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Income receipt and mortality – Evidence from Swedish public sector employees

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Abstract

In this paper, we study the short-run effect of salary receipt on mortality among Swedish public sector employees. By using data on variation in paydays across work-places, we completely control for mortality patterns related to, for example, public holidays and other special days or events coinciding with paydays and for general within-month and within-week mortality patterns. We find a dramatic increase in mortality on the day salaries arrive. The increase is especially pronounced for younger workers and for deaths due to activity-related causes such as heart conditions and strokes. Additionally, the effect is entirely driven by an increase in mortality among low income individuals, who are more likely to experience liquidity constraints. All things considered, our results suggest that an increase in general economic activity on salary receipt is an important cause of the excess mortality.

Keywords: Income, Mortality, Health, Consumption, Liquidity constraints, Permanent income hypothesis.
JEL codes: D91; H31; H55; I10; I12; I38.

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1 Introduction

A large and growing literature has established a positive relationship between health and income, showing that mortality and morbidity rates are lower for high-income individuals (see, e.g., Smith, 1999; Deaton, 2003). However, several studies using data from developed countries show that mortality rates follow a pro-cyclical pattern, suggesting that the positive association between income and health does not apply to temporary income changes at the aggregate level.[1] The pro-cyclical pattern is not restricted to mortality, but has also been found for self-reported physical health (Ruhm, 2003), health-related behavior, such as smoking and excess weight (Ruhm, 2005), and infant health (Dehejia and Lleras-Muney, 2004).

A possible explanation for this ambiguity is that income receipt has adverse short-run health effects that partly offset the positive long-run association between income and health. In this paper, we consider this possibility by studying the short-run effect of salary payments on mortality among Swedish public sector employees during a six-year period.

Since paydays are not randomly assigned, a simple comparison of mortality rates around salary payments may fail to identify a causal effect for two reasons. First, general within-month and within-week mortality patterns due to, for example, habits and access to health care may obscure the effect of salary receipt.[2] Second, salary payments may covary with holidays or other days where mortality is exceptionally high or low for reasons unrelated to salary receipt.

To overcome these difficulties, we have collected information on individual variation in paydays for the entire population of Swedish public sector employees between 1995 and 2000. Combining register data with survey-based information on exact paydays for each worker throughout the period, we use a date-fixed effects strategy to identify the mortality effect of salary receipt, i.e. we include a separate fixed effect for each specific day. This identification strategy allows us to completely control for both general within-month and within-week mortality patterns and mortality patterns related to holidays and other special days coinciding with paydays.[3]

[1] E.g. Ruhm (2000), Neumayer (2004), Tapia Granados (2005), Gerdtham and Ruhm (2006) find evidence of a a pro-cyclical mortality pattern. These results are questioned by Gerdtham and Johannesson (2005), who find evidence of a counter-cyclical mortality pattern at the individual level among Swedish males.

[2] Such cycles have previously been documented by Evans and Moore (2012) and Phillips *et al.* (1999)

[3] Stephens Jr. (2006) and Huffman and Barenstein (2005) use individual variation in paydays to study consumption patterns. However, we are, to our knowledge, the first to use variation in paydays to study health outcomes.

Our sample covers approximately 22% of the Swedish work force. Hence, our data gives us the possibility to both study the mortality response to salary receipt for a large and heterogeneous population and look into the underlying mechanisms by studying differences in responsiveness between sub-groups. We further assess the mechanisms behind the mortality effect by linking information on the causes of death to each deceased individual. By studying mortality patterns during the days surrounding payday, we also investigate whether the increase in mortality is mainly due to harvesting, i.e. a hastening of the deaths of frail individuals by a few days, or whether it predominantly consists of additional premature deaths.

Our findings indicate that the mortality consequences of salary receipt are large. We find a 23% increase in total mortality, corresponding to approximately 96 premature deaths per year if extended to include the entire Swedish working-age population, on the day that salary payments arrive. The increase in mortality is not offset by a subsequent decline, suggesting that the excess mortality is not due to significant harvesting, but mainly consists of additional premature deaths. Circulatory conditions are the main reason behind the excess mortality, representing an entire 83% of the total increase. The number of deaths due to heart conditions and strokes increases by approximately 67% and 119% respectively on payday. We also find that the effect is entirely driven by an increase in mortality among low income individuals and is especially pronounced for younger workers, the mortality rate among 18 to 35-year-olds increase by a significant 164% on the day salary payments arrive.

To interpret our findings, we connect our results to several strands of literature. A number of studies show that households increase their time-sensitive consumption, such as purchases of perishable goods (e.g., fresh food) and instant consumption items, (e.g., restaurant meals and admissions for entertainment events), upon an anticipated income receipt, thus not complying with the life cycle/permanent income hypothesis (LC/PIH).[4,5] Several studies find that the increase is greater for households with low incomes or low liquid wealth, suggesting that liquidity constraints limit consumption smoothing among these groups (see, e.g., Stephens Jr., 2006; Johnson *et al.*, 2006; Mastrobuoni and Weinberg, 2009). Additionally, Stephens Jr. (2006) finds that young people tend to increase consumption more than older individuals upon income receipt. Hence, consistent with our findings, any health-related

[4]The LC/PIH states that individuals maximize utility by smoothing consumption over time. Thus, an anticipated income receipt should not affect consumption.

[5]See, e.g., Shea (1995), Shapiro and Slemrod (1995), Parker (1999), Souleles (1999), Stephens Jr. (2003), Shapiro (2005), Johnson *et al.* (2006), Stephens Jr. (2006), Elger (2012), Huffman and Barenstein (2005) and Stephens Jr. and Unayama (2011) for empirical evidence against the LC/PIH.

consequences of this increase in consumption should be especially pronounced for young individuals and individuals with low incomes or liquid wealth, as these groups are likely to exhibit consumption behavior that is relatively sensitive to income receipt.

Our results, indicating that circulatory conditions are the main reason behind the mortality effect and that the excess mortality is greater among younger individuals, suggest that an increase in consumption activity is the underlying cause of the mortality increase. If consumption increases upon salary receipt, this is likely to result in a temporary rise in general activity, due to, for example, an increase in travel and the pursuit of leisure activities.[6] The raised activity level may in turn lead to a short-term increase in mortality due to causes that are activity-related and characterized by a short space of time between onset and death. Since the most credible channels of the mortality effect exhibit these traits, mortality within groups with a higher share of deaths due to acute causes should be affected to a relatively greater extent by salary receipt than mortality within other groups. Consistent with our findings, this again suggests that mortality should increase to a greater extent among younger individuals than among older people. Also, consistent with our results, several studies find a strong connection between various types of activities and circulatory conditions, such as heart attacks and strokes, suggesting that the number of deaths within this category increases during periods of increased activity.[7] Conversely, the mortality effects of income receipt may also include certain elements working in the opposite direction, such as the relief of economic stress, which could lead to a reduction in mortality due to circulatory diseases. This is supported by a large medical literature, which documents a strong connection between emotional and financial stress and circulatory conditions (see Steptoe and Kivimäki, 2013 for an overview).

