Discussion Paper Series

IZA DP No. 18401

February 2026

The Part-Time Penalty

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Abstract

We study the part-time penalty. Using Danish register data, the Danish Labor Force Survey, and hospital personnel records, we show that the pay gap between part-time and full-time workers is sizable and increases over the career because the two groups accumulate different levels of human capital over time. Our best estimates of the part-time penalty are for nurses. The penalty is 14 percent at the beginning of the career and increases by 0.5 percent each year. This pay gap is closely related to the development of nurses' competence level, highlighting the persistent effects that part-time work has on lifetime earnings.

JEL classification

M5, J3, J16, J22, J24, J31

Keywords

part-time penalty, career, gender, pay gap

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* Acknolwedgement. The authors thank the participants at Texas AM, NBER SI'25, COPE'25, SOLE'24, and numerous seminars for their comments. The financial support from Hospitalsenhenden MidtVest is greatly acknowledged

Introduction

When individuals work part-time, their earnings are lower. Is this so-called 'part-time penalty' merely a result of shorter work hours, or do shorter work hours also affect wages? If time spent on the job is unimportant for wages, the part-time penalty will remain constant over employees' careers, as pay is proportional to hours worked. However, if workers learn on the job, full-time workers will accumulate more human capital over time than part-time workers, and their productivity and wages will grow faster (Blank, 1990; Hirsch, 2005; Paul, 2016). Consequently, the part-time penalty will increase with time. Moreover, part-time workers cannot eliminate the part-time penalty by shifting to full-time work, as their productivity and wages are determined by the accumulated human capital of which part-time workers have less.

Earlier work from Britain (Manning and Petrongolo, 2008) shows that almost half of women experience part-time work and that women employed part-time have substantially lower hourly wages than women employed full-time. The prevalence of part-time employment is lower in the US, but the pay difference between part-time and full-time workers is also significant (Hirsch, 2005). However, an unconditional wage differential is not a reasonable measure of the part-time penalty, as Manning and Petrongolo (2008) point out, because part-time and full-time workers can have very different characteristics and often work in different occupations.

Attempts to estimate the part-time penalty typically control for worker and job characteristics, and doing so considerably reduces estimates of the pay gap between part-time and full-time workers (Hirsch, 2005; Manning and Petrongolo, 2008). Although these insights are important, estimation of the part-time penalty is still challenged by the fact that many worker and job characteristics (including occupational choice) are outcomes that follow from the decision to work part-time, which implies that, in practice, part-time workers may face an entirely different wage determination process from the one faced by full-time workers. Blank (1990) recognizes this challenge. However, her attempts to overcome the issues econometrically resulted in sharply different conclusions, which led Holden (1990), in her comment on Blank's work, to conclude that our understanding of the part-time work effect is shaky.

In this paper, we strive to estimate the magnitude of the part-time penalty, to determine

how it evolves over the career, and to understand the mechanism causing this development. To guide our empirical work, we present a simple theoretical framework, which is based on the job assignment models of Gibbons and Waldman (1999) and Gicheva (2013). This setup is typically used to model the high-end labor market with a focus on the importance of long working hours for wages and promotions among young professionals (Gicheva, 2013; Frederiksen, Kato, and Smith, 2024). We focus on the broader labor market, where standard hours are the norm, part-time work is common, and overtime work is rare. For this reason, we reconfigure the model for this situation and explicitly model the intensive labor supply margin, which gives rise to the notion of part-time, full-time, and overtime workers; and we emphasize the learning mechanism (the accumulation of human capital) as a driver of productivity and wage growth. This setup allows us to determine the wage gap between part-time and full-time workers and to highlight important dynamics linking hours worked to pay differences between part-time and full-time workers over time.

We use Danish register data and the Danish Labor Force Survey because of its detailed information on working hours to produce estimates of the pay gap between workers on part-time and full-time in Denmark. We also present estimates for professions (pharmacy, law, and business) that have received recent attention in the literature (Goldin, 2014) and for nurses. This focus on professions reduces complexity and allows us to produce a precise estimate of the part time penalty (for the focal profession). It also allows us to contribute to the ongoing discussion of how the return to work hours vary across professions.

We pay special attention to the nursing profession because it is an ideal (almost stylized) setting to estimate the part-time penalty and to study details related to the part-time/full-time pay gap.[1] That is, part-time is common among nurses and the workforce in the nursing profession is highly homogeneous. Nurses are predominantly female (96 percent of nurses are women) and because the profession has strict entry requirements, all nurses have a formal 3.5-year nurse education in addition to a high-school degree. Furthermore, we know when the nurses graduated from nursing school, and thus we know when they entered the nursing profession. This is important because the pay of nurses is determined in part by the experience obtained as a nurse. In addition to this, we have access to personnel records for nurses from a regional hospital, allowing a deep analysis of what drives pay differences between part-time and full-time nurses.

[1]For a detailed discussion of the returns to nursing in Denmark, see Friedrich and Hackmann (2021),

We estimate the unconditional earnings gap between part-time and full-time workers in Denmark to be 53 percent. For Danish nurses, it is 24 percent.[2] Because it is notoriously difficult to estimate the development over time in the part-time/full-time earnings gap for workers in general, we do this for particular professions, where we know the graduation date from the education program. This implies that we can produce estimates of pay gaps for workers in a given profession from the time they enter the profession and throughout their careers. Using this approach, we find that the pay gap between part-time and full-time workers is close to 20 percent across professions at the onset of the career. More importantly, we find that the professions identified by Goldin (2014) to be non-linear (having a convex relation between hours worked and pay) such as law and business have longer average hours and higher career penalties for part-time work than linear professions such as pharmacy (where the relation between hours worked and pay is linear). For nurses, the pay gap at the time of entry into the nursing profession is 14 percent and it increases by 0.5 percent per year thereafter.

