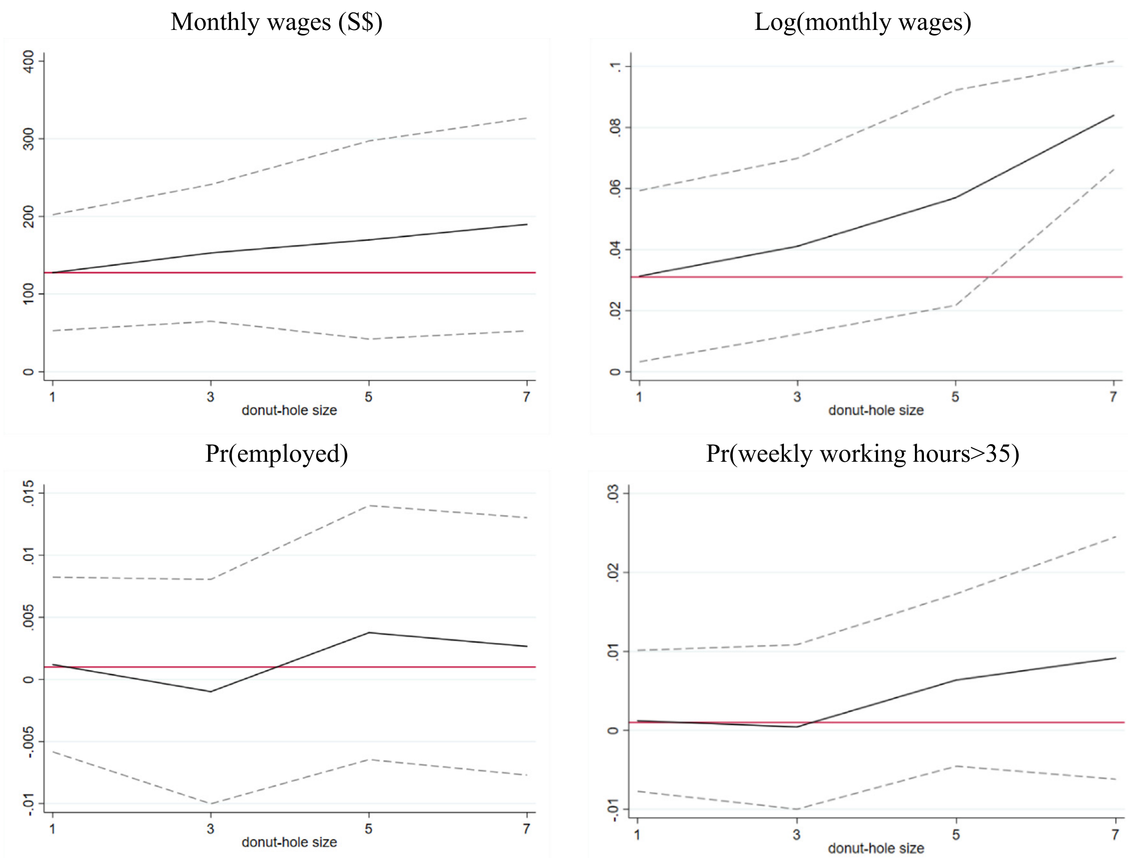

Fig. A2. Discontinuities in Labor Market Outcomes with Donut-hole Approaches. Data source: The Singapore Life Panel. Notes: We exclude self-employed individuals and foreign citizens from the sample. Solid lines indicate estimated discontinuities in labor market outcomes with different sizes of donut-holes, while using the baseline bandwidth (i.e., 12 months). Dotted lines indicate 95% confidence intervals.

Appendix B. Theoretical Framework

B.1. Baseline Model

We present a simple model that can predict the labor market impacts of payroll taxation, accounting for the institutional characteristics of Singapore's labor market and age-specific payroll tax rate schedule. We build the model on the standard labor market framework by studying the effects of payroll taxes and mandated benefits (Summers, 1989).

