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Labour market consequences of cerebral palsy in Sweden: Essays on the impact of an early-onset disability

Abstract

Cerebral palsy (CP) is lifelong early-onset disability with a prevalence of 2-3 per 1000 live births. CP affects posture, muscle tone and movement, and may be associated with several secondary conditions and comorbidities. CP is associated with high societal costs, much of which stems from interventions to facilitate societal participation and improve functional abilities. However, little is known about the magnitude and trends of the labour market consequences of CP. This thesis examines the labour market consequences of CP, explore the mechanisms through which CP affects labour market outcomes, and assess the role of the Swedish social insurance system to mitigate the consequences of CP.

The analyses were performed using data constructed from several Swedish administrative registers. All persons diagnosed with CP between 1990 and 2015 in Sweden were identified. A comparison group without CP was generated based on sex, year of birth and municipality of residence at the time of birth. A variety of econometric techniques were employed in the papers that constitute this thesis.

The results show that CP has significant labour market consequences, with substantial variations across severity and sex of the individual. Persons with CP have lower employment rates and earnings compared to persons without CP, with the labour market outcomes of persons with CP worsening between 1990 and 2015. Further, CP affects labour market outcomes primarily through direct channels, suggesting that CP *per se* has significant negative labour market consequences. The results also highlight the importance of management of secondary conditions and comorbidities to improve labour market outcomes of persons with CP. For parents, the effect of having a child with CP differs between mothers and fathers. Whereas fathers' labour market outcomes decrease marginally in the short run, mothers' labour market outcomes decrease in the short-run and increase in the long run. For both persons with CP and parents of children with CP, the results show that the Swedish social insurance system offsets some part of the negative labour market consequences and costs of having a child with CP through non-work related benefits and transfers.

In a broader perspective, the results shed light on the socioeconomic consequences of a specific disability. The results draw attention to the worsening labour market outcomes of persons with CP in Sweden in spite of recent improvements in assistive technologies and flexible employment schemes.

Key words

Cerebral palsy, disability, pain, children, labour market, employment, earnings, mediation analysis, decomposition analysis, event study, Sweden

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To William, Sidney & Afia.

Contents

Abstract

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In a broader perspective, the results shed light on the socioeconomic consequences of a specific disability. The results draw attention to the worsening labour market outcomes of persons with CP in Sweden in spite of recent improvements in assistive technologies and flexible employment schemes.

Populärvetenskaplig sammanfattning på svenska

Cerebral pares (CP) är en funktionsnedsättning som begränsar en persons förmåga att röra sig. CP beror på en hjärnskada som inträffar före två års ålder och som drabbar 2-3 per 1000 födslar. De fysiska besvären varierar mellan olika person men begränsar ofta, tillsammans med bidiagnoser och samsjuklighet, en persons möjlighet till ett aktivt och inkluderande liv. Denna doktorsavhandling undersöker hur CP påverkar deltagande i arbetslivet för både personer med CP och för föräldrar till barn med CP, samt i vilken grad den svenska socialförsäkringen mildrar de eventuella negativa konsekvenserna av CP.

Genom att sammanställa information från flera administrativa register om alla personer med CP i Sverige 1990-2015 samt en kontrollgrupp utan CP, kan effekten av CP på arbetsmarknadsutfall studeras. Ett flertal olika statistiska metoder har använts i analyserna. Resultaten visar att personer med CP är anställda i mindre utsträckning och har lägre lön, samt att konsekvenserna varierar över kön och grad av funktionsnedsättning. Studierna visar även att utfallet på arbetsmarknaden har försämrats för personer med CP över perioden sedan 1990, vilket är förvånande utifrån de förbättringar inom teknologi och arbetsvillkor som har skett under perioden. En stor del av dessa negativa effekter är en direkt följd av CP, men det finns även betydande indirekta effekter som går genom utbildning, hälsa och familjeförhållande. Avhandlingens resultat framhäver vikten av att minimera risken och effekter av bidiagnoser och samsjuklighet då smärta visats leda till lägre deltagande på arbetsmarknaden bland personer mer CP.

Effekten på föräldrars arbetsmarknadsutfall av att ha ett barn med CP skiljer sig åt mellan män och kvinnor. Jämfört med föräldrar till barn utan CP minskade arbetsmarknadsutfallen för män marginellt på kort sikt efter att ha fått ett barn med CP medan för kvinnor minskade arbetsmarknadsutfallen på kort sikt men ökade på lång sikt. Anledningen till det förbättrade arbetsmarknadsutfallet för kvinnor på lång sikt är okänd men möjliga förklaring diskuteras i avhandlingen, såsom personlig assistans och ökade omkostnader. Det är viktigt att dessa resultat ses i relation till andra effekter på föräldrar och familjen i stort, såsom mental hälsa och övergripande livskvalitet.