In our theoretical model, worker learning on the job (and human capital accumulation) is the key mechanism that causes the pay gap between part-time and full-time workers to increase over time. Using register data, we provide evidence for this mechanism by showing that the pay gap indeed increases over the employees' careers in many professions, and in nursing in particular. We also show that part-time workers shifting to full-time work have lower earnings than those persistently working full-time, reflecting that part-time work has resulted in relatively low human capital accumulation and productivity. Similarly, we find that full-time workers changing to part-time have higher earnings than those persistently working part-time, reflecting that full-time experience has resulted in a relatively high level of accumulated human capital and productivity.

We also establish direct evidence of this learning mechanism using hospital data. Theoretically, we argue for a mechanism that transforms hours into productivity and pay. Hospital personnel files allow us to establish *how* this is done in practice because they contain information on the structure of wages, including wage supplements. Such supplements are

[2] An earlier study for the US by Hirsch and Schumacher (1995) finds no such pay difference for licensed practical nurses and even a small premium for registered nurses. Other studies of particular occupations/professions such as Montgomery and Cosgrove (1995) and Mocan and Tekin (2003) establish pay gaps in child care establishments, but their results are sensitive to empirical specification.

given for non-standard work hours and competencies. We use this information to show that full-time nurses receive competency supplements faster than part-time nurses and that these supplements are larger for full-time nurses. This points directly to the learning mechanism and is an illustrative example of learning at work: longer hours lead to faster competency development. Consequently, part-time workers cannot eliminate the part-time penalty simply by shifting to full-time work as they do not possess the competences associated with the higher pay.

These findings are of broader interest because of the evidence that on-the-job learning connects hours worked to productivity and pay. This implies that decisions made early in life, such as working part-time while having small children, have persistent effects on earnings, and recent research shows that women may not be sufficiently informed about such consequences (Costa-Ramón et al., 2024). Furthermore, a lower average labor supply of women in combination with persistent wage effects makes it clear that working hours should play an important role in any discussion of the gender wage gap (Blau and Kahn, 2017; Goldin, 2014; Manning and Robinson, 2004).

The paper proceeds as follows. In the next section, we develop a theoretical model that allows us to derive and study the pay differential between part-time and full-time workers. In Section 3, we present data and descriptive statistics, and we show the results in Section 4. In Section 5, we evaluate the model's key assumption that learning is causing the changes in the part-time penalty over the career. Section 6 concludes the paper.

Theory

In this section, we derive the part-time penalty using a simple model of hours and earnings. This work is based on the job assignment model of Gibbons and Waldman (1999), which we augment with an explicit labor supply decision as in Gicheva (2013). In this framework, we can show that the pay gap between part-time and full-time workers is the compound effect of hours worked and differences in wages, and we can establish how it develops over time.

The model

We consider a two-period model. Workers are employed in jobs with formal competency requirements: $T_k, k = 1, 2, 3$. A worker with competences exceeding T_k but not T_{k+1}can be employed at job level $j \leq k$. New workers enter the labor market with a competency level $\eta_1 = 1$ and accumulate human capital according to $\eta_{t+1} = (1 + \theta_i h_t)$, where h_t is the hours worked at time t and $\theta_i \sim f$ is the speed of learning of a given individual. We assume $T_1 \leq \eta_1 \leq T_2$, such that all workers start their employment at job level 1.

Productivity in the first period is $Y_1 = h_1$. In period two, productivity is a function of accumulated human capital $(1 + \theta_i h_1)$, hours worked (h_2), and job level (j): $Y_{j2} = c_j(1 + \theta_i h_1)h_2$ with $1 = c_1 < c_2 < c_3$, which implies that human capital becomes more effective at higher job levels. Due to complete information and perfect competition, employers assign workers to jobs that match their level of competences and pay a wage equal to productivity.

Workers have disutility from work and heterogeneous preferences for leisure as in Gicheva (2013). The costs of effort functions are $C(h_t) = \frac{1}{2}h_t^2$, and the worker's preference for leisure is indicated by $b_i \sim g$. Thus, workers choose work hours to maximize utility across j:

$$U_{ij} = h_1 - \frac{1}{2}h_1^2 + c_j(1 + \theta_i h_1)h_2 - \frac{1}{2}h_2^2 - b_i.$$

Consequently, workers end up at job level j^* in period two and they have a labor supply of:

$$h_1^{j*} = h_2^{j*} = 1/(1 - c_{j*}\theta_i),$$

which implies that the labor supply for a given individual is constant over time.[3] Furthermore, hours worked, speed of learning, and job level feed into the production function and, in turn, determine the worker's productivity and pay.

In general, the labor supply will be higher for workers with a higher learning capacity (θ_i) who also end up at higher job levels. That is, we can show that for some (low) values of θ_i workers will have short hours and remain at job level 1; yet there exist cut-off values for θ_i such that individuals with intermediate values of θ_i will work longer and end up at job level 2 in the second period, and those with the highest values of θ_i will have the

[3]Earlier work by Blank (1998) and Manning and Robinson (2004), and our own results below show that work hours are indeed highly persistent over time.

longest hours and move to job level 3. Furthermore, for a given θ_i it is possible to show that leisure preferences can be so strong (b_i large) that such individuals prefer to work short hours and stay at job level 1, whereas other workers with the same θ_i, but more moderate b_i, will have longer hours and move to a higher job level. Hence, individuals will choose different levels of labor supply, but the same level of labor supply over time. This gives rise to the notion of part-time, full-time, and over-time workers.

If we compare part-time workers to other individuals (full-time and over-time workers), they have lower earnings. Toward the beginning of the career, the earnings difference simply reflects that part-timers work shorter hours. However, part-time workers also accumulate less human capital, and they move slower in the job hierarchy than full-time workers, and for this reason, their productivity and pay growth are slower. Hence, later in the career, the difference in earnings between part-time workers and other workers becomes the compound effect of shorter hours *and* lower pay (and productivity) per hour. This implies that the pay differences between part-time and full-time workers, which we refer to as the part-time penalty, begin small and then increase as the career progresses.