Our paper also relates to several studies that document a rise in mortality upon periodic and expected income receipt for specific demographic and socioeconomic

[6] An increase in travel could, e.g., be due to shopping activities. Additionally, an increase in non-shopping activities upon income receipt is illustrated by Stephens Jr. (2003), who find that the consumption of food away from home and instant consumption items, such as admissions to entertainment or sporting events or fees for participation in sports or for lessons enjoy a greater relative increase than the consumption of, e.g., fresh food to be consumed at home.

[7] An increase in the risk the of onset of circulatory diseases has been connected to, e.g., sleep deprivation due to the spring transition to daylight saving time (Janszky and Ljung, 2008) emotional excitement during sporting events (Wilbert-Lampen *et al.*, 2008; Carroll *et al.*, 2002; Piira *et al.*, 2012) heavy physical exertion (Albert *et al.*, 2000; Mittleman *et al.*, 1993), eating a heavy meal (Lipovetsky *et al.*, 2004), having sex (Moller *et al.*, 2001), and returning to work after the weekend (Witte *et al.*, 2005; Willich *et al.*, 1994).

groups. A link between income receipt, substance consumption and death is relatively well-documented, with several studies finding an increase in substance-related mortality and morbidity following income receipt, for example, welfare payments (Verhuel *et al.*, 1997; Riddell and Riddell, 2006; Dobkin and Puller, 2007). In a paper closely related to our study, Evans and Moore (2011) broaden the evidence on the mortality effects of income receipt by showing that the excess mortality is not restricted to welfare clients and drug users, but is also evident in other groups and for various causes of death. Using US data, the authors find a substantial increase in mortality following income receipt (i.e. pay checks and social security checks) amongst military personnel and social security recipients. Among social security recipients, the increase is especially pronounced for deaths due to heart attacks and external causes, such as accidents, homicides and suicides, suggesting that the rise in mortality is (at least partly) driven by an increase in activity upon income receipt.

Our results provide new evidence on the mortality effect of periodic and expected income receipt by showing that a substantial mortality effect is evident for a broad working-age population, and not confined to specific demographic and socioeconomic groups. We find that the mortality effect mainly consists of additional premature deaths, rather than resulting from harvesting. Using individual variation in paydays, we show that these results are not due to seasonal or non-seasonal variations in mortality being correlated with salary payments. We also show that a within-month mortality cycle obscures the mortality effect, indicating that the causal effect is greater than previously suggested. Additionally, our analysis provides further evidence against the LC/PIH, suggesting that an increase in economic activity upon income receipt is the main mechanism behind the excess mortality. For our population, a rise in general activity, rather than an increase in health-impeding consumption of specific goods, such as alcohol and illegal substances, appears to be the main cause of the excess mortality.

The remainder of the paper unfolds as follows. Section 2 describes the data. Section 3 discusses our empirical strategy. Section 4 reports our results, including both our main findings on total mortality and results from separate analyses of specific causes of death and sample subgroups. In Section 5, we discuss our findings.

2 Data

2.1 Payday data

In Sweden, employers have the right to decide which day of the month to pay their employees' salaries. However, in the public sector, paydays are determined at an aggregate level, which means that they vary between (specific) local authorities, counties and the central government (henceforth defined as public sector units), but are shared by all workers within each unit. Using a survey, we collected information on the exact paydays for each unit during the period 1995 to 2000.[8] We obtained full responses from 280 out of 290 local authorities, all 21 counties and the central government.[9] These public sector units cover approximately 22% of the total work force.

Paydays vary across units due to differences in regular paydays, rules that apply when this day occurs on a weekend or public holiday, and special rules regarding the December payment. The regular payday is the day when salaries are normally paid unless it occurs on a weekend or public holiday. It occurs on the 25th of each month for central government workers, and varies between the 25th and the 28th for workers employed by local authorities and counties. If the regular payday occurs on a weekend, some units make salary payments on the preceding Friday. Other units, including the central government, employ a different set of rules, where salary payments are made on the preceding Friday if the regular payday occurs on a Saturday and on the following Monday if it occurs on a Sunday. Most units pay December salaries before the Christmas holidays, while some occasionally make salary payments after the holidays. Additionally, some units apply specific rules, for example, making salary payments on the second or third last working day of each month.[10]

[8]Private sector employees are not included in our sample. The reason for this is that paydays are determined at the workplace level. Hence, information on individual paydays for the entire private sector population (or a representative sample thereof) is extremely difficult to obtain.

[9]The local authorities are the main providers of childcare, care for the elderly, and primary and secondary education. The counties primarily provide health care services and public transportation. The central government is responsible for, e.g., the police force and the military and runs the vast majority of universities. The ten most common professional categories in the Swedish public sector in 2001 were: health care workers and workers in the care for the and elderly, primary school teachers, preschool and after school activities teachers, nurses, upper-secondary school teachers, administrative staff, other office staff, university teachers, health care specialists, and midwives/other specialist nurses. Together, these categories represent approximately 64% of all public sector employees.

[10]The exact rules for each public sector unit are available from the authors upon request.

Table 1: Number of Swedish public sector employees receiving salary payments on each day of 1995.

	Day of month								
Month	21	22	23	24	25	26	27	28	29
1					128,261	54,344	518,587		
2			527	239,525			432,507	24,810	
3				203,472			501,642	62,052	22,123
4					146,728	80,409	509,689	62,470	
5				145,945		608,737			43,109
6		18,480				202,787	500,579	74,304	
7					144,652	56,663	529,931	61,459	
8					684,073			72,261	38,928
9					146,661	57,359	538,147	62,376	
10					145,790	56,691	595,217		
11				197,924			503,986	81,458	
12	8,819	706,972					52,648	6,746	

Notes: Own calculations using employment records and the payday survey. No salaries were paid during the 1st through 20th or the 30th through the 31st of the month during this year.