För både personer med CP och föräldrar till barn med CP visar resultaten att det svenska socialförsäkringssystemet kompenserar en del av de negativa konsekvenserna, främst genom generella bidrag. Trots detta kvarstår betydande negativa konsekvenser och avhandlingen visar därmed på de negativa socioekonomiska konsekvenser som funktionsnedsättningar medför.

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Lund, September, 2023.

Derek Asuman

List of publications

This thesis is based on the following publications, referred to by their Roman numerals:

I **Asuman, D.**, Gerdtham, Ulf-G., Alriksson-Schmidt, A., Nordin, M., Jarl, J. Labour market consequences of an early-onset disability: the case of cerebral palsy. *Applied Economics*, 2023, pp. 1-18

II **Asuman, D.**, Gerdtham, Ulf-G., Alriksson-Schmidt, A., Nordin, M., Jarl, J. Explaining disability gaps in labour market attachment in Sweden: The case of cerebral palsy. *Manuscript*

III **Asuman, D.**, Gerdtham, Ulf-G., Alriksson-Schmidt, A., Rodby Bousquet, E., Andersen, G. L., Jarl, J. Pain and labour outcomes: a longitudinal study of adults with cerebral palsy in Sweden. *Disability & Health Journal*

IV **Asuman, D.**, Gerdtham, Ulf-G., Alriksson-Schmidt, A., Nordin, M., Jarl, J. The impact of child disability on parental labour market outcomes. *Manuscript*

Introduction

It has long been argued that living with a disability does not need to be a negative experience. Nevertheless, moving through life for persons with disabilities is certainly a different experience. How persons with disabilities and by extension their families fare depends on factors such as type and severity of disability (Charles, 2003) as well as environmental factors such as family support, social - public health policies, interpretation and enforcement of laws, and societal attitudes(Ólafsson, 2005).

There is a burgeoning body of literature that examines the economic consequences of disabilities. However, these studies have also treated disability as a homogeneous group, neglecting the peculiarities of specific diagnoses or conditions. The consequences of a disability, as well as the mechanism by which disability affects socioeconomic outcomes, may differ in several ways. As such, there is a need to understand the consequences of specific disabilities to improve the policy response to mitigate the potential negative consequences.

This thesis is a compilation of four independent but related papers with cerebral palsy (CP), an permanent early-onset disability, as the central theme. Each paper investigates the consequences and explore the mechanisms through CP affects the labour market outcomes adults with CP as well as parents of child with CP.

Background

Disability as an evolving concept

Disability, as has been commonly said, is a part of the human condition. According to the World Health Organisation (WHO), an estimated 1.3 billion people, about 16% of the world's population lived with a disability as at 2021 (World Health Oragnization, 2022). However, persons with disabilities constitute one of the most marginalized populations globally (World Health Organization, 2011; World Health

Oragnization, 2022). Historically, persons with disabilities have faced discrimination and stigmatization in many spheres of daily life and activities that have negatively affect their access to education, health and employment, resulting in worse social and economic outcomes and reduced quality of life.

The conceptual framing of disability has evolved rapidly in the last decades, owing to the activism of organizations of persons with disabilities, as well as practitioners and researchers. The concept of disability has extended beyond an individual medical focus to a structural social perspective. This shift in the framing of disability reflects the fact that disabilities are dynamic, multifaceted and complex. This change in framing, has also resulted in changes to policy options to address the needs of persons with disabilities.

Disability was previously viewed within a so-called *medical* model that emphasised disability as the result of unusual or abnormal structures of functioning of the body or mind. Under the medical model, a disability was viewed as a misfortune, and focuses on prevention, treatment and care of conditions that result in disabilities (Marks, 1997; Ólafsson, 2005). Thus, a disability was viewed as primarily an individual's lost of functioning arising out of an underlying health condition. This framework fails to acknowledge the role of environmental and social factors that interact with impairments in intellectual and body functions that causes limitations in participation and a reduced capacity to live a *normal* life.

In recent times however, the definition of disability has evolved to include the social environment that inhibits functioning due to a health condition. This *social* model views disability as interactions between body structures and function, activities and participation, and contextual factors (World Health Organization, 2001). The social model makes a distinction between impairments and disability. Whereas impairments refer to functional limitations, disability arises from the organisation of society that excludes persons with impairments. Thus, in this model, disability arises from the social environment, and argues that disability arises due to societal failure to eliminate barriers and accommodate persons in social life rather than an underlying health condition or impairment (Ólafsson, 2005). In this context, social environment and support systems play a crucial role to ensure the full integration and participation of all persons.

Economic consequences of disabilities

In recent years, there is a burgeoning body of literature that examines the socioeconomic consequences of disabilities. This shift of interest follows decades of neglect in both policy and research, given that persons with disabilities constitute a

significant proportion of the population of many countries. Globally, the evidence shows significant negative effects of disability on labour market (Mizunoya and Mitra, 2013; Ameri et al., 2018) and other socioeconomic outcomes such as household welfare (Mitra et al., 2011; Hanass-Hancock and Mitra, 2016; Asuman et al., 2021), and access to health care (Sakellariou and Rotarou, 2017) and education (Ahmed et al., 2021).