Let t_a denote the payroll tax rate levied on employers hiring workers aged$a$, and τ_a denote the payroll tax rate levied on employees aged$a$. For example,$t_{59} = .13$,$t_{60} = .09$,$\tau_{59} = .13$, and $\tau_{60} = .075$ in Singapore during our sample period.

Consider the labor market for workers aged 59 years. The market equilibrium for these workers is point A in Fig. A4, where the labor demand and supply curves are denoted by D_{59} andS_{59}, respectively.

If workers aged 60 and 59 are homogenous, the demand curve for 60-year-old workers (D_{60}) will be located above D_{59} because of a lower tax rate for the former group. When the labor market is perfectly competitive, the gap between the two demand curves is$(t_{59} - t_{60})w$, where w denotes the wages paid to homogeneous workers. This gap occurs because firms incur extra costs for hiring 59-year-old workers who have a higher payroll tax rate.

If an employer can exercise power over wage setting for its workers, the full benefit of $(t_{59} - t_{60})w$ will not be passed on to workers aged 60. Instead, only a fraction of the benefit will be transmitted to workers, and its magnitude will depend on the degree of the employer's market power. We assume that $\delta_f(t_{59} - t_{60})w$ will be passed on workers aged 60, where δ_f ($\in[0, 1]$) measures the inverse of the employer's market power and is equal to 1 in the case of a perfectly competitive labor market. The demand curve for 60-year-old workers (D_{60}) will shift up from D_{59} by$\delta_f(t_{59} - t_{60})w$..

As the payroll taxes levied on employers go to the workers' individual CPF savings accounts, the supply curve for workers aged 60 (S_{60}) will be located aboveS_{59}. If workers consider the reduction in employers' CPF contribution as a loss in compensation, the gap between the two supply curves will be$(t_{59} - t_{60})w$.

In general, the tax-benefit linkage for payroll taxes imposed upon employers in other countries may not be as strong as in Singapore. Let λ_f ($\in[0, 1]$) denote the degree of tax-benefit linkage for payroll taxes paid by firms, where λ_f is equal to 1 if the linkage is the strongest (as in Singapore) and 0 if there is no linkage.

If workers are unionized and share benefits among employees, the loss of contributions to workers aged 60 will be shared with colleagues aged 59, and the loss to workers aged 60, relative to those aged 59, will be$\delta_w\lambda_f(t_{59} - t_{60})w$, where δ_w measures the extent of benefits (losses) accrued to workers aged 60 with benefit sharing within a union. Owing to this effect, the labor supply curve for 60-year-old workers (S_{60}) will shift up from that for 59-year-old workers (S_{59}) by$\delta_w\lambda_f(t_{59} - t_{60})w$..

Another change occurring at age 60 pertains to the reduced payroll taxes levied on 60-year-old workers. In Singapore, this reduction will result in reduced contributions to their own CPF accounts