The differences in payment rules result in substantial variation in actual paydays. Table 1 exemplifies this by reporting the number of workers in our sample who were paid each day in 1995. The variation can be illustrated by using April 1995, where it was at its lowest as none of the most common regular paydays (i.e. the 25th to the 28th) occurred on a weekend. 63.8% of our sample were paid on the 27th and 18.4% on 25th, reflecting the most common paydays for local authority and central government employees, respectively. Substantial shares of workers were also paid on the 24th (10.0%) and 26th (7.8%). The variation was even greater during those months when some of the most common regular paydays occurred on a weekend or holiday, for example December 1995, where the actual paydays varied between the 21th and 28th with no salary payments occurring between the 23th and 26th.

2.2 Employment records and outcomes

We link the information on unit-specific paydays to individual-level data from three nation-wide registers. We identify public sector workers through employment records, which link employers and employees on a monthly basis. The register is based on tax records and links each individual to all employers from which (s)he receives any kind of cash transfer during any specific month. The cash transfers mostly consist of labor income, but also include social insurance schemes paid for by the employer, such as short-term sick leave insurance. Using sector codes and geographical information, we link the employment records to each separate public sector unit and to our survey information on paydays. We include individuals in the data starting from their second month working for the same employer, thus ruling out one-month work-spells. In order to primarily connect each individual to the salary payment that affects him or her the most, individuals are connected to employers from the 10th of the month where they receive their salary to the 9th of the following month, i.e. a person employed in unit x between January 1st and April 30th is linked to unit x between January 10th and May 9th in our data. We further exclude individuals with multiple employers, as they may receive salary payments on several occasions each month.

The resulting sample, described in Table 2, consists of 846,916 individuals employed in 298 of the 312 existing public sector units. 55% of the workers are employed by a local authority, while 28% and 16% are employed by a county and the central government respectively. The size of the units varies according to the government level and between individual counties and local authorities. The central government is the largest individual employer, while counties are on average larger than local authorities. The individuals in our sample are of working age (18-66) and heterogeneous.

Table 2: Sample statistics

	All units (1)	Central government (2)	Counties (3)	Local authorities (4)
# Units	298	1	24	273
Total # employees	846,916	137,720	241,128	467,922
Average unit size	2,842	137,720	10,047	1,714
Max unit size	137,720	137,720	32,564	16,945
Min unit size	187	137,720	961	187
With children 0-15	0.35	0.29	0.36	0.36
Male	0.24	0.57	0.17	0.18
Married	0.57	0.54	0.58	0.57
Age $<$ 35	0.21	0.22	0.18	0.23
Age 35-50	0.41	0.38	0.45	0.39
Age $>$ 50	0.38	0.4	0.36	0.38
Income quartile 1	0.15	0.09	0.13	0.17
Income quartile 2	0.35	0.15	0.34	0.41
Income quartile 3	0.3	.32	0.33	0.28
Income quartile 4	0.21	0.45	0.19	0.15
Daily deaths	0.376	0.448	0.354	0.366

Notes: Daily deaths is daily mortality per 100,000 employees.

Our sample generally resembles the Swedish work-force with the exception of the fact that male workers are under-represented, amounting to 24% of our sample compared to 52% of the total work force. The share of male workers differs between the public sector levels; 57% of central government employees, 17% of county employees and 18% of local authority employees are male. The distribution of the age of the workers and their family situation is similar across the three types of public sector units. However, incomes are on average considerably higher among central government employees than among county and local authority workers.

We further add death records from the *National Causes of Death register* to our data, obtaining a panel with daily information on employment, salary receipt, and mortality for each individual. The death records contain information on date, place, main cause and up to 11 additional contributing causes of death (coded in accordance with the International Classification of Diseases, ICD), for all individual deaths of permanent Swedish residents. The information is provided by a medical doctor or through a clinical or forensic autopsy. Using ICD9 and ICD10 codes, we create broad cause of death categories to be analyzed separately. These categories are based on ICD standard classifications, and include circulatory conditions, substance-related deaths, external causes, and cancer. In each cause of death category, we include all deaths where at least one of the contributing causes registered belongs to this category.

Table 3: Daily number of deaths. Total and by cause of death. Swedish public sector employees 1995-2000.

	Daily number of deaths	Daily deaths per 100,000 employees
Total deaths	2.87	0.377
Circulatory diseases	0.83	0.108
Heart conditions	0.60	0.079
Stroke	0.19	0.025
Substance-related	0.19	0.025
External causes	0.39	0.051
Traffic fatalities	0.08	0.011
Suicide	0.18	0.024
Cancer	1.70	0.222

Notes: In each cause of death category, we include all deaths where at least one of the contributing causes registered belongs to this category. A complete list of the ICD codes used for categorization can be found in Table A.1 in the Appendix

We also carry out separate analyses of specific circulatory conditions, i.e. heart conditions and strokes, and specific external causes, including traffic fatalities and suicides. Table 3 displays the mean daily mortality due to each of these causes. A complete list of the ICD codes used for categorization can be found in Table A.1 in the Appendix.

Finally, we add information from the *Population register* (LOUISE), which contains yearly records of a rich set of background variables for the entire Swedish working-age (16-64) population. We use this information to divide our sample into subgroups based on income, age and sex, to be analyzed separately.

3 Empirical strategy

Since all the employees in a public sector unit share the same payday, we aggregate the data, creating daily unit-level mortality averages. The reason for aggregating the data is purely practical; a data set including separate observations for each specific individual on each specific day would be too large to handle. We define our dependent variable y_{jt} as the daily unit-level mortality per 100,000 employees. Our baseline model for the mortality rate for unit j on day d in month s and year y is:

$$y_{jmdy} = \nu_y + \delta_m + \mu_d + \gamma Payday_{jmdy} + \sum_{k=1}^{6} \alpha_k Weekday_{mdy}(k) + \sum_{k=1}^{S} \beta_k Special_{mdy}(k) + \varepsilon_{jmdy} \quad (1)$$

The indicator variable $Payday_{jmdy}$ identifies the day that salaries are received. Thus, γ captures the mortality effect of income receipt on this day. However, if consumption behavior is the link between salary payments and mortality, the effects may not be instantaneous, but spread out over the period surrounding a payday. To identify such potential effects, we also include a set of dummy variables capturing the effects for the seven days before and after each payday.

Our baseline model controls for various seasonal effects by including an extensive set of fixed effects. We control for potential between-year and between-month differences in mortality through year-fixed effects (ν_y) and month-fixed effects (δ_m). There may also exist, as suggested by Evans and Moore (2011), an independent within-month mortality cycle, which could obscure the relationship between mortality and salary payments. We control for this possibility by adding day-of-month fixed effects (μ_d). Additionally, salaries are paid on weekdays, and are generally paid on Fridays or Mondays when the regular payday occurs on a weekend. As this results in a disproportionate frequency of payments on these days, weekday patterns may obscure any association between salary payments and daily mortality rates. By adding fixed effects for each day of the week ($Weekday(k)$), we control for this possibility. We also include fixed effects for all public holidays and the two days preceding and two days following each holiday ($Special(k)$), as mortality is likely to be exceptionally high or low on these days.[11] In order to capture regional mortality trends and cycles, we also add interactions between the year and month dummies and public sector unit.