A number of potential mechanism linking disability to socioeconomic outcomes have also been identified. Disability may affect human capital accumulation through academic performance and educational attainment (Majid, 2015; Greve et al., 2017; Jarl and Alriksson-Schmidt, 2021). Lundborg et al. (2014) and Johar and Truong (2014) argue that uncertainties about future health and labour market performance may lower the economic incentives to invest in higher education for persons with disabilities. Disability may also affect socioeconomic outcomes through occupational choice (Pagán, 2009; Persson et al., 2016, 2018), as well as productivity and hours worked (Jones, 2006; Baldwin and Choe, 2014; Castro et al., 2019).

In the labour market, persons with disabilities may face stigmatization and discrimination if employers infer lower productivity to persons with disabilities based on negative stereotypes (Baldwin and Johnson, 2006; Guryan and Charles, 2013; Baert, 2016; Ameri et al., 2018; Kruse et al., 2018; Bellemare et al., 2019; Bjørnshagen and Ugreninov, 2021), or perceived a high cost to hiring persons with disabilities (Gunderson and Hyatt, 1996; Schur, 2003). Persons with disabilities are more likely to be skill mismatched in the labour market, with acute adverse effects on earnings (Jones, 2011). However, the effect of disability on skills mismatch differ by the duration of disability, as persons with longer duration of disability are more likely to be employed in jobs better matched to their impairments (Choe and Baldwin, 2017). Equally, the burden of daily management of the underlying health condition as well as related complication and comorbidities may drive labour market outcomes through increased absenteeism and reduced work effort (Atella et al., 2008; Persson et al., 2016).

There exist substantial intra-disability variations, especially in secondary conditions, comorbidities and function. These differences within the population with disabilities results in differences in socioeconomic outcomes (Jones, 2011). For example, persons with a motor impairment, who also experience some other secondary might have worse outcomes than persons with the same motor impairment but no secondary conditions. It is therefore important to understand variations within the population with disabilities to design policies aimed at improving the socioeconomic prospects of persons with disabilities (Berthoud, 2003; Silverstein et al., 2005).

The potential effects of living with a disability may not be restricted to the individual

only as there may exist spill-over effects on other members of the family, especially parents, spouses and siblings. Despite potentially substantial economic effects, there is a paucity of evidence on the spillover effects of disabilities. Children with disabilities require more care, support and attention than typically developing children. Standard economic theories of household production (Becker, 1965) predicts two potential outcomes. On one hand, parents may stay out of the labour force for a prolonged period or take up jobs with greater flexibility so as to be able to attend to the needs of the child. Prolonged labour market disruptions, as well as unpredictable work absence may hurt future employment and earnings prospects of parents of children with disabilities (Goldin, 2014; Azmat et al., 2022). Indeed, a recent study by Gunnsteinsson and Steingrimsdottir (2019) has shown negative consequences of child disabilities on parental labour market outcomes. On the other hand, parents of children with disabilities may increase their labour market activities in order to offset the extra costs of caring for a child with a disability. As a result, parents of children may experience increased stress, physical and mental fatigue as well as reduce quality of life and life satisfaction (Aktan et al., 2020; Farajzadeh et al., 2020; Fritz and Sewell-Roberts, 2020).

Most of the evidence on the relationship between disability and socioeconomic outcomes have used broad measures of disability rather than specific conditions, treating disabilities as a homogeneous group. Equally, the evidence on disability have focused predominantly on late-onset disabilities. However, the socioeconomic consequences of disability, as well as the mechanism by which disability affects socioeconomic outcomes, may differ by type, onset, severity, duration, as well comorbidities and secondary conditions (Charles, 2003). For example, persons with early onset disability may invest in disability-specific human capital that improve ability to cope with the condition, but may be less valuable in the labour market (Jones, 2016). On the other hand, persons with late-onset disabilities may be compensated by the social insurance to mitigate the consequences of lost earnings (Jones, 2011).

This thesis contributes to the literature by focusing on Cerebral Palsy (CP), the most common early onset motor disability. CP is a permanent neurodevelopmental disability that affect movement and posture (Rosenbaum et al., 2007), with substantial intra-disability variation in function and severity. Some persons with CP function independently whereas others experience severe limitations and require around-the-clock assistance with activities of daily living with implications for the entire family (Andrén and Grimby, 2004). In addition, CP poses significant cost on individuals, families, the health and social welfare system, and the economy in general (Wang et al., 2008; Kruse et al., 2009; Park et al., 2011; Tonmukayakul et al., 2018). In spite of the frequency of occurrence, and the high cost of interventions to facilitate

participation and engagement, the labour market consequences of living with CP have been little studied due to the lack of reliable data on CP diagnosis. This thesis use national-level data to provide a population level estimate of the labour consequences of CP in Sweden.The thesis also examines heterogeneities in the consequences of CP across severity of the condition.