We further note that the worker's decision to work a particular number of hours is also a choice of a particular earnings trajectory. Consequently, workers cannot jump between trajectories simply by changing working hours. For example, it is not possible for part-time workers to jump to the earnings trajectory of full-time workers because they do not possess the level of accumulated human capital associated with that trajectory.

Data and Descriptive Statistics

We estimate the part-time penalty using Danish employer-employee data and the Danish Labor Force Survey (DLFS). Our sample period is 1994 to 2022. In this period, the register data comprises 5.0 million unique working individuals and 69 million person-year observations. The register data contains detailed information on earnings, gender, age, experience, education, graduation time, and a broad set of covariates, including occupation, but lack detailed information on work hours. We obtain reliable information on work hours from the DLFS, which is a comprehensive survey of a representative sample

of Danes conducted every year.[4] When merging this sample with the register data, we obtain a regression sample with 882,437 observations.

We will show two sets of estimates of the pay gap between part-time and full-time workers. The first set is based on the representative sample of Danes. The second set focuses on professions (pharmacists, lawyers, and business) that have received recent attention in the literature (Goldin, 2014), and nurses. The primary motivation for studying particular professions is that we know the time of graduation, and hence the time when the individual enters a given profession[5]; and the added benefit is reduction in complexity. Hence, we can, for instance, compare pharmacists working part-time with pharmacists working full-time at various career stages. This will lead to more precise estimates of the part-time/full-time pay gap for relevant groups of workers in the labor market. The focus on nurses is taking this to the extreme. In addition to knowing the graduation date from nursing school, the nursing profession is highly regulated and populated by a highly homogeneous group of individuals in terms of gender and educational background: 96 percent are women and they all have a 3.5-year nursing education on top of a high school degree.

Table 1 shows descriptive statistics for these groups. Column 1 contains statistics for the full sample, and columns 2-5 present statistics for professions. The average earnings in the full sample is DKK 320,198 (sd = 233,306) (7.5 DKK = 1 EUR). For nurses, the earnings are 355,920. Earnings in the other professions are much higher: Pharmacists earn 571,416 on average, lawyers earn 577,299 on average, and business people have average earnings of 611,831. In the full sample, the gender split is almost equal. Across the professions, the gender split is very different, with the proportion of women in business being 35 percent, in law it is 56 percent, among pharmacists it is 76 percent, and as already noted, it is 96 percent in nursing. The average age is between 40 and 46, and the average experience is in the range of 14 to 21 years.

The lower part of Table 1 shows one of the benefits of focusing on particular professions. We define a profession as the group of individuals who have a Master's degree in pharmacy,

[4]The DLFS is very similar to the CPS in the US. For more detail see, for instance, Frederiksen, Kato and Smith (2024).

[5]We discuss below how we use information about *actual* experience before and after graduation to improve our estimates of the part time penalty. The benefits of using actual experience instead of, for instance, potential experience have also recently been discussed in Deming (2025).

law, or business, or a degree from nursing school. Knowing the graduation date from these education programs, we can split experience into experience before and after graduation. This implies that we can produce estimates of pay differences between part-time and full-time individuals that are not contaminated by experiences from before graduation. For all professions, this is important because experience before graduation typically constitutes 25 percent of total experience with significant variation between individuals. For example, in the nurse sample, the experience before graduation is 5.70 years (sd = 4.00) and the experience as a nurse is 15.22 years.

Table 1: Descriptive statistics

	Full sample	Nurses	Pharmacists	Lawyers	Business
Earnings	320,198	355,920	571,416	577,299	611,831
	(233,306)	(129,865)	(314,834)	(354,954)	(460,921)
Woman	0.4925	0.9608	0.7604	0.5558	0.3500
Age	41.62	45.61	42.74	43.37	39.81
	(13.53)	(10.63)	(11.16)	(11.32)	(9.77)
Experience	17.50	20.92	16.25	17.12	13.97
	(12.34)	(10.90)	(10.87)	(11.17)	(9.61)
Experience at graduation		5.70	3.17	4.63	3.93
		(4.00)	(3.86)	(5.27)	(3.99)
Years since graduation		17.71	14.65	14.03	11.38
		(10.44)	(10.00)	(10.30)	(9.18)
Experience since graduation		15.22	13.08	12.49	10.04
		(9.60)	(9.43)	(9.63)	(8.40)
# Observations	882,437	22,574	1,373	5,076	12,997

Note: Standard deviations are reported in parentheses.

We obtain information on working hours from the Labor Force Survey. Although the survey contains various measures of hours worked, conceptually, the accumulation of human capital should be more closely related to usual working hours than any other measure of working hours, and for this reason, we use this measure in our analysis.

The descriptive statistics for hours are presented in Table 2. The standard work time in Denmark is 37 hours per week. In the full sample (column 1), the average usual labor

supply is 33.66 hours per week and working hours are higher for men than for women on average (columns 2-3). The fact that the work week is generally short in Denmark compared to other countries has recently been documented in Frederiksen, Kato, and Smith (2024) and is evident when comparing Danish work hours to the international numbers presented in Gethin and Saez (2025).

Table 2: Working Hours

	Full sample	Men	Women	Nurses	Pharmacists	Lawyers	Business
h	33.66	35.80	31.45	33.72	36.83	39.04	38.78
sd(h)	11.37	11.31	11.00	7.52	7.07	8.48	8.37
Part time ($h < 37$)	0.3310	0.1988	0.4672	0.5096	0.2017	0.1340	0.1041
Full time ($h = 37$)	0.5049	0.5748	0.4329	0.3897	0.5849	0.4892	0.5696
Over time ($h > 37$)	0.1641	0.2264	0.0998	0.1007	0.2134	0.3769	0.3263
Observations	882,437	447,857	434,580	22,574	1,373	5,076	12,997

Labor supply varies significantly between professions. In law and business, the usual work week is close to 40 hours, with 10-13 percent working part-time, 49-57 percent working full-time, and 32-38 percent working overtime. In pharmacy, the average labor supply is close to standard hours (36.83 hours per week), 58 percent work full-time, and the reminder is split equally between part-time and overtime. That lawyers and business people work long hours and often take on overtime is consistent with Goldin's observation that they work in professions where the return to hours is convex (Goldin, 2014). In contrast, pharmacy is a profession in which hours are rewarded linearly. In this context, the labor supply of nurses becomes particularly interesting. Nurses work on average 33.72 hours per week, and more than 50 percent work part-time. This is in despite of a labor shortage in nursing, which implies that nurses can freely choose their hours of work. Below, we estimate the consequences of such work-hour choices for pay.