Model 1 captures most aggregate changes in mortality rates correlated with salary payments. However, the variation in paydays across public sector units allows us to estimate an even more flexible model, including date-fixed effects, i.e. a separate fixed effect for each specific day ($Date_{mdy}$), to control for further events not accounted for by the seasonal and holiday-related fixed effects. Thus, the model

$$y_{jmdy} = Date_{mdy} + \gamma Payday_{jmdy} + \varepsilon_{jmdy} \quad (2)$$

controls not only for reoccurring mortality patterns, but also for additional events that correlate with both mortality and salary payments.

Concerning estimation details, each observation is weighted by the number of employees in the specific unit. The standard errors are clustered at the public sector unit level, allowing the unit mortality rates to be correlated over time.

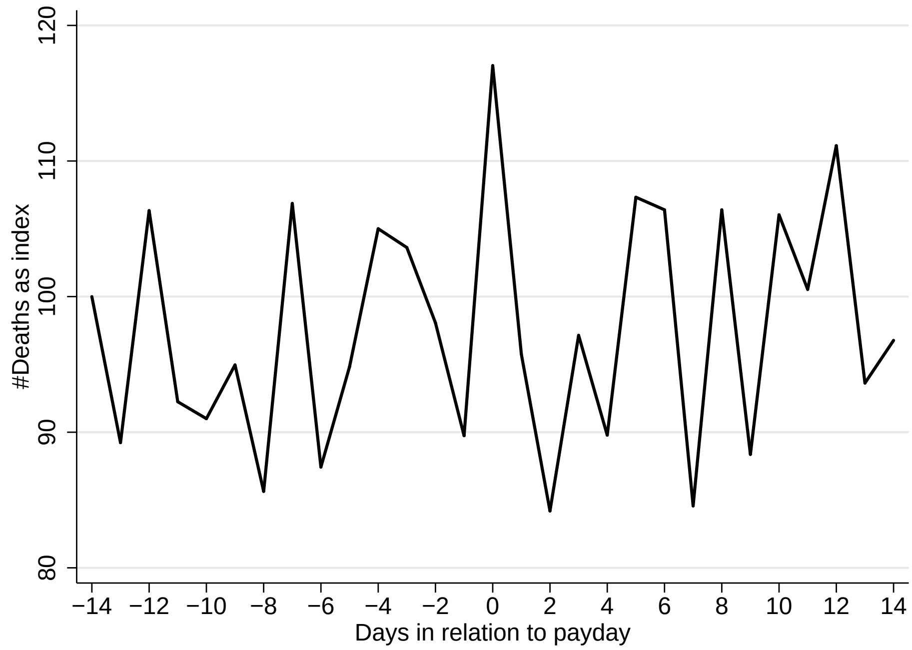
4 Results

A simple plot of mortality rates around payday reveals a sharp, non-lasting peak on the day that salaries arrive (see Figure 1). The mean mortality is similar during the two weeks before and the two weeks after payday. The increase in mortality is quantified in Table 4, column 1, which displays the raw mortality differential. Mortality increases by nearly 21% on the day salaries arrive. In column 2, we control for potential seasonal effects in mortality that covary with salary payments by adding fixed effects for year, month, day of the week and special days (e.g. holidays). The estimates remain relatively unaffected, suggesting that neither weekday patterns nor annual or monthly variations are a driving force behind the mortality pattern around salary payments.

In column 3 of Table 4, we also control for potential within-month mortality patterns by adding day-of-month fixed effects to the regression. This increases the payday coefficient, suggesting that a general decrease in mortality around the time salaries are paid, i.e. at the end of the month, partly offsets the payday effect, causing a downward bias in the estimates provided in columns 1 and 2. Such a

[11] The exact dates are available from the authors upon request.

Figure 1: Index for the daily number of deaths by days in relation to payday.



Notes: Mortality rate for Swedish public sector employees, 1995-2000. The mortality on day 14 before payday is standardized to 100.

mortality cycle is likely to be related to a within-month behavioral pattern, possibly connected to consumption. A potential explanation is that most reoccurring monthly payments, for example, mortgages and bills, are concentrated at the end of the month, which could mitigate the mortality effects from salary receipt as less money is available for discretionary purposes. This reasoning is in line with the results found by Evans and Moore (2011), who show that mortality in counties with a high proportion of military personnel is more sensitive to a mid-month than an end-of-month military pay check. As displayed in column 4, the results remain unaffected when controlling for regional mortality trends and cycles by adding interactions between the year and month dummies and public sector unit.

Our preferred specification, displayed in column 5, adds date-fixed effects in order to control not only for the cyclical or holiday-related mortality fluctuations discussed above, but also for the possibility that other days that exhibit exceptionally high or low mortality rates covary with paydays. The results reveal a significant 23% increase in mortality associated with payday, corresponding to 0.66 additional deaths per payday or 7.92 deaths per year in our sample. Extended to the entire Swedish working-age (18-64) population, a 23% increase in mortality corresponds to 7.98

Table 4: WLS estimates of daily mortality per 100,000 employees in relation to payday.

	(1)	(2)	(3)	(4)	(5)
Payday - 3 to 7 days	0.00989	0.00412	0.0520**	0.0525**	0.0343
	(0.0140)	(0.0144)	(0.0216)	(0.0217)	(0.0240)
Payday - 1 to 2 days	-0.0116	-0.0169	0.0403	0.0411	0.00861
	(0.0173)	(0.0171)	(0.0292)	(0.0296)	(0.0336)
Payday	0.0778***	0.0744***	0.128***	0.129***	0.0884**
	(0.0272)	(0.0285)	(0.0363)	(0.0368)	(0.0399)
Payday + 1 to 2 days	-0.0267	-0.0306	0.0274	0.0289	-0.0473
	(0.0264)	(0.0277)	(0.0352)	(0.0363)	(0.0395)
Payday + 3 to 6 days	0.0126	0.0159	0.0551**	0.0563**	0.0304
	(0.0156)	(0.0160)	(0.0266)	(0.0271)	(0.0361)
Year FE		Yes	Yes	Yes	
Month FE		Yes	Yes	Yes	
Special FE		Yes	Yes	Yes	
Weekday FE		Yes	Yes	Yes	
Day of Month FE			Yes	Yes	
Year x Unit				Yes	
Month x Unit				Yes	
Date FE					Yes
Mean	0.377	0.377	0.377	0.377	0.377
Observations	620,921	620,921	620,921	620,921	620,921
Public Sector Units	298	298	298	298	298

Notes: *, ** and *** denote significance at the 10, 5 and 1 percent levels. Standard errors clustered at the public sector unit level in parentheses. Each observation is weighted by the number of employees in the specific unit. Date FE represents a separate fixed effect for each specific day.

additional deaths per payday, i.e. nearly 96 deaths per year.[12]

The inclusion of date-fixed effects yields non-significant coefficients on all days surrounding payday, indicating that the mortality response to salary receipt is immediate.[13] Thus, if the excess mortality is the result of changes in consumption behaviour, these behavioural changes seem to occur only in the very short term.