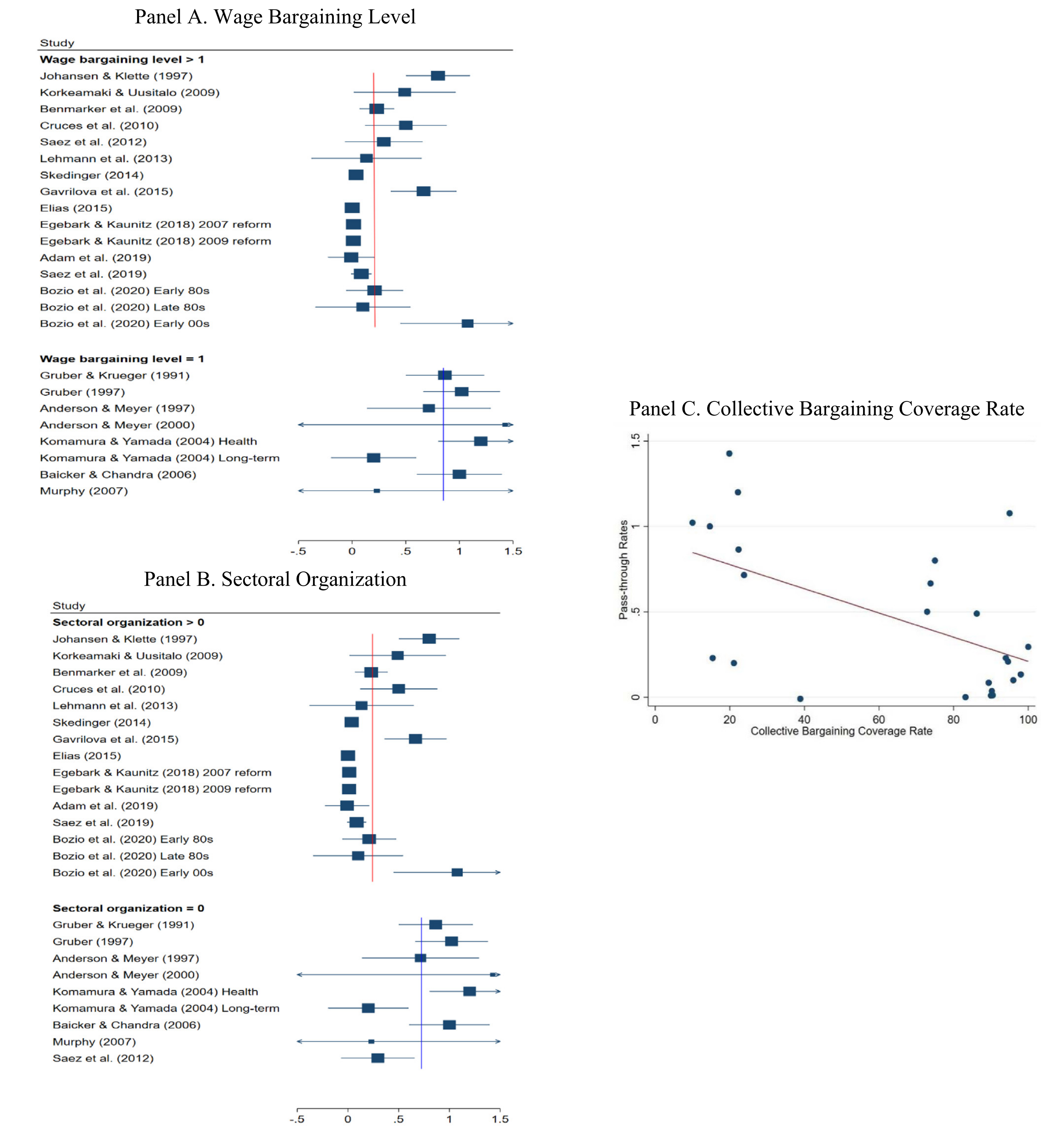

Fig. A3. Pass-through Rate by Wage Bargaining Levels. Panel A. Wage Bargaining Level. Panel B. Sectoral Organization. Panel C. Collective Bargaining Coverage Rate. Note: Vertical lines in panels A and B show the weighted averages in each group.

by$(\tau_{59} - \tau_{60})w$. If a worker matches this reduction with an increase in private saving by$(\tau_{59} - \tau_{60})w$, thus leaving the total savings intact, the payroll tax cut at age 60 will leave the financial situation of 60-year-old workers intact.

However, the tax-benefit linkage for payroll taxes levied on employees in other countries may not be as strong as in Singapore. Let λ_w ($\epsilon[0, 1]$) denote the portion of employee taxes that are passed on to the individual benefits of workers. If 60-year-old workers match the reduced contributions,$\lambda_w(\tau_{59} - \tau_{60})w$, with increased private savings, this part of the payroll tax reduction will not have an impact on their decisions, including labor supply. The rest of the tax rate reduction will lower the net wage for 60-year-