It has previously been shown by Blank (1998) and Manning and Robinson (2004), that individuals' working hours are highly persistent, and we confirm this finding in Table 3. Comparing usual work hours that are one year apart for a given individual[6], 79 percent

[6]For a subset of individuals we have repeated observations, see Frederiksen, Kato and Smith (2024), who use the same data, for a detailed discussion.

of those working full-time in year t also worked full-time in year *t-1*. For part-timers and over-timers, the proportions are 77 and 54 percent, respectively. While the pattern is similar for the various professions, the persistence in part-time work is particularly high for for nurses: 86 percent of nurses who work part-time in t also worked part-time in *t-1*. The high persistence in work hours (and, in particular, in part-time work among nurses) will prove particularly useful in our endeavors to estimate the part-time penalty.

Table 3: Persistence in working hours

	Part-time *(t)*	Full-time *(t)*	Overtime *(t)*	Part-time *(t)*	Full-time *(t)*	Overtime *(t)*
(t-1)		*All*				
Part time	0.7685	0.1708	0.0606			
Full-time	0.0871	0.7896	0.1233			
Overtime	0.1010	0.3590	0.5400			
		Nurses			*Pharmacists*	
Part time	0.8621	0.0985	0.0395	0.6706	0.1882	0.1412
Full-time	0.1223	0.7620	0.1158	0.0565	0.8043	0.1391
Overtime	0.2735	0.3617	0.3647	0.0976	0.3659	0.5366
		Lawyers			*Business*	
Part time	0.5816	0.2194	0.1990	0.4834	0.2680	0.2486
Full-time	0.0470	0.7407	0.2123	0.0356	0.7590	0.2054
Overtime	0.0717	0.2665	0.6618	0.0701	0.3239	0.6060

Note: In the construction of the table we use individuals with hours information available in consecutive years. This is the case for 245,257 individuals in the large sample (*All*), 6,649 for nurses, 397 for pharmacists, 1,442 for lawyers, and 3,668 for business. The numbers show the proportion of individuals in a given state in year time t-1 who move to a given state in year t. The rows sum to one for each hours measure.

Results

In this section, we estimate the pay gap between part-time and full-time workers. We present results using the representative sample of Danish workers and for particular professions. We also estimate how the pay gap evolves over time. Our best estimate of the part-time penalty is based on the nurse sample, where we find a part-time/full-time pay

gap of 14 percent at the time of entry into the nurse profession and that this gap increases by 0.5 percent each year thereafter.

Estimation of the part-time penalty

We present estimates of part-time/full-time pay differences in Table 4. In column 1 we show results from a regression of ln(earnings) on dummies for part-time, full-time (reference group), and overtime. In this regression, we establish a "raw" pay gap between part-time and full-time workers of 83.64 percent; and a gap between full-time and overtime workers of 10.91 percent. In column 2 we control for a quadratic in age and year (23), industry (14), and sector (2) fixed-effects, and obtain a part-time/full-time pay gap of 52.76 percent. Estimating this regression in nurse data (column 3) shows a pay gap between part-time and full-time nurses of 23.75 percent.

In column 4 we estimate how the pay gap develops over the career of nurses.[7] This development is established augmenting the regression from column 3 with a variable for "Time since graduation" and its interactions with work-hour categories. We find that earnings growth is about one percent per year for full-time nurses, and approximately half a percent lower for part-time nurses, implying a widening pay gap of about half a percent per year from the time of graduation (with a base of 14.37 percent).[8]

In columns 5-7, we estimate similar regressions for pharmacists, lawyers, and business people. It is particularly interesting to see that in the non-linear professions (law and business) earnings growth is high and at a level of 2 to 3.5 percent per year, and that such professions have the largest increase in the penalty for part-time work over time: ca. 0.75 percent per year. For the "linear" profession (pharmacy), the pay growth is also around 2 percent, but the penalty for part-time work is fairly low and insignificant.

[7] We benefit from knowledge about graduation dates. Earlier attempts to estimate the development in the part-time penalty, such as Hirsch (2005), rely on potential experience (or age).

[8] Nurse pay increases by seniority. The seniority is determined by the time employed and is not weighted by hours worked. Hence, the difference in pay growth between part-time and full-time workers is not driven by systematic differences determined by the employment contract. Furthermore, the discussion of differential access to amenities between part-time and full-time workers important in Blank (1990) is not relevant in the case of Danish nurses because they all have equal access to such amenities.