Aetiology of CP

CP affects 2-3 per 1000 live births (Kirby et al., 2011; Smithers-Sheedy et al., 2014). Recent estimates, however, report decreasing prevalence across Europe (Sellier et al., 2016; Hollung et al., 2018; Larsen et al., 2021; McIntyre et al., 2022), Canada (Robertson et al., 2017), Japan (Touyama et al., 2016), Australia (Galea et al., 2019), and China (He et al., 2017). In Sweden, Himmelmann and Uvebrant (2018) estimates the prevalence of CP to be 2 per 1000 live births between 2007 to 2010. CP is caused by a non-progressive brain damage that occurs in a developing fetal or infant brain (Rosenbaum et al., 2007; Kirby et al., 2011), and may be associated with comorbidities and secondary conditions such as epilepsy and musculoskeletal problems that may worsen over time. In Sweden, the diagnosis of CP typically occurs before 4 years of age.

The etiology of CP is complex and oftentimes uncertain, with the underlying causes poorly understood (McIntyre et al., 2013; Korzeniewski et al., 2018). CP is seldom caused by a single factor, often resulting from several predisposing factors (Himmelmann and Uvebrant, 2018; Korzeniewski et al., 2018). Previous studies have identified several potential risk factors of CP, which may be antenatal, neonatal, postnatal or combined. Some prominent risk factors of CP include congenital brain malformation, complications and infections during pregnancy and delivery, low birth weight, low gestation age at delivery and multiple gestation. Socioeconomic characteristics such as low maternal age at birth, educational attainment, multiple pregnancies and low socioeconomic status have been found to be correlated with an increased risk of CP (Korzeniewski et al., 2018; Michael-Asalu et al., 2019).

CP affects posture, muscle tone and movement, and the level of functional abilities associated with CP varies greatly. About 40% of children with CP are unable to walk independently (Kirby et al., 2011; Christensen et al., 2014). The primary motor disorder may be accompanied by impairments of sensation, perception, cognition, communication, and behaviour (Rosenbaum et al., 2007; Smithers-Sheedy et al., 2014). It is also estimated that 33% to 63% of individuals with CP have a speech difficulty (Mei et al., 2020) and one-half have an intellectual disability (Reid et al., 2016). Further, the prevalence of mental health disorders is high among individuals with CP (Rackauskaite et al., 2016; Whitney et al., 2019).

The Surveillance of Cerebral Palsy in Europe (SCPE) identifies three broad categories of CP; *spastic*, *dyskinetic* and *ataxic* CP. According to the classification, spastic CP is characterized by increased, but varying tone (unusually tight and stiff muscle) and pathological reflexes (Cans, 2000). Spastic CP may be either unilateral (when limbs on one side are involved) or bilateral (when limbs on both sides are involved). Ataxic CP is characterized by loss of orderly muscular coordination so that movements are performed with abnormal force, rhythm, and accuracy (Cans, 2000). Dyskinetic CP on the other hand is characterized by involuntary, uncontrolled, recurring, and occasionally stereotyped movements (Cans, 2000). Dyskinetic CP is further sub-grouped into dystonic and choreo-athetotic. Dystonic CP involves reduced activity and usually increased tone whilst choreo-athetotic CP involves increased activity and usually decreased tone.

The classification of CP in recent times has moved from the underlying impairment to focus on functioning (Korzeniewski et al., 2018) in line with the World Health Organization's International Classification of Functioning, Disability and Health (ICF). In this thesis, CP is identified as a disability within the ICF model. CP may limit activity participation when the impairments caused by the brain damage interacts with contextual and environmental factors to reduce functioning in domains such as movement and posture, self-care, communication, and manual ability.

Aims

The overall objective of this thesis was to examine the socioeconomic consequences of living with CP in Sweden, and through this understand the compensating effects of the Swedish social insurance system on potential negative effects of living with CP. The thesis focuses on labour market outcomes of adults with CP, and parents of children with CP. The included papers aim to capture and explain the overall gaps in labour market outcomes between persons with CP and a matched comparison group without CP drawn from the general population as well as differences within the population of adults with CP, and explore the spillover effects of CP on the labour market outcomes of parents of children with CP.

The thesis has the following specific aims:

i. Estimate the overall gaps in labour market outcomes between persons with and without CP, and explore the evolution of the gaps and understand the mechanisms through which CP affects labour market outcomes (Papers I and II).

ii. Examine labour market differences with the population with CP by assessing

the association between pain, a common secondary condition, and labour market outcomes (Paper III).

iii. Assess spillover effects of CP by tracing the labour market outcomes of parents in response to having a child with CP (Paper IV)

iv. Assess the role of the Swedish social insurance system to mitigate the labour market consequences of CP for both persons with CP and parents of children with CP (Papers I, III and IV).