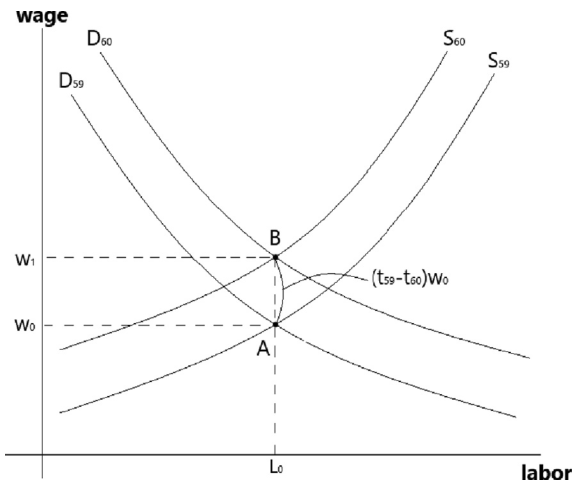

Fig. A4. Labor Market Equilibrium. Note: Point A (B) pertains to the market equilibrium for workers aged 59 (60) years, where the labor demand and supply curves are denoted by D59 (D60) and S59 (S60), respectively.

old workers, and the size of this reduction will be$\delta_w(1-\lambda_w)(\tau_{59}-\tau_{60})w$, where δ_w occurs because the benefit of tax reduction is shared within a union. This effect will shift down the labor supply curve for 60-year-old workers (S_{60}) from that for 59-year-old workers (S_{59}) by $\delta_w(1-\lambda_w)(\tau_{59}-\tau_{60})w$..

Combining both the effect of payroll taxes levied on employers and the effect of taxes levied on employees, it remains theoretically ambiguous whether S_{60} is located above or belowS_{59}. We discuss several special cases in the following sections.

B.1.1. Full linkage and competitive labor market: The Singaporean case

Under the payroll tax scheme in Singapore, the tax-benefit linkage is the strongest (λ_f=λ_w = 1) and the labor market is competitive without any market power on either the supply or demand side (δ_f=δ_w = 1). In this case, both the demand and supply curves for workers aged 60 will shift upward by the same amount (=$(t_{59}-t_{60})w$) from the curves for workers aged 59. The market equilibrium for workers aged 60 will then be at point B in Fig. A4. The wage rate for 60-year-old workers will be higher than that for 59-year-old workers, but the employment for both age groups will be identical. These predictions are tested in our empirical analysis.

B.1.2. Full linkage and non-competitive labor market

When the tax-benefit linkage is the strongest (λ_f=λ_w = 1), but the labor market is not competitive (δ_f < 1, δ_w<1), the demand curve for 60-year-old workers will shift upward by $\delta_f(t_{59}-t_{60})w$ from that for 59-year-old workers. The supply curve for the former will shift upward by$\delta_w(t_{59}-t_{60})w$..

The wage rate for 60-year-old workers is likely to be higher than that for 59-year-old workers. However, the wage difference will be smaller the less competitive the labor market is (that is, the smaller δ_f and δ_w are). The employment difference will be minimal if the magnitudes of the shifts of D_{60} and S_{60} are similar. In contrast to the result of Bozio et al. (2020) showing that the strength of tax-benefit linkage determines the pass-through rate, this finding implies that the pass-through rate will decrease with decreasing degree of labor market competitiveness even when the tax-benefit linkage is the strongest.

B.1.3. No linkage and rent sharing within a union

Suppose that the labor market is characterized by no tax-benefit linkage (λ_f=λ_w = 0) and a union practices rent sharing among workers where employers are competitive (δ_w < 1, δ_f=1). This situation corresponds to the Swedish case studied by Saez et al. (2019). The demand curve for 60-year-old workers will shift upward by w and the supply curve will shift downward by$\delta_w(\tau_{59}-\tau_{60})w$. If δ_w is small enough due to effective benefit sharing between 59-year-old and 60-year-old workers within a union, the wage difference will be negligible and the employment level of 60-year-old workers will be larger than that of 59-year-old workers because the former receive higher net wages with smaller out-of-pocket payroll taxes. This prediction is consistent with the findings of Saez et al. (2019).