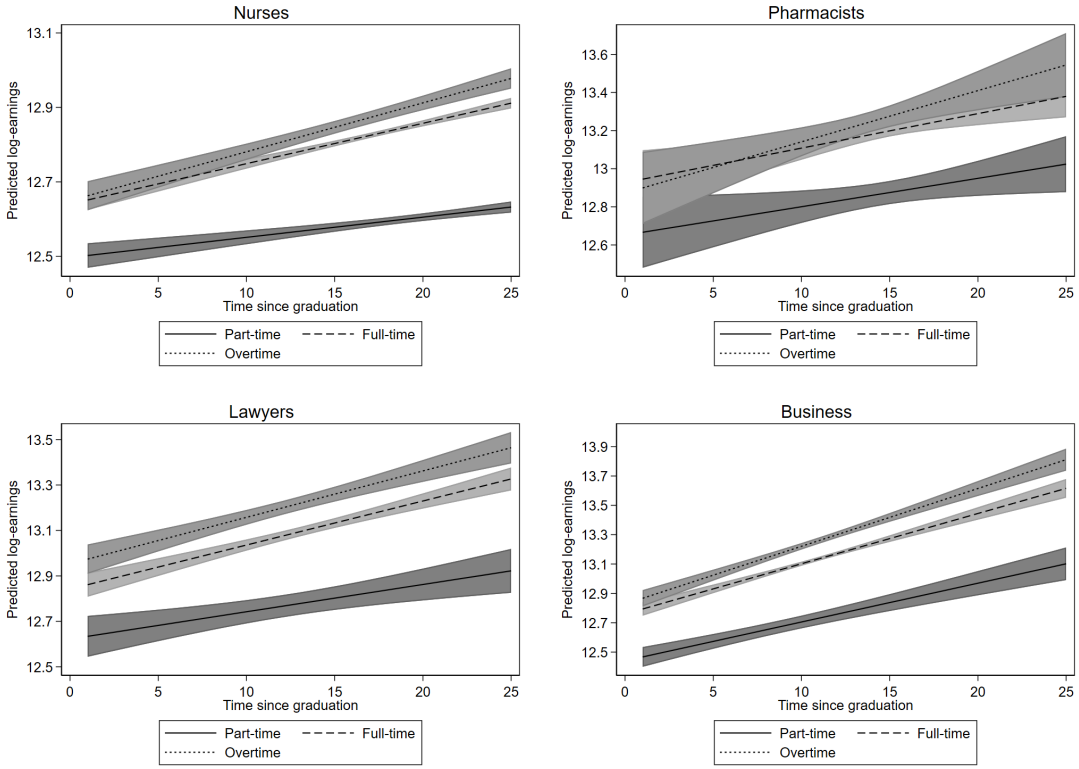
Table 4: The part-time penalty (log-earnings regressions)

	Full sample	Full sample	Nurses	Nurses	Pharmacists	Lawyers	Business
Part-time (PT)	-0.8364***	-0.5276***	-0.2375***	-0.1437***	-0.2755***	-0.2199***	-0.3189***
	(0.0028)	(0.0021)	(0.0066)	(0.0116)	(0.0656)	(0.0435)	(0.0291)
Full-time (FT)	-	-	-	-	-	-	-
Overtime (OT)	0.1091***	0.1590***	0.0541***	0.0091	-0.0549	0.1114***	0.0677***
	(0.0023)	(0.0020)	(0.0095)	(0.0161)	(0.0588)	(0.0272)	(0.0194)
Time since graduation	-	-	-	0.0108***	0.0181***	0.0194***	0.0342***
				(0.0008)	(0.0054)	(0.0020)	(0.0023)
Time since graduation x PT	-	-	-	-0.0054***	-0.0032	-0.0074**	-0.0078***
				(0.0006)	(0.0040)	(0.0030)	(0.0026)
Time since graduation x OT	-	-	-	0.0023**	0.0088**	0.0010	0.0051***
				(0.0009)	(0.0042)	(0.0019)	(0.0016)
Covars	No	Yes	Yes	Yes	Yes	Yes	Yes
# Observations	882,437	882,437	22,574	22,574	1,373	5,076	12,997

Note: Regressions control for: quadratics in age and year (23), industry (14), and sector fixed-effects. Standard errors are clustered. Significance levels: 0.1* 0.05**, and 0.01***.

We illustrate the differential earnings growth by work-hour categories in Figure 1 using the results from Table 4 columns 4-7. For newly educated part-time nurses, the predicted ln(earnings) are 12.50, while full-time nurses earn 12.65, and overtime nurses earn 12.66. This implies an early career earnings gap between part-time and full-time nurses of ca. 14.5 percent and between part-time and over-time nurses of ca. 15.5 percent. After 25 years, ln-earnings for part-time nurses have increased to 12.63 and the earnings gap between part-time and full-time nurses to 27.9 percent, reflecting the increase in the earnings gap of a little over 0.5 percent per year. For the non-linear professions (law and business), there is also a clear divergence in pay between part-time and full-time workers, whereas the linear profession (pharmacy) exhibit parallel development in pay for part-time and full-time workers.

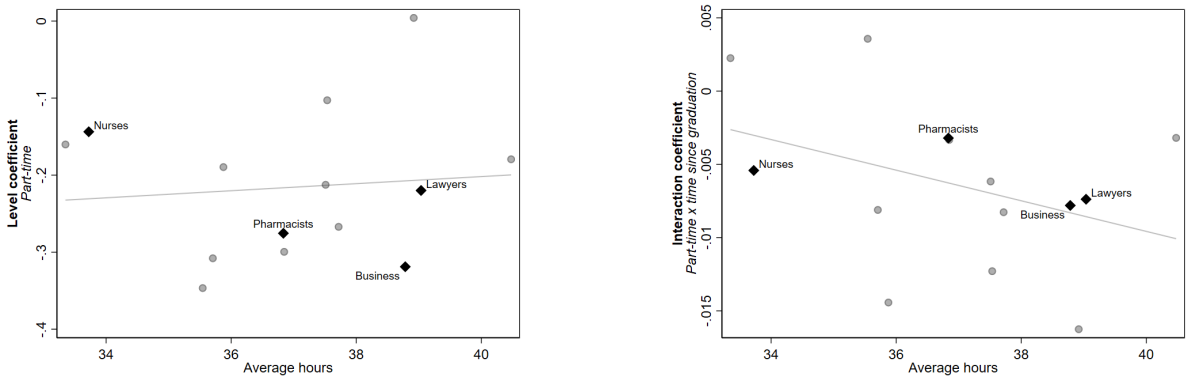
Figure 1: Part-time penalty over time



To position these results in a bigger picture, we constructed samples for all Master's degree programs in Denmark, kept those where we have at least 1000 observations, and then for each profession, we estimated the model used in Table 4 columns 4-7. In Figure 2, we plot, in panel (a), the "level coefficient" for the part-time dummy against the average

hours worked in the profession. We find that the initial pay gap between part-time and full-time workers is negative and typically at a level of 20 percent. This initial pay gap does not systematically depend on the number of hours typically worked in the profession.