Study context and data

Study context

Sweden, like other Scandinavian countries, is well known for its egalitarian gender attitudes and generous welfare system. Healthcare is primarily tax-funded and decentralised. Universal healthcare is the norm, with emphasis on equal access to services and availability of free or greatly subsidized assistive devices, medications and treatments. In addition, the Swedish labour market is characterized by high union density, with relatively strong labour and employer organisations and collective bargaining agreements that ensures that wages are determined at the industry level (Andersen et al., 2014). Sweden has also enacted laws against disability discrimination in the labour market such as the 2009 Discrimination Act and ratified international treaties such as the United Nations Convention on the Rights of Persons with Disabilities. There are several active labour market policies aimed at improving the position of jobseekers with disabilities (Angelov and Eliason, 2018).

The Swedish legal system emphasis the right to independent living for persons with extensive disabilities enshrined in the Act Concerning Support and Service for Persons with Certain Functional Impairments (LSS) enacted in 1994. The law provides opportunities for persons with considerable or permanent functional impairments to have equal living conditions and enjoy full participation in community life. The law provides benefits to persons with disabilities such as the right to a personal assistant. Benefits are not dependent on the financial means of the individual (family or caregivers for a child), but the needs of the person with disability. In addition, persons with disabilities as well as parents of children with disabilities may qualify for other benefits (Alriksson-Schmidt et al., 2021). In the context of an expansive welfare state, Sweden provides a unique opportunity to study how social benefits compensate potential negative consequences of disabilities for individuals and their families.

Data

The analyses in this thesis are based Swedish national administrative registers. There exist several national population-based administrative registers that contain valuable information on socioeconomic and demographic characteristics as well as healthcare usage. In addition, the unique personal identification numbers (Swedish: *personnummer*) allows individuals to be linked across different registers. The availability of large population data, enables this thesis to provide one of the few national-level estimates of the labour market consequences of CP.

Data sources

The thesis leverages rich data from Swedish national administrative registers. All individuals diagnosed with cerebral palsy, and living in Sweden between 1990 and 2015 are identified using diagnostic code (ICD 10) G80 from the National Quality Register and Follow-up Program for Cerebral Palsy, National Patient Register, and the Medical Births Registers. A comparison group matched on based on sex, year of birth and municipality of residence was drawn from the general population at a 5:1 ratio using the Register of the Total Population. Siblings of individuals with CP were excluded from the comparison group, as the presence of substantial spillover effect of growing up with a sibling with CP may bias the estimates. The parents of the identified cases and controls were also identified using the Multi-generation Register. All identified persons were followed from 1990 (or birth) until 2015 (or death), i.e. a maximum of 26 years for each person.

All identified persons were linked using national identification numbers to national and regional registers on demographic, socioeconomic, and disease specific factors as well as health care utilisation and drug prescriptions. Information on several labour market outcomes, social security benefits, and other socioeconomic outcomes, were obtained from the Longitudinal Integration Database for Health Insurance and Labour Market Studies (*Swedish:* Longitidinell Intergrationsdatabas för Sjukförsäkrings och Arbetsmarknadsstudier, LISA). LISA is updated yearly for all individuals older than 15 years old and registered in Sweden as at 31 December since 1990, and since 2010 data for individuals 15 years old has been included.

Demographic information for all individuals were obtained from the Register of the Total Population, which contains basic information on all persons registered in Sweden. Information on healthcare utilisation is obtained from the National Patients Register, while pregnancy and birth-related information were sourced from the Medical Births Register (MBR). The NPR contains information on all health care

episodes in in-patient care (hospitals) and specialised out-patient care while MBR contains data on all deliveries in Sweden. Information on drug prescriptions were obtained from the Prescribed Drugs Register, which contains data on all prescribed drugs dispensed in pharmacies in Sweden. Disability specific information for the cases is extracted from the National Quality Register and Follow-up Program for Cerebral Palsy (CPUP), a follow-up surveillance program for persons with CP in Sweden.

Sample construction

Patient registers have been shown to overestimate the prevalence of persons with CP (Hollung et al., 2018). As such a strict criteria was applied to exclude individuals who are not considered to have CP from the sample for the analyses. Individuals with an acquired brain damage (ICD10: G00, S061, S062, S063, S067, S068, S069) after the age of two, but no CP diagnosis before the brain damage are excluded. Further, individuals are excluded if they have other diagnoses (ICD10: G60, G61, G62, G71, G72, G834, G95, E71, E72, E74, E75, E76, E830, G114, G12, G31, G37, Q06, Q743.) that are considered incompatible with CP. Finally, individuals who have been excluded from the CPUP register are excluded from the sample.