B.2 Theoretical Analysis of Payroll Tax Rate Reduction at Ages 55 and 65.

We employ the baseline model in Appendix B.1 to analyze the tax rate reductions at ages 55 and 65. In this analysis of the Singaporean case, we assume that the tax-benefit linkage is the strongest (λ_f=λ_w = 1) and the labor market is competitive without any market power on either the supply or demand side (δ_f=δ_w = 1).

B.1.4. Payroll tax rate reduction at age 55

First, on the labor demand side, a decrease in payroll tax on employers will shift the demand curve for workers aged 55 by $(t_{54}-t_{55})w$ from that for 54-year-old workers, as shown in Fig. A4.

Kim and Koh (2020) report that many Singaporean workers aged 55 are liquidity-constrained. Let us first analyze the labor

Table A2
CPF Contribution Rates onward (% of wage) by Age.

Employee's age (in years)	By Employer	By Employee	Total
55 and below	17	20	37
Above 55 to 60	13	13	26
Above 60 to 65	9	7.5	16.5
Above 65	7.5	5	12.5

Source: Singapore Central Provident Fund Board (2016).
Note: There were no changes in the CPF contribution rates during the study period from January 2016 onward.

Table A1
Allocation Rate (% of wage) of CPF Contributions by Account and Age.

Employee's age (in years)	Ordinary Account	Special Account	Medisave Account	Total
35 and below	23	6	8	37
Above 35 to 45	21	7	9	37
Above 45 to 50	19	8	10	37
Above 50 to 55	15 (14)	11.5 (10.5)	10.5	37
Above 55 to 60	12	3.5	10.5	26
Above 60 to 65	3.5	2.5	10.5	16.5
Above 65	1	1	10.5	12.5

Source: CPF Board (2016).
Notes: There were no changes in the allocation rate of CPF contributions except for the age category 50–55 during our study period, except for one age category (50–55) in 2015. Different allocation rates are shown in parentheses.

Table A3
Discontinuities in Demographic Characteristics Upon Turning 60.

	Years of education (1)	Male (2)	Chinese (3)	Indian (4)	Malay (5)	Married (6)
1[Age > 60th Birthday]	0.054**	0.002	0.003	−0.001	−0.003	−0.003
	(0.026)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)
Observations	44,322	44,322	44,322	44,322	44,322	44,322
R-squared	0.001	0.000	0.000	0.000	0.000	0.000
Control mean	12.28	0.45	0.86	0.05	0.07	0.80
Bandwidth	12	12	12	12	12	12

Data source: The Singapore Life Panel.
Notes: Standard errors in parentheses are clustered at the age level and corrected for heteroskedasticity. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4
Discontinuity in Labor Market Outcomes among Foreigners. or Self-employed Singaporeans.

Dependent variables:	Monthly wages (1)	Log(monthly wages) (2)	Pr(employed) (3)	Pr(Weekly working hours > 35) (4)
1[Age > 60th Birthday]	144.5	0.028	−0.003	−0.002
	(116.6)	(0.018)	(0.003)	(0.002)
Observations	4,788	4,778	5,504	5,504
R-squared	0.0002	0.0002	0.0003	0.0003
Mean of control	S$3,143	7.63	0.004	0.004
Bandwidth	12	12	12	12

Data source: The Singapore Life Panel.
Notes: We include self-employed individuals and foreign citizens from the sample. We do not include any control variables. Standard errors in parentheses are clustered at the age level and corrected for heteroskedasticity. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5
Heterogeneous Discontinuities in Labor Market Outcomes. By Gender and Education Attainment Level.