Figure 2: Part-time penalty across professions



(a) Initial pay gap between part-time and full-time workers

(b) Change in pay gap between part-time and full-time workers

Note: The figures position the professions of particular interest (black dots) on the background of all professions (gray dots) with at least 1000 observations.

More interesting is the association in Figure 2 (panel b) between average hours worked in a profession and the widening of the pay gap between part-time and full-time workers over the career (the coefficient on the interaction term between part-time and "time since graduation"). Our results show that the non-linear professions (law and business) tend to have long hours and a larger penalty for part-time work than linear professions (pharmacy), and this relationship generalizes to a broader set of professions. This observation corroborates the finding in Goldin (2014) that professions reward hours differently.

Robustness

In the following, we evaluate the robustness of our results. We do this using the sample of nurses because it is the most complete dataset, and because we continue the analysis of nurses in the next section, where we take a closer look at the learning mechanism and human capital accumulation.

In Table 5, column 1, we replicate the baseline nurse results from column 3 in Table 4 for convenience. In column 2, we show the results for nurses employed in the public

sector. Denmark has public health care, and consequently, most health care services are provided in the public sector. However, there are private clinics and hospitals, and some nurses work in employment agencies and are called in on an ad hoc basis to assist public healthcare providers when needed. In our data, 16.7 percent of nurses work in the private sector, and excluding those from analysis leads to results that are very similar to baseline results. In column 3, we narrow the sample further by focusing on public sector nurses who are registered to work in the health care sector (78,3 percent of our original sample). This restriction is also inconsequential for the results.

An additional analysis of this type excludes nurses with foreign income (column 4). The reason we conduct this analysis is that it is well known (a recurring theme in public media) that Danish nurses have strong financial incentives to work in Norway, and supposedly many Danish nurses make use of that option. The register-data that we use contain information about Danes, including Danes with foreign income, but not Danes working abroad with no Danish income or tax liability to Denmark. In our sample, we observe that only 0.8 percent of nurses have foreign income, yet, for such nurses, foreign income constitutes 21 percent of total income on average. Omitting this small proportion of nurses from the analysis has little consequence for the results.

We can also control for grades in high school and nursing school. This would be important if such variables reflect differences in innate ability or performance. However, data on grades are only available for a subset of nurses, and they have been more frequent in recent years. Analysis is further complicated by the shift in the grade-point scale from a "13-point scale" to a "7-point scale" in 2006. We deal with this by augmenting our baseline model with dummies for each combination of grade and scale. For these reasons, the results using grade information (presented in columns 5 and 6) should only be considered a sensitivity check; nevertheless, the results from these regressions are similar to earlier results.

Table 5: Robustness analysis (Nurses)

	Baseline	Public sector	Public health care	No foreign income^{+}	Grades from high school	Grades from nursing school^{++}	No change in hours	No change in hours IV
Part-time	-0.2375***	-0.2157***	-0.2010***	-0.2533***	-0.2224***	-0.2171***	-0.2495***	-0.2877***
	(0.0066)	(0.0062)	(0.0054)	(0.0075)	(0.0083)	(0.0151)	(0.0089)	(0.0452)
Full-time	-	-	-	-	-	-	-	-
Overtime	0.0541***	0.0489***	0.0497***	0.0792***	0.0553***	0.0960***	0.1046***	0.0802**
	(0.0095)	(0.0093)	(0.0085)	(0.0125)	(0.0129)	(0.0325)	(0.0217)	(0.0339)
# Observations	22,574	18,799	17,679	18,953	13,645	4,182	5,138	5,138

Note: All regressions control for: quadratics in age and year (22), industry (13), and sector fixed-effects. Standard errors are clustered. Significance levels: 0.1* 0.05**, and 0.01***. $^{+}$Register data on foreign income (and tax) is available from 2002 onward. $^{++}$ Register data on nursing school grades started in 2004 and is only available for a subset of nurses.

Now, let us turn to a more subtle point. Theoretically, we have set up individual labor supply to be constant across time, which gave rise to the notion of part-time and full-time workers and led to the result that earnings trajectories are markedly different for part-time and full-time workers. Up to this point, we have referred to part-time and full-time workers and relied on the fact that hours of work are highly persistent, as documented in Table 3 where we showed that 86 percent of part-time nurses choose to work part-time in consecutive years (see also Blank (1998) and Manning and Robinson (2004) for evidence of the high persistence in work hours). Despite that it is very common for part-time nurses to continue in part-time work, we do see empirically that some nurses shift work-hour category. One way to interpret this is that we have some sort of measurement error in the work-hour category dummies. To be precise, some of the nurses we classify as part-time nurses may have had full-time experiences (at some point), which would lead to an upward bias in our estimate of the part-time/full-time pay gap. That is, the estimated pay gap is too small. For those we classify as full-time nurses, the situation may have been the opposite (i.e., a part-time experience), which would also lead to the estimated pay gap being too small.

To address this issue, we reapply the data comprising nurses with work-hour observations in consecutive years that we used to construct Table 3. We simply select the smaller sample of nurses who have been employed in the same work-hour category in consecutive years (and omit nurses with only one observation on hours worked or a shift in the work-hour category). The results (column 7) confirm the expectation that the point estimate on the part-time dummy is somewhat lower than the baseline result.

Finally, we apply an instrumental variable approach to this regression to purge the estimate of any remaining measurement error (column 8)[9] and produce a point estimate indistinguishable from previous results. That is, the confidence interval for the IV result of 29 percent, contains the baseline result. Hence, our results are robust and are judged to be only moderately affected by measurement error.

[9]We use the conventional instruments for part-time from the literature, i.e., children and partner (Blank, 1990)

The learning mechanism

In our theoretical model, a learning mechanism drives productivity and pay dynamics. When workers choose to work part-time or full-time, the learning mechanism determines how much human capital is accumulated and, as a consequence, how productivity and pay develop over time. Evidence for this learning mechanism was established above, where we showed that part-time workers had slower pay growth than full-time workers. In the following, we provide additional evidence for this mechanism.