[12]The results are quantitatively similar for units smaller and larger than the median, although a larger variance in daily mortality for smaller units render the estimates insignificant. This suggests that the overall mortality pattern is not driven by influential observations such as a small unit which happens to have a large number of deaths on a particular day, giving rise to a very large relative mortality ratio. Table A.3 in the Appendix displays the results from our preferred specification, i.e. model 2, run separately for units smaller and larger than the median.

[13]We obtained similar results when estimating models 1 and 2 allowing for a separate effect on each of the seven days preceding and following payday, see table A.2 in the appendix.

This finding runs in sharp contrast to Evans and Moore (2011), who find that the mortality level remains raised for several days after income receipt. This discrepancy could be due to differences in payment methods; during the time period covered by our study, Swedish public sector employers used direct deposit for salary payments, whereas the payments studied by Evans and Moore (2011), i.e. US social security payments and military salaries, were generally made by physical cheques during the period studied. This payment method could potentially delay the behavioral response to income receipt, as individuals have to cash pay checks in order to access their salaries or social security benefits.

Next, we examine the immediate mortality effect displayed in Table 4 in more detail. First, in Table 5, we test for mortality effects during the weekend after salary receipt, by including additional treatment indicators into model (2). In column 2, we allow for a general effect during the weekend after salary receipt and in column 3 we include an additional interaction effect for weekends when the payday occurred on the preceding Friday. The results from this exercise show no evidence of an increase in mortality during the weekend after salary payments. This is true regardless of whether salaries are paid on a Friday or earlier during the week.

Table 5: WLS estimates of daily mortality per 100,000 employees during the weekend after salary receipt.

	(1)	(2)	(3)
Payday	0.0884**	0.0979**	0.0976**
	(0.0399)	(0.0383)	(0.0387)
Weekend after payday;			
Payday on Friday same week			0.0101
			(0.0638)
Weekend after payday;			
Payday during Mon-Fri same week		-0.0701	-0.0743
		(0.0800)	(0.0941)
Date FE	Yes	Yes	Yes
Mean	0.377	0.377	0.377
Observations	620,921	620,921	620,921
Public Sector Units	298	298	298

Notes: *, ** and *** denote significance at the 10, 5 and 1 percent levels. Standard errors clustered at the public sector unit level in parentheses. Each observation is weighted by the number of employees in the specific unit. Date FE represents a separate fixed effect for each specific day. "Paid on Friday same week" is an indicator for the weekend after salary receipt given that payday occurred on a Friday. "Paid during Mon-Fri same week" is an indicator for the weekend after salary receipt regardless of which day of the week salary was received.

Second, in Table 6 we examine whether the mortality response depends on which day of the week salaries are received. Using Monday as our reference category, we add interactions between the payday indicator and dummies representing the other days of the week (i.e. Tuesday to Friday) to model (2). Our results reveal no significant differences to the mortality response depending on which day of the week salaries are received. This suggests that the over-all mortality response does not vary due to differences in for example habits and access to health care over the course of the week.

Table 6: WLS estimates of daily mortality per 100,000 employees in relation to payday. Heterogeneous effects of a payday occurring on different days of the week.

	(1)	(2)
Payday	0.0884**	0.0469
	(0.0399)	(0.0585)
Payday on Tuesday		0.151
		(0.150)
Payday on Wednesday		0.102
		(0.0765)
Payday on Thursday		-0.0307
		(0.0811)
Payday on Friday		0.0166
		(0.0790)
Date FE	Yes	Yes
Mean	0.377	0.377
Observations	620,921	620,921
Public Sector Units	298	298

Notes: *, ** and *** denote significance at the 10, 5 and 1 percent levels. Standard errors clustered at the public sector unit level in parentheses. Each observation is weighted by the number of employees in the specific unit. Date FE represents a separate fixed effect for each specific day. The reference day is Monday.

4.1 Harvesting

The implications of the results reported above depend largely on whether the excess mortality around salary receipt is mainly due to additional premature deaths, which would not otherwise have taken place, or whether it is a result of harvesting, i.e. a displacement of the deaths of frail individuals by a few days.[14] If harvesting is the

[14]Evans and Moore (2011) show evidence of harvesting in connection with infrequent income receipt. However, the existence of harvesting in connection to expected and periodical income

main force behind excess mortality around payday, an increase in mortality rates shortly after the income receipt would be offset by a subsequent decline. As shown in Table 4, no such pattern exists around the time of salary payments, suggesting that the increase in mortality around salary receipt is not a mere displacement of deaths, but mainly consists of additional premature deaths.[15,16]

4.2 Mortality channels - analysis by cause of death

By investigating the channels that connect salary receipt to mortality, we assess the mechanisms behind the mortality response. If an increase in activity is the link between salary receipt and mortality, the excess mortality is likely to consist of deaths due to activity-related causes characterized by a short space of time from onset to death, such as heart attacks, strokes and external causes, rather than long-term, slowly progressing illnesses. We also investigate the responsiveness of substance-related mortality to salary receipt.

Table 7 reports the results from model 2, which includes date-fixed effects, run separately for certain broad cause of death categories. Column 1 is identical to column 4 in Table 4, representing all causes of death. Column 2 presents the results for mortality due to circulatory conditions, such as strokes and heart attacks. We find that mortality due to circulatory conditions increases by 66% on the day salaries are received. The increase corresponds to approximately 83% of the entire mortality response and applies to both heart conditions and strokes, which increase by 66.7% and 118.8% respectively (see columns 3 and 4).