Paper I used data of persons with CP and their matched controls aged 20-64 years in Sweden during 1990-2015. The sample includes 77,971 individuals made up of 13,000 persons with CP and 64,971 persons in the comparison group. In Paper II, the estimation was based on a repeated cross-sectional data of adults aged 20-64 years old and living in Sweden before 2001 and 2015. The sample was restricted to 2001 as information from outpatient registers are available from 2001. The analyses are performed separately for each year, as such the sample composition changes each year.

Paper III was a longitudinal cohort study using data of working-aged individuals (20-64 years of age) diagnosed with CP living in Sweden between 2006 and 2015. The final sample included 6,899 individuals (3,813 men and 3,086 women) and 53,657 person-years. The main explanatory variable, *pain*, was sourced from the Prescribed Drug Register which was established in July, 2005. As such the analysis begins from 2006, when data for the entire year was available.

In Paper IV, the sample was based on parents of children with CP and their matched comparison group. A balanced panel of parents who are observed five years before the event of childbirth to ten years after was constructed. The analysis was restricted to the first-born of mothers to avoid endogeneity that might arise from future births. Parents with multiple gestation, as non-singleton births have been shown to be a risk factor of CP were excluded. The final sample included 6778 matched mother-child

pairs, of which 1,014 (15%) are mothers of children with CP, and 6778 father-child paired matches of which 1,012 (15%) of fathers of children with CP.

Methods

This section presents and discusses some of the key aspects of the empirical strategies applied in the data analysis, first in general and thereafter for each objective of this thesis.

Definition of key variables

Measurement of labour market outcomes

This thesis examines two primary labour market outcomes - employment and earnings.

Employment The LISA data contains the employment status of all individuals aged 15 and above as of November of the year. However, only individuals with strong attachments to the labour market were included in the main analysis. To do this, a threshold of annual earnings from employment exceeding at least 100,000 Swedish kronor (SEK) adjusted to 2015 prices, excluding work-related allowances was imposed following previous studies (Nordin and Rooth, 2009; Dackehag et al., 2015; Lovén et al., 2017). The threshold is equivalent to 3 months of full-time employment per year based on an average salary. Thus, an individual is defined to be employed if s/he earned at least SEK 100,000 in the calendar year, adjusted for inflation. This measure of employment is sometimes referred to as employment at the intensive margin. Nordin and Rooth (2009) shows that the earnings threshold may be arbitrary and finds no differences across the choice of a threshold. The *sensitivity* of the results were therefore tested at alternative earnings thresholds. First, an indicator was constructed that defined a person to be employed if s/he was employed as at November, unconditional on earnings from employment and referred to as extensive margin employment. The results were also tested alternative thresholds of at least SEK 50,000 and SEK 150,000.

Earnings In Papers I, III and IV, earnings from employment was defined as is all earnings from employment and self-employment that are reported to Swedish Tax Agency. In Paper II however, earnings was earnings as annual gross salary from employment. Earnings from self-employment was excluded from the definition of earnings in Paper II to avoid an underestimation of the labour market gaps due to persons with CP engaging with self-employed activities due to discrimination, real or perceived, from employers. An alternative definition in Paper I, earnings was expanded to include total earned income from employment as defined above, plus work-related benefits, i.e. social benefits conditioned on employment (e.g. sickness benefit, parental leave benefit, pregnancy benefit, sick pay guarantee, work injury compensation, parental benefit, child care benefit, rehabilitation allowance). Work-related benefits are conditioned on labor market activity, and the amount is related to the individual income level. This definition of earnings enables us to measure the compensating effect of the social insurance system on earnings losses to persons with CP.

Other outcomes In addition to employment and earnings, the consequence of CP on disposable income was examined in most papers that form part of this thesis. Disposable income was defined as total income received (including allowances and benefits) minus taxes paid. Disposable income was measured at the individual level. In Paper I; disposable income allows us to capture the compensating effect of the social insurance system through non-work related benefits while Paper IV, it gives an indication of the financial resources available to parents.

CP severity

The most common approach to classify CP severity is based on gross motor function. The Gross Motor Function Classification System (GMFCS) is a five-level system that classifies gross motor function based on self-initiated movement abilities (Rosenbaum et al., 2008). Higher GMFCS levels correspond to greater gross motor functional impairment (Andersen et al., 2008). GMFCS levels I to III corresponds to self initiated movement with support or a hand-held device whilst levels IV and V corresponds to severe motor impairments that prevent independent functioning. Gross motor function has been shown to be strongly correlated with communication and manual ability (Compagnone et al., 2014) as well as intellectual disability (Reid et al., 2018). The expanded and revised version of the Gross Motor Function Classification System (GMFCS) (Palisano et al., 2000; Rosenbaum et al., 2008; Palisano et al., 2008) was used to classify CP into mild (GMFCS I-III) or severe (GMFCS IV-V), using information from the CPUP register.