Individuals' characteristics:	By gender		By education	
	Male (1)	Female (2)	Tertiary (3)	Less than tertiary (4)
A. Dependent variable: Monthly wages				
1[Age > 60th Birthday]	248.5***	4.61	179.9**	−3.14
	(63.6)	(34.44)	(82.7)	(32.8)
Observations	14,770	13,683	10,998	17,455
Control mean	4,737	2,983	6,228	2,435
B. Dependent variable: Log(monthly wages)				
1[Age > 60th Birthday]	0.053***	0.009	0.027	0.011
	(0.016)	(0.018)	(0.016)	(0.017)
Observations	14,714	13,620	10,975	17,359
Control mean	8.07	7.58	8.38	7.49
C. Dependent variable: Pr(employed)				
1[Age > 60th Birthday]	−0.004	0.005	−0.001	0.002
	(0.005)	(0.005)	(0.004)	(0.004)
Observations	20,019	24,303	15,993	28,329
Control mean	0.75	0.55	0.68	0.61
D. Dependent variable: Pr(Weekly working hours > 35)				
1[Age > 60th Birthday]	−0.004	0.005	0.002	−0.001
	(0.007)	(0.004)	(0.004)	(0.007)
Observations	20,019	24,303	15,993	28,329
Control mean	0.61	0.39	0.55	0.45

Data source: The Singapore Life Panel.
Notes: We exclude self-employed individuals and foreign citizens from the sample. We do not include any control variables. Standard errors in parentheses are clustered at the age level and corrected for heteroskedasticity. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

supply of workers under liquidity constraints. The labor supply curve for workers aged 55 under liquidity constraints can be affected by both payroll tax on employers and that on employees. They have an incentive to supply labor at a lower wage level than those without binding liquidity constraints when the payroll tax contribution by employers is reduced. Workers reaching age 55 with liquidity constraints will be willing to supply the same amount of labor with a wage increase smaller than$(t_{54} - t_{55})w$. Therefore, the labor supply curve will shift *upward* by less than$(t_{54} - t_{55})w$..

For those under liquidity constraints, the payroll tax cut in employee contributions can also affect their labor supply curve. Reduced contributions to the CPF account will relax the binding constraints of a 55-year-old worker under liquidity constraints, which would induce a 55-year-old worker to accept a wage lower than that of a 54-year-old worker. Therefore, the labor supply

Table A6
Discontinuities in Labor Market Outcomes upon Turning 55. *By Household Net Worth.*

Dependent variables:	Monthly wages (1)	Log(monthly wages) (2)	Pr(employed) (3)	Pr(Weekly working hours > 35) (4)
A. Above median				
1[Age > 55th Birthday]	54.91	0.021*	−0.002	0.002
	(70.63)	(0.012)	(0.003)	(0.003)
Observations	16,387	16,354	21,456	21,456
R-squared	0.000	0.001	0.001	0.001
B. Below median				
1[Age > 55th Birthday]	−66.58	0.012	0.007	0.026***
	(43.34)	(0.014)	(0.006)	(0.007)
Observations	12,340	12,296	18,463	18,463
R-squared	0.046	0.056	0.042	0.041

Data source: The Singapore Life Panel.
Notes: We exclude self-employed individuals and foreign citizens from the sample. We do not include any control variables. Standard errors in parentheses are clustered at the age level and corrected for heteroskedasticity. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A7
Discontinuities in Labor Market Outcomes upon Turning 65. *Among Non-retired Workers.*

Dependent variables:	Monthly wages (1)	Log(monthly wages) (2)	Pr(employed) (3)	Pr(Weekly working hours > 35) (4)
1[Age > 65th Birthday]	121.7**	0.021**	0.012	0.010
	(45.7)	(0.009)	(0.008)	(0.009)
Observations	6,641	6,640	6,837	6,837
R-squared	0.0005	0.0004	0.022	0.003

Data source: The Singapore Life Panel.
Notes: We exclude self-employed individuals and foreign citizens from the sample and restrict the sample to individuals who continue to be employed at least until 6 months after their 65th birthday. We do not include any control variables. Standard errors in parentheses are clustered at the age level and corrected for heteroskedasticity. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A8
Anecdotal Evidence on Employers' Wage Adjustment Practice in Singapore.