Column 5 displays results for substance-related deaths. The coefficients on payday and the subsequent days show no evidence of substance-related mortality increasing following income receipt. This contradicts the results found by Evans and Moore (2011) for social security recipients and by, for example, Verhuel *et al.* (1997), Riddell and Riddell (2006) and Dobkin and Puller (2007) for welfare clients and drug users. It is possible that the discrepancy between the studies is due to sample differences. As all individuals in our sample are currently employed, they may be less likely to suffer from grave addiction than the non-employed individuals in earlier studies, which reduces the occurrence of substance-related deaths. Additionally, due to their rel-

receipt has not, to our knowledge, been explored.

[15]However, it is also worth noting that such a pattern may arise if a decline in mortality following a harvesting effect on the actual payday offsets an increase in additional premature deaths during the days following payday.

[16]The results remain similar when estimating models 1 and 2 allowing for a separate effect on each of the seven days preceding and following payday, see Table A.2 in the Appendix.

Table 7: WLS estimates of daily mortality per 100,000 employees in relation to payday. Total mortality and by cause of death.

	All deaths	Circulatory	Heart conditions	Strokes	Substance-related
	(1)	(2)	(3)	(4)	(5)
Payday - 3 to 7 days	0.0343	0.00711	0.0117	0.00673	0.00231
	(0.0240)	(0.0137)	(0.0120)	(0.00645)	(0.00746)
Payday - 1 to 2 days	0.00861	0.0110	0.0300*	0.00605	-0.00131
	(0.0336)	(0.0206)	(0.0172)	(0.00835)	(0.00863)
Payday	0.0884**	0.0715***	0.0527***	0.0297**	-0.000818
	(0.0399)	(0.0261)	(0.0194)	(0.0124)	(0.0107)
Payday + 1 to 2 days	-0.0473	-0.0184	-0.0102	0.0146	-0.00767
	(0.0395)	(0.0218)	(0.0182)	(0.00960)	(0.00862)
Payday + 3 to 6 days	0.0304	0.0278	0.0252	0.0117*	-0.000379
	(0.0361)	(0.0216)	(0.0188)	(0.00604)	(0.00604)
Means	0.377	0.108	0.079	0.025	0.025
Observations	620,921	620,921	620,921	620,921	620,921
Public Sector Units	298	298	298	298	298
	External	Traffic	Suicide	Cancer	
	(6)	(7)	(8)	(9)	
Payday - 3 to 7 days	-0.000529	0.00759**	-0.0161**	0.0346	
	(0.00976)	(0.00307)	(0.00731)	(0.0219)	
Payday - 1 to 2 days	-0.00451	0.00887**	-0.0102	0.00320	
	(0.0112)	(0.00390)	(0.0109)	(0.0263)	
Payday	-0.00976	0.00635	-0.0120*	0.0275	
	(0.0142)	(0.00510)	(0.00729)	(0.0321)	
Payday + 1 to 2 days	-0.0142	0.00492	-0.0146	-0.0329	
	(0.0114)	(0.00625)	(0.00930)	(0.0306)	
Payday + 3 to 6 days	-0.00536	0.00512	-0.0172***	0.0124	
	(0.00813)	(0.00468)	(0.00550)	(0.0264)	
Means	0.051	0.011	0.024	0.222	
Observations	620,921	620,921	620,921	620,921	
Public Sector Units	298	298	298	298	

Notes: *, ** and *** denote significance at the 10, 5 and 1 percent levels. Standard errors clustered at the public sector unit level in parentheses. In each specification the number of observations is 620,921. Each observation is weighted by the number of employees in the specific unit. All models include separate fixed effect for each specific day. In each cause of death category, we include all deaths where at least one of the contributing causes registered belongs to this category. A complete list of the ICD codes used for categorization can be found in appendix 5, table A.1.

atively higher incomes, the individuals in our sample may be less likely than for example welfare clients and retirees to exhibit a substance consumption behavior that is very sensitive to income receipt.

Column 6 shows the estimates for external causes of death, such as accidents, homicides and suicides. The estimates are negative and insignificant, indicating that external causes is not the driving force behind the excess mortality in our sample. Similarly, we find no significant effects of salary payments on traffic fatalities (column 7). Also, mortality due to suicide (column 8) does not seem to increase following salary payments.

Finally, we use cancer deaths as a placebo test, as deaths belonging to this category are unlikely to be affected by activity. As expected, we do not find any patterns related to the timing of salary receipt, as shown in Table 7, column 9.

4.3 Heterogeneous effects by age, income and sex

An additional indication of the mechanisms linking salary receipt to mortality could be obtained by studying between-group differences in mortality responsiveness to salary receipt. If consumption activity is the link between income receipt and mortality, this responsiveness is likely to vary between groups due to differences in consumption smoothing and risk-taking behavior. To this end we use our preferred model including date-fixed effects (i.e. model 2), using the daily unit-level mortality for each subgroup, rather than the total unit-level mortality, as our outcome variable.

First, different-age individuals are likely to respond differently to income receipt due to differences in, for example, current health stocks or the volatility of consumption behavior. The results displayed in Table 8, columns 1-3, show that the excess mortality on payday is substantially higher for younger than for older workers. For the 16-35 age group, mortality increases by a statistically significant 125% on the day salaries arrive, compared to a 29% increase for workers over the age of 50. Conversely, the mortality rate for workers aged 36-50 declines during the days after salaries are received.

Our results are in line with the findings in Evans and Moore (2011). Comparing social security recipients to working-age populations in counties with a high military presence, and comparing different-age social security recipients, the authors find that the association between mortality and income receipt is stronger for younger adults. Evans and Moore (2011) suggest that the differences between age groups reflect more variable activity levels and a larger fraction of deaths due to acute causes for

Table 8: WLS estimates of daily mortality per 100,000 employees in relation to payday. Total and by subgroup.