Human capital accumulation

Theoretically, we can show that when learning is important, part-time workers will have lower productivity and pay than full-time workers, and part-time workers cannot eliminate the part-time penalty simply by switching to full-time employment. When part-timers do shift to full-time employment, their earnings will naturally be higher, yet they cannot jump to the earnings trajectory of full-time workers because their level of accumulated human capital is too low. Instead, they will find themselves earning more than before, but at a level which corresponds to the pay level of a full-time worker with fewer years of experience.

Table 6: The part-time penalty (Fixed-effects estimation)

	All	Nurses
Part-time (PT)	-0.1096***	-0.0448***
	(0.0012)	(0.0041)
Full-time (FT)	-	-
Overtime (OT)	-0.0026**	-0.0024
	(0.0011)	(0.0045)
# Observations	882,437	22,574

Note: Regressions control for: quadratics in age and year (22), industry (13), and sector fixed-effects. Significance levels: 0.1* 0.05**, and 0.01***.

We test this assertion in Table 6, where we present results from a fixed-effects model.

These results show that across all workers, part-time work reduces earnings by 11 percent compared to full-time, and for nurses, the reduction is 4.5 percent. These estimates identified of individuals moving between part-time and full-time show that the pay changes associated with a switch in hours are modest compared to the average pay differences between full-time and part-time workers (Table 4). Hence, in line with the learning mechanism, a worker's accumulated human capital constitutes a persistent component in worker pay and mute pay responses to shifts in hours.

Competency development

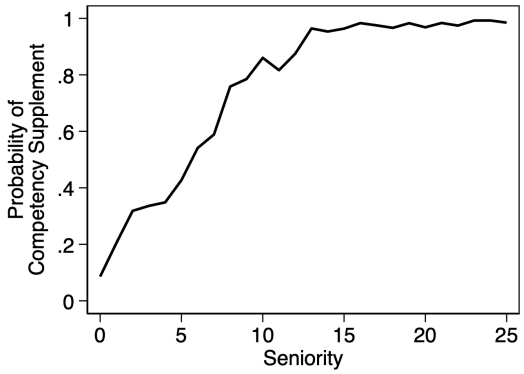
Furthermore, the theoretical model contains an explicit process: The learning mechanism transforms hours worked into human capital, and in turn, the level of accumulated human capital determines productivity and pay. However, from this structure, it is not clear *how* hours are transformed into human capital and pay in practice. To shed light on this "black box" process, we use data from a regional hospital located in the western part of Denmark. Unlike previously used register data, hospital data contain detailed information on the structure of nurse pay. Most importantly, the data contain detailed information on supplements paid for competences and nonstandard work hours (evening, night, Saturday, and Sunday). This information allows us to investigate the relationship between hours worked and competency development (which the hospital is willing to pay for), providing a concrete example of how hours are transformed into pay. In addition, it will confirm that there is a close link between competency development and human capital accumulation.

The sample period is 2017 to 2021, and during this period, the hospital employed 816 nurses on average.[10] Nurses often receive supplements. In a given year, 90.6 percent of nurses receive at least one supplement for non-standard work, and 79.4 percent receive competency supplements. For the average nurse, the work-hour supplement adds 10 percent to pay and the competency supplement contributes an additional 4 percent.

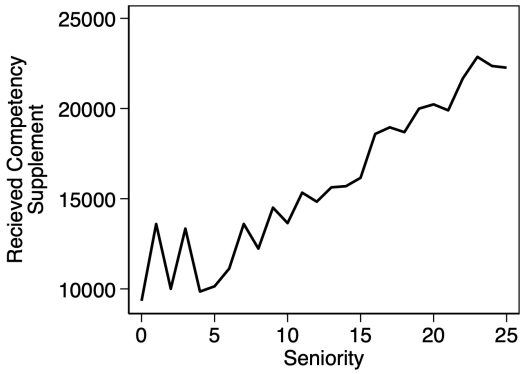
[10]The hospital covers a population of 287,000 people. The hospital data that we use for analysis contain information on 1,052 unique nurses and 4,082 nurse-year observations for the period 2017 to 2021. Hospital nurses are fairly similar to the population of nurses. However, hospital nurses are slightly younger (44.56 vs 45.61 years in the register data), even more female (98.41 percent vs. 96.08 percent in register data), and their earnings are somewhat higher 395,076 (SD=121,026) compared to 355,920 (SD=129,865) in the register data.

The importance of learning is shown in two ways. First, the proportion of nurses who receive a competency supplement is low at the beginning of the career (10-20 percent) and increases with seniority, with almost all nurses receiving a competency supplement after 10 years of service (Figure 3a). Second, competency supplements are small in magnitude early in the career and grow steadily with seniority (Figure 3c).

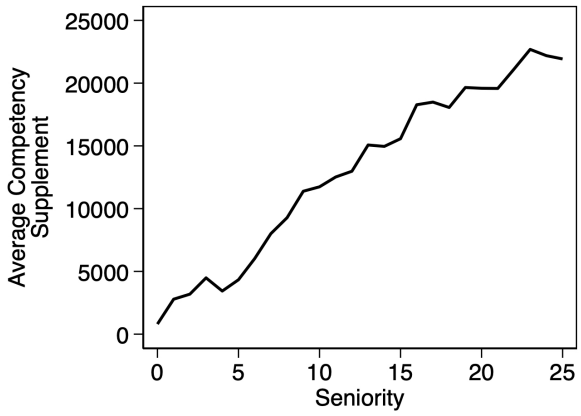
Figure 3: Competency supplements and seniority



(a) Proportion of nurses with a competency supplement.



(b) Received competency supplement.



(c) Average competency supplement.

Note: In all figures, the 3 percent with highest seniority are not shown.