CP subtypes have been shown to be correlated to motor function (Jonsson et al.,

2019). For a large proportion of our persons with CP, GMFCS information was missing and in those cases, severity was classified based on CP-subtypes. Persons with spastic hemiplegia, and ataxic CP are classified as mild. Also, persons with spastic diplegia who at any time received a diagnosis of spastic hemiplegia, and persons with dyskinetic CP were classified as severe except those with a diagnosis of choreoathetoid (G803B), who generally are classified at lower GMFCS levels, and for the purpose of this study were coded as having mild CP. On the other hand, persons with spastic tetraplegia CP were classified as severe. Persons with dyskinetic CP with a diagnosis of dystonia (G803A or G803X) or unknown tonus/choreoathetoid, and mixed sub-types were considered severe. Those with spastic diplegia without a diagnosis of tonus/choreoathetoid, hemiplegia or tetraplegia, as well as those with unspecific sub-types could not be classified in terms of severity and were thus excluded from the analyses stratified on severity.

Empirical strategies

The labour market consequences of cerebral palsy

The main focus of Papers I and II was to estimate the overall gaps and sources of labour market gaps between persons with CP and comparison group without CP, and explore the pathways through which CP affects labour market outcomes. All analyses were conducted separately for men and women similar to Longhi (2017) to avoid capturing gender effects on labour market outcomes (Mondéjar-Jiménez et al., 2009) in the labour market consequences of CP.

Overall labour market gaps

To estimate the overall labour market gaps, an Ordinary Least Squares (OLS) regression (Equation 1) was estimated within a pooled matched framework to compare persons with CP and the comparison group without CP;

$$y_{irt} = \alpha + \beta CP_{ir} + \gamma X_{irt} + \delta_t + \omega_r + \kappa_{rt} + \epsilon_{irt} \quad (1)$$

where y_{irt} is the labour market outcome of individual i residing in region r in year t; CP_{ir} is a binary variable indicating CP status of the individual; X_{irt} is a vector of control variables; δ_t is year dummies that capture year-specific changes; ω_r is region fixed effects that capture regional differences in labour market policies and conditions; κ_{rt} is an interaction between region and year to control for labour market shocks that

affect all individuals in a particular region over time; ϵ_{irt} is a random error term. Standard errors are clustered at the individual level.

To examine heterogeneity in the consequences of CP, CP was redefined based on severity. Further, the indicator variable for CP was interacted with year dummies age categories (20-29, 30-39, 40-49, 50-59 and 60-65) to capture yearly differences in the labour consequences of CP and over the life-cycle.

Pathways between CP and labour market outcomes

To understand the potential mechanisms between CP and labour market outcomes, mediation analysis technique was adopted. The technique disentangled the total effect of CP on employment and earnings into one part that measures an *indirect effect* that operates through potential intermediate variables or mediators and another part captures the *direct effect* that is not explained by the mediator (Imai et al., 2010). The direct effect may include other unmeasured mediators, including discrimination. Four potential mediating paths were studied - education, sector of employment, having children, and health status, proxied by long-term sickness absence and use of inpatient care. The analysis were performed separately for each mediator.

Explaining sources and contributions of labour market gaps

Labour outcomes were assumed to be described by an equation of the form presented in Equation 2 and estimated separately for groups with and without CP (Malo and Pagán, 2012) for each year from 2001 to 2015;

$$y_{it} = \alpha + \beta X_{it} + \sigma_r + \rho_s + \epsilon_{it} \tag{2}$$

where y_{it} is labour market outcome for individual i at year t; X_{it} is a vector of characteristics that affect labour market outcomes; σ_r captures regional fixed-effects; ρ_s captures industry fixed-effects; ϵ_{it} is a idiosyncratic error term.

The total gaps between persons with and without CP were decomposed into two parts using a technique proposed by Kitagawa (1955), Oaxaca (1973), and Blinder (1973). One part of the gap, referred to as the *explained* component, is attributed to differences in observed characteristics between the groups. The second, *unexplained* part captures the gap that arises due to differences in the returns (coefficient) to the same characteristics between the groups. The technique has been extended to include binary outcomes (Fairlie, 2005) and quantiles (Fortin et al., 2011). These extensions are applied to decompose employment and earnings from employment at

the mean and selected quantiles. The quantile decomposition allows for the assessing heterogeneities along the distribution of earnings.

Pain and labour market outcome of adults with CP

The thesis also investigated the association between pain and labour outcomes of adults with CP with a longitudinal setting. The sample for this study was limited to working-aged individuals (20-64 years of age) living in Sweden between 2006 and 2015. Based on previous research, the association between pain and labour outcomes was estimated as an individual-level fixed-effects (FE) regression.

Pain in a specific year was defined as having a pain diagnosis in the National Patient Register (in- and outpatient care) or being dispensed pain-related prescription medication (see Table A1 for the list of diagnoses and medications) as registered in the Pharmaceutical Register. The definition of pain in this study includes medication and diagnoses of both CP- and non-CP-related pain. Over the counter pain medications without prescription were not included as they are not registered in the Pharmaceutical Register.