	Aged 16-35 (1)	Aged 36-50 (2)	Aged 51-66 (3)	Female workers (4)	Male workers (5)
Payday - 3 to 7 days	-0.0155	0.0462	0.0494	0.0289	0.0867
	(0.0295)	(0.0284)	(0.0569)	(0.0512)	(0.0764)
Payday - 1 to 2 days	-0.0161	-0.0540	0.0867	-0.0296	0.164**
	(0.0329)	(0.0445)	(0.0747)	(0.0478)	(0.0810)
Payday	0.0785**	-0.0209	0.215**	0.0967*	0.182*
	(0.0398)	(0.0437)	(0.0945)	(0.0565)	(0.0942)
Payday + 1 to 2 days	0.0155	-0.0855**	-0.0410	-0.0213	-0.0540
	(0.0429)	(0.0355)	(0.0860)	(0.0430)	(0.100)
Payday + 3 to 6 days	0.0218	-0.0223	0.0933	-0.00513	0.122
	(0.0317)	(0.0263)	(0.0933)	(0.0346)	(0.0849)
Means	0.0628	0.194	0.749	0.325	0.537
Observations	620,890	620,921	620,921	620,921	620,890
Public Sector Units	298	298	298	298	298
	Income Quartile 1 (6)	Income Quartile 2 (7)	Income Quartile 3 (8)	Income Quartile 4 (9)	
Payday - 3 to 7 days	0.142	0.0379	0.00378	0.0324	
	(0.187)	(0.0681)	(0.0277)	(0.0255)	
Payday - 1 to 2 days	-0.152	0.106	0.0664**	-0.0659**	
	(0.235)	(0.0756)	(0.0298)	(0.0283)	
Payday	0.378	0.134*	0.00286	-0.0381	
	(0.260)	(0.0754)	(0.0367)	(0.0527)	
Payday + 1 to 2 days	-0.309	-0.0233	0.0349	-0.0531	
	(0.227)	(0.0873)	(0.0323)	(0.0326)	
Payday + 3 to 6 days	0.0116	0.0308	0.0242	0.0404	
	(0.192)	(0.0563)	(0.0257)	(0.0263)	
Means	1.615	0.269	0.091	0.097	
Observations	620,921	620,921	620,921	620,890	
Public Sector Units	298	298	298	298	

Notes: *, ** and *** denote significance at the 10, 5 and 1 percent levels. Standard errors clustered at the public sector unit level in parentheses. Each observation is weighted by the number of employees in the specific unit. All models include separate fixed effect for each specific day.

younger individuals. However, the large difference in mortality responses between middle-age and older workers displayed in Table 8 also indicates a greater sensitivity to changes in activity levels among older workers. Taken together with the increase in mortality due to circulatory diseases following salary payments, the substantial mortality increase among older individuals suggests that a large share of the excess mortality occurs among individuals with pre-existing health conditions. However, since we find that the excess mortality does not appear to be a mere displacement of deaths that would have happened shortly anyway, our results suggest that the deceased individuals may have been prone to for example heart attacks or strokes, but that their deaths would not have happened in the near future, had it not been for income receipt. A possible explanation for the decline in mortality on the days following income receipt for 36 to 50-year-old workers is that the relief of economic stress and/or the consumption of health-promoting goods dominate the positive mortality effects of increased activity and unhealthy consumption for this group.[17]

Second, liquidity constraints may pose restrictions on consumption smoothing, which may in turn increase mortality responsiveness. If this is the case, the excess mortality around salary payments is likely to differ across income brackets, with low-income individuals displaying the greatest mortality effects. The results presented in Table 8, columns 6-9, show that this is the case in our population. We find an increase in mortality on the day salaries arrive for the two lower income quartiles, although statistically insignificant in the lowest quartile, possibly due to a small sample size. For the second quartile, mortality increases by a statistically significant 50% on payday. We do not find any mortality effects of salary receipt for the two higher income quartiles.[18,19] Taken together, these results suggest that liquidity constraints pose restrictions on income smoothing, which leads to an increase in activity levels with a subsequent increase in mortality when salaries are paid.

Third, it is possible that mortality responses to salary receipt differ between the sexes, due to differences in, for example, consumption smoothing and general risk-

[17]Many individuals belonging to the 36-50 age group have young children living at home, causing a strain on the household economy and reducing the possibility of unhealthy consumption patterns. This appears as a credible explanation for the reduction in mortality following income receipt for this group. However, separate estimations of models 1 and 2 on workers with and without 0-15-year-old children did not reveal any significant differences in mortality patterns around income receipt between parents and non-parents.

[18]The lower income quartiles include a larger share of younger employees than the higher quartiles, suggesting that the difference in responsiveness may be partly due to age rather than income differentials. However, weighting the observations to correct for the differing age distributions yields results similar to those presented in Table 8.

[19]The differential responsiveness may not only be due to differences in liquidity, but may also reflect between-group differences in time preferences.

taking behavior. However, despite large differences in baseline mortality, we find that the mortality responsiveness to salary receipt is relatively similar for female and male workers, whose mortality rates increase by 30% and 34% on payday respectively (see columns 4 and 5 of Table 8).

5 Concluding remarks

In this paper, we show that the mortality effects of income receipt are not restricted to certain socioeconomic or demographic groups, but can also be found in a heterogeneous and representative working-age population. Our findings suggest that the effects are due to additional premature deaths rather than harvesting, indicating that the excess mortality comprises a significant loss of lives.

Our results provide further evidence against the LC/PIH for a broad group of individuals, and suggest that the lack of income smoothing has significant adverse health consequences. However, our data does not allow us to investigate how the size or frequency of income receipt affects the size of the mortality effects. Hence, our analysis does not give any advice on the optimal pay frequency for minimizing these effects. For example, several smaller payments may not mitigate the mortality consequences but rather create further occasions where mortality is exceptionally high. Rather, the policy recommendations that can be drawn from our results relate to the staffing of, for example, health care facilities over the course of the month and during periods of raised economic activity.

The generality of the mortality effects lends further strength to the hypothesis of the difference between the negative short-term and positive long-term effects of income of health being the link connecting the positive (individual and aggregate) long-term relationship between income and health to the pro-cyclical mortality patterns and counter-cyclical patterns in health behavior documented in recent studies (Ruhm (2000, 2003, 2005), Gerdtham and Ruhm (2006), Neumayer (2004), Tapia Granados (2005) and Dehejia and Lleras-Muney (2004)). If an increase in consumption has a negative short-term impact on health at the individual level for a large share of the population, the general increase in economic activity that occurs during an upturn is more likely to cause a rise in aggregate mortality.

Our findings also relate to the literature on the gradient between longevity and economic status. For Swedish workers, the probability of survival until age 65 (given survival until age 25) is approximately 3.3 percentage points lower for persons belonging to the second income quartile than for individuals in the top quartile.[20] An approximate calculation shows that if, as suggested by our results, mortality increases by 50% for individuals with lower than average incomes on each payday, i.e. 12 days each year, while mortality rates remain unaffected by salary receipt for higher income individuals (see Table 8), the excess mortality due to income receipt alone explains approximately 0.09 percentage points or 2.6% of this difference in survival rates. Although only accounting for a modest share of the total income-longevity gradient, this finding points towards a relatively unexplored connection between consumption smoothing behavior and income-health inequalities.

Additionally, the analysis underlines the importance of the time horizon of individual-level studies on the relationship between income and health. As pointed out by Evans and Moore (2011), the conflicting short and long-term effects require researchers to start measuring the total impact of income on health at the time of receipt, and also make it more difficult to identify a causal link between income and health using exogenous variation in income. Consequently, the distinction between short and long-term effects is likely to be crucial in studies on the income/health relationship at both the aggregate and individual levels.