We investigate these findings in more detail in Table 7. In column 1, we regress a dummy for receiving a competency supplement on seniority and controls, and the results confirm that the likelihood of receiving a competency supplement increases in seniority. In column 2 (upper part), we augment the model with actual annual hours worked and show that

both hours and seniority increase the likelihood of receiving a supplement.[11] Column 3 is the most comprehensive model that includes hours, seniority, their interaction, and controls. In this model, the result that the likelihood of receiving a competency supplement increases in hours and seniority is preserved. Using scheduled annual hours (lower part) results in similar findings. In columns 4-6 of Table 7, we estimate similar models using the magnitude of the competency supplement as the dependent variable, and we confirm that hours and seniority lead to higher competency supplements.

Hours and accumulation of human capital can also be important for promotion (Frederiksen, Kato, and Smith, 2024). However, our attempt to analyze this link is challenged by the limited upward mobility of nurses. In Appendix Figure A1, we show the job hierarchy for nurses and common career mobility patterns, yet, we only observe 51 upward moves in our sample, preventing us from conducting further analysis on this topic. Despite this, we can conclude that promotions play a minor role in our story of how hours are important for nurses' competency development and pay.

In conclusion, we have that working hours are important for pay. Theoretically, this connection is established by the process transforming hours into human capital, and subsequently into pay. Our empirical analysis provides a concrete example of this, where accumulated hours link to nurses' competency development, which the hospital is willing to pay for.

[11] There are two measures of hours available in the hospital data: Planned and actual working hours. In contrast to our work on the labor force survey data, where we used weekly hours worked usually, we used yearly hours when working on hospital data. One reason for doing this is that it is difficult to translate the measured hours in the hospital data to weekly hours given the way they are registered. Variation in days per month, timing of vacation, distribution of holidays, etc. impose undesirable variation when we attempt to construct measures of weekly hours in the hospital data. This challenge has been recognized in earlier research, as reflected in the discussion in Holden (1990).

Table 7: Competency supplements

	Likelihood	Likelihood	Likelihood	Magnitude	Magnitude	Magnitude
Actual annual hours/1000 (AH)		0.0669***	0.1288***		5,347.6***	42.1
		(0.0187)	(0.0354)		(740.50)	(861.42)
Seniority (S)	0.0602***	0.0593***	0.0746***	1,159.6***	1,087.7***	295.9
	(0.0045)	(0.0045)	(0.0082)	(183.01)	(181.31)	(286.54)
Seniority square/100 (S^2)	-0.1196***	-0.1178***	-0.1592***	-2,059.9***	-1,912.3***	-696.8
	(0.0103)	(0.0102)	(0.0250)	(643.42)	(628.08)	(1,075.79)
S x AH			-0.0121**			670.7***
			(0.0053)			(226.35)
S^2 x AH			0.0322*			-1,092.9
			(0.0167)			(790.00)
Scheduled annual hours/1000 (SH)		0.0309**	0.0275		4,226.5***	-971.0*
		(0.0143)	(0.0252)		(494.22)	(505.94)
Seniority (S)	0.0602***	0.0596***	0.0703***	1,159.6***	1,080.2***	248.9
	(0.0045)	(0.0045)	(0.0075)	(183.01)	(182.09)	(244.21)
Seniority square/100 (S^2)	-0.1196***	-0.1188***	-0.1664***	-2,059.9***	-1,952.3***	-882.5
	(0.0103)	(0.0102)	(0.0221)	(643.42)	(633.13)	(855.35)
S x SH			-0.0059			633.4***
			(0.0038)			(130.80)
S^2 x SH			0.0273**			-945.7**
			(0.0114)			(407.12)
# Observations	4,082	4,082	4,082	4,082	4,082	4,082

Note: All regressions control for: quadratics in age, and year (5) fixed-effects. Standard errors are clustered. Significance levels: 0.1* 0.05**, and 0.01***.

Conclusion

In this paper, we study the part-time penalty. To understand how pay progresses for part-time and full-time workers, we develop a theoretical framework that connects hours worked to pay. Through that lens and a series of empirical tests, we conclude that there is a significant pay gap between part-time and full-time workers. This pay gap increases over the course of the career because the two groups accumulate different levels of human capital over time.

We provide estimates of the part-time/full-time pay gap based on register data for a random sample of the population. However, our most convincing estimates of the part-time penalty are established using data from particular professions, and for nurses in particular. The nursing profession is highly homogeneous in terms of gender and educational background, and from the data we know the nurses' graduation date. This allows for comparison of earnings of part-time and full-time nurses at various stages of their career and production of estimates of the so-called part-time penalty.

Complementing our analysis of register data with personnel data on nurses from a regional hospital, we also shed light on the human capital accumulation process that causes the part-time pay penalty to increase over the career. Most importantly, we are able to link human capital accumulation directly to competency development. This link is important because human capital plays an important role in many economic models. In some cases, we have a clear understanding of what human capital is. One such example is the link between human capital and formal education. In other cases, human capital is more elusive. This is often the case when we study human capital development in the context of the workplace. Naturally, formal training programs in firms link directly to the concept of human capital, whereas the concrete materialization of "specific human capital" and "informal on-the-job training" are harder to pin down. We hope that our analysis and the identified link between human capital accumulation and competency development will be seen as a genuine attempt to advance our understanding of *how* human capital building unfolds in the workplace.

Our analysis also makes the case that working hours are important for lifetime earnings. This insight resonates well with earlier research by Manning and Robinson (2004) who link part-time work to the gender pay gap and to the arguments in Goldin (2014) connecting

hours worked, their flexibility and how they are remunerated to the gender gap. Our contribution to this discussion is to point out that part-time work has ramifications for earnings early in the career and that such ramifications increase over time. Adding to this is contemporary research showing that women may not be sufficiently aware of how their decisions, such as working part-time early in life when they have small children, influence future earnings and retirement savings (Costa-Ramón et al., 2024). Clearly, much more should be done to understand the complexity surrounding part-time work and its consequences for workers.

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Appendix

Figure A1: Observed Nurse Career Path