Policy awareness (Q1)	Wage adjustment (Q2)	Sector (Q3)	Age (Q4)	Firm size (Q5)
Yes	Yes; 3–5% for each 5-year period	Financial services	58	Not sure; large GLC
Yes	Yes; 10%	Manufacturing, electronics	55	100 and above
Yes	Yes; 5–10%	Civil service, home affairs	57	Not sure
Yes	Yes; 5%	Teaching	61	100 and above
Yes	No	Engineering	64	100 and above
No	No	Security services	56	100 and above
Yes	No	Postal services	56	100 and above
Yes	No	Construction	58	50–99
Yes	No	Civil servant	55	100 and above
Yes	Yes; 5–10%	Construction	57	100 and above
Yes	Yes; less than 1%	Engineering	62	100 and above
Yes	No	Non-profit sector (working for children with special needs)	57	0–49

Notes. Q1. Do you know whether employer-paying CPF contribution rates decrease as CPF members reach ages of 55, 60, and 65? Q2. Did you experience an increase in your base salary as you reached those ages? Q3. Which industry do you belong to? Q4. What is your age? Q5. What is your firm size in terms of the number of employees? Choose one of the following: 0–49, 50–99, or 100 and above.

curve of workers aged 55 years can shift *downward* compared with the supply curve of workers aged 54. Note that this labor supply response to the reduced payroll tax rate in employee contributions would not take place for a worker with no liquidity constraints, because private savings will increase to compensate for the reduction in forced savings (i.e., lower CPF contributions), leaving his utility intact.

Allowing withdrawals at age 55 will have an additional impact on the labor supply curve for those aged 55 with liquidity constraints. It will have an income effect for liquidity-constrained workers aged 55, reducing their labor supply and shifting the labor supply curve upward.

If the upward shift in the labor supply curve at age 55 due to reduced employer contributions or allowing withdrawals is dominated by a downward shift due to the reduction in employee contributions, the net impact can lower the labor supply curve for workers under liquidity constraints.[28] Otherwise, the labor supply curve will shift up.

For 55-year-old workers without liquidity constraints, a reduction of payroll taxes will shift up the labor supply curve by$(t_{54} - t_{55})w$, which is similar to the result of our baseline model of Appendix B.1 for 60-year-old workers. Since the withdrawal from the CPF accounts is allowed each year after reaching 55 (letting 60-year-old workers have five opportunities of withdrawal)

[28] This scenario is possible because the tax rate reduction for employers on employees aged 54 to 55 is 4 percentage points; this is smaller than the tax rate reduction of 7 percentage points for employees.

and workers aged 60 are not generally concerned with housing or educational expenditures, workers reaching 60 are not likely to be liquidity constrained.

B.1.5. Payroll tax rate reduction at age 65

The tax cut at age 65 is accompanied by other changes in retirement-related policies, such as the allowance of pension benefits and Silver Support Scheme. As a result of these additional policy changes, we cannot make definite predictions of wage and employment changes at the cutoff age of 65.

Appendix C. Anecdotal Evidence on Employers' Wage Adjustment Practice in Singapore

We do not have access to official statistics or survey data on how employers adjust workers' wages following the payroll tax rate changes upon turning 55, 60, and 65. To address this issue, we collected anecdotal evidence by interviewing 12 workers in Singapore who reached the cutoff ages. To avoid surveyor desirability bias, we asked the staff members of a university-based research center in Singapore to contact 1–2 personal acquaintances to ask about their personal wage adjustment experiences when they turned either 55, 60, or 65. Specifically, we asked the following questions to local employees in Singapore (via the research center staff).

Q1. Do you know whether employer-paying CPF contribution rates decrease as CPF members reach ages of 55, 60, and 65?

Q2. Did you experience an increase in your base salary as you reached those ages?

Q3. Which industry do you belong to?

Q4. What is your age?

Q5. What is your firm size in terms of the number of employees? Choose one of the following: 0–49, 50–99, or 100 and above.

We report the responses delivered to us verbatim in Table A8.

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