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[20] We divided the Swedish working population into income quartiles using employment records from 1998. Using death records from 1999, we predicted the probability of survival until age 65, which is the standard retirement age in Sweden, given survival until age 25 for each income quartile. The survival rate for the top quartile (second quartile) is 95.2 (91.8) percent.

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Appendix

Table A.1: Coding of the cause of death categories.

	ICD9	ICD10
Circulatory	390-459	I00-I99
Heart conditions	390-398, 402, 404, 410-429	I00-I11, I13, I20, I22-I51
Stroke	430-439	I60-I69
Substance related[a]	291-292, 303-304, 305.2-305.9, 357.5-357.6, 425.5, 535.3, 571.0-571.3, 760.7, 779.5, 790.3, 947.3, 962.1, 965, 967-970, 977.3, 980, E850-E858, E860, E863, E935.0-E935.2, E937-E940, E950.0-E950.5, E962.0, E980	F10-F16, F170, F173-F175, F177-F179, F18-F19, F55, G312, G611, G620, G6212, I426, K70, K73-K74, R780, T282, T287, T385, T387, T390-T394, T398-T414, T423-T424, T426-T428, T430-436, T438-440, T443, T450-T451, T465, T478, T483, T487, T490, T506-T507, T509-T513, T518-T519, X4, Y1, Y430, Y450-Y451, Y453, Y455, Y468, Y478-Y484, Y490-Y502, Y508-Y510, Y513, Y525, Y553, Y557, Y560
External	E870-E869, E880-E929, E950-E999	V01-Y39, Y85-Y98
Traffic	E800-E849	V01-V99
Suicide	E950-E959	X60-X84
Cancer	140-239	C00-C97

[a]The category identifying substance-related deaths is identical to the category used in Evans and Moore (2012, 2011), apart from the exclusion of diagnoses associated with potentially substance-related pregnancy complications and substance-related diagnoses in newborn children. The following ICD codes are excluded in our study, but included in Evans and Moore (2012, 2011); ICD9: 640-641, 6483, 6565; ICD10: O200, O208-O209, O365, O438, O440-O441, O450, O458-O460, O468-O469, O670, O678-O679, O993.

Table A.2: WLS estimates of daily mortality per 100,000 employees in relation to payday.

	(1)	(2)	(3)	(4)	(5)
Payday	0.0778***	0.0753***	0.145***	0.146***	0.106**
	(0.0272)	(0.0284)	(0.0410)	(0.0412)	(0.0448)
Payday+1	-0.00436	-0.0129	0.0520	0.0537	-0.0190
	(0.0336)	(0.0338)	(0.0386)	(0.0391)	(0.0499)
Payday+2	-0.0490*	-0.0525*	0.0122	0.0143	-0.0609
	(0.0268)	(0.0288)	(0.0360)	(0.0374)	(0.0454)
Payday+3	0.000107	-0.00176	0.0654	0.0673*	0.0369
	(0.0264)	(0.0273)	(0.0397)	(0.0392)	(0.0523)
Payday+4	-0.0284	-0.0243	0.0140	0.0152	-0.00928
	(0.0235)	(0.0243)	(0.0346)	(0.0352)	(0.0400)
Payday+5	0.0413	0.0434	0.0767*	0.0783*	0.0478
	(0.0310)	(0.0334)	(0.0399)	(0.0410)	(0.0361)
Payday+6	0.0377	0.0472*	0.0636**	0.0649**	0.0499
	(0.0247)	(0.0250)	(0.0294)	(0.0296)	(0.0532)
Payday-1	-0.0276	-0.0274	0.0564	0.0577	0.0313
	(0.0227)	(0.0228)	(0.0434)	(0.0433)	(0.0556)
Payday-2	0.00431	-0.00637	0.0690*	0.0701*	0.0247
	(0.0255)	(0.0251)	(0.0359)	(0.0364)	(0.0391)
Payday-3	0.0256	0.0260	0.0998**	0.101***	0.0967***
	(0.0248)	(0.0254)	(0.0388)	(0.0385)	(0.0330)
Payday-4	0.0309	0.0244	0.0851**	0.0858**	0.0441
	(0.0258)	(0.0264)	(0.0337)	(0.0338)	(0.0362)
Payday-5	-0.00830	-0.0271	0.0380	0.0386	-0.00600
	(0.0238)	(0.0236)	(0.0321)	(0.0321)	(0.0328)
Payday-6	-0.0368	-0.0463*	-0.0137	-0.0132	-0.0261
	(0.0253)	(0.0257)	(0.0309)	(0.0310)	(0.0357)
Payday-7	0.0381	0.0409	0.0805***	0.0808***	0.0575
	(0.0270)	(0.0279)	(0.0308)	(0.0309)	(0.0363)
Year FE		Yes	Yes	Yes	
Month FE		Yes	Yes	Yes	
Special FE		Yes	Yes	Yes	
Weekday FE		Yes	Yes	Yes	
Day of Month FE			Yes	Yes	
Year x Unit				Yes	
Month x Unit				Yes	
Date FE					Yes
Mean	0.377	0.377	0.377	0.377	0.377
Observations	620,921	620,921	620,921	620,921	620,921
Public Sector Units	298	298	298	298	298

Notes: *, ** and *** denote significance at the 10, 5 and 1 percent levels. Standard errors clustered at the public sector unit level in parentheses. Each observation is weighted by the number of employees in the specific unit. Date FE represents a separate fixed effect for each specific day.

Table A.3: Payday estimates for large and small public sector units.

	All (1)	Small units (2)	Large units (3)
Payday - 3 to 7 days	0.0343	-0.286	0.0410
	(0.0240)	(0.303)	(0.0257)
Payday - 1 to 2 days	0.00861	0.239	0.00734
	(0.0336)	(0.404)	(0.0347)
Payday	0.0884**	0.116	0.101**
	(0.0399)	(0.430)	(0.0388)
Payday + 1 to 2 days	-0.0473	-1.022*	-0.0388
	(0.0395)	(0.607)	(0.0435)
Payday + 3 to 6 days	0.0304	-0.00807	0.0378
	(0.0361)	(0.496)	(0.0383)
Observations	620,921	310,377	310,544
Public sector units	298	149	149

Notes: *, ** and *** denote significance at the 10, 5 and 1 percent levels. Small (large) units are all units smaller (larger) than the medium unit size. Standard errors clustered at the public sector unit level in parentheses. Each observation is weighted by the number of employees in the specific unit. All models include separate fixed effect for each specific day.