Estimating the association between pain and labour market outcomes using an individual fixed-effects regression reduce bias that may arise from unobservable time invariant individual characteristics that may influence both pain and labour market outcomes. The sample was stratified by sex and severity of CP to study if the association between pain and labour market outcomes varied across these stratification. Further, potential mechanisms of how pain could affect labour market outcomes were investigated, with indicators related to the social welfare system as outcome variables (early retirement, receipt of unemployment benefits, and sickness leave for at least 14 days).

Parental labour market response to having a child with CP

The empirical strategy in Paper IV was based on an event study framework. An event study traces out the full dynamic effect of the event. An OLS regression of the Equation 3 is estimated separately for mothers and fathers

$$y_{irst} = \sum_{\substack{j=-5 \\ j\neq -1}}^{+10} \alpha_j (j = t) D_i + \sum_{\substack{j=-5 \\ j\neq -1}}^{+10} \beta_j (j = t) + \sum_i \gamma_i X_{irst} + \sum_k \delta_k (k = age_{is}) + \sum_y \phi_y (y = s) + \sigma_r + \epsilon_{irst} \tag{3}$$

where y_{ist} is the labour market outcome of interest of parent i in region r at calendar year s and event time t. The first term of the equation is a set of event time dummies.

Event time is defined as the years relative to the birth of a child. We denote the year of birth of the child by $t = 0$, and index all years relative to that year. We omit event time $t = -1$, so that the coefficients for the other time dummies measure the effect relative to one year before the birth. D_i is an indicator variable which equals to 1 if the parent has a child with CP. The α_j coefficients are estimates of the effect of having a child with CP, i.e., the difference between parents with children with CP and the control with typically developing children, the average treatment effect on the treated (ATT).

The event of having a child with CP mostly coincides with the timing of birth. Parental labour market responses to having a child with CP may be conflated by the effects of childbirth, which is associated with substantial labour market penalties especially for mothers (Kleven et al., 2019; Rosenbaum, 2021). β_j estimates the coefficients of having a child on labour market outcomes (child penalties). $\alpha_j + \beta_j$ represents the coefficients of the treatment group. In the results, α_j coefficients are plotted for a variety of outcomes. A set of assumptions are required to interpret the results are causal. In the main paper, it has been shown that CP satisfies these requirements.

X_i is a set of background characteristics were included as controls. In addition, a full set of age and calendar year dummies were included to control for underlying non-parametric trends in parents labour market outcomes and take into account year-specific fluctuations respectively. Region of residence were included as dummies to capture regional differences in labour market conditions. ϵ_{irst} is the error term. The standard errors were clustered at the level of the individual, allowing for correlations across years.

Results

This section summarizes the main results of the four papers included in this thesis. For a full presentation of the results, the reader is referred to the separate papers.

Labour market consequences of CP

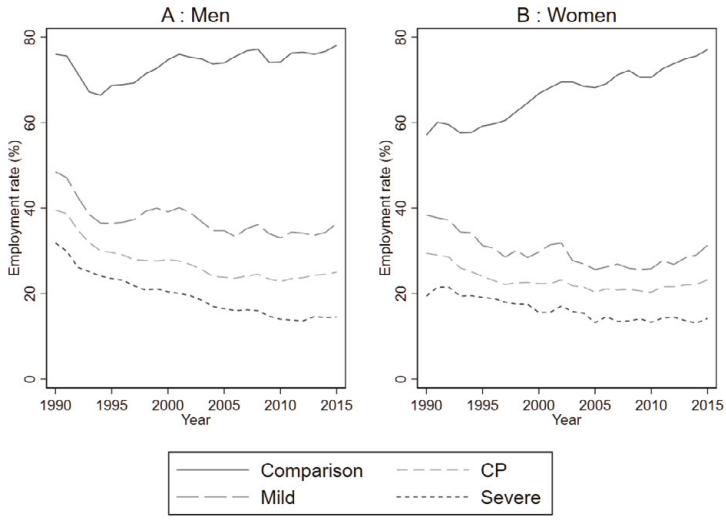
Papers I and II focused on measuring the magnitude of the labour market consequences of CP, and understanding the sources of the consequences and factors through CP affects labour market outcomes.

Trends in labour market outcomes of persons with CP

Figure 1 shows the trend of employment and average earnings for persons with CP and the comparison group between 1990 and 2015. Employment rates decline steadily among persons with CP and only plateau/turn upward during the latter years (Figure 1a) while average earnings of the comparison group without CP increased substantial over the period compared to persons with CP (Figure 1b), resulting in a widening in labour market outcomes between persons with CP and the comparison group.

Figure 1 – Trends in employment and average earnings if employed, 1990-2015

(a) Employment rates



(b) Earnings if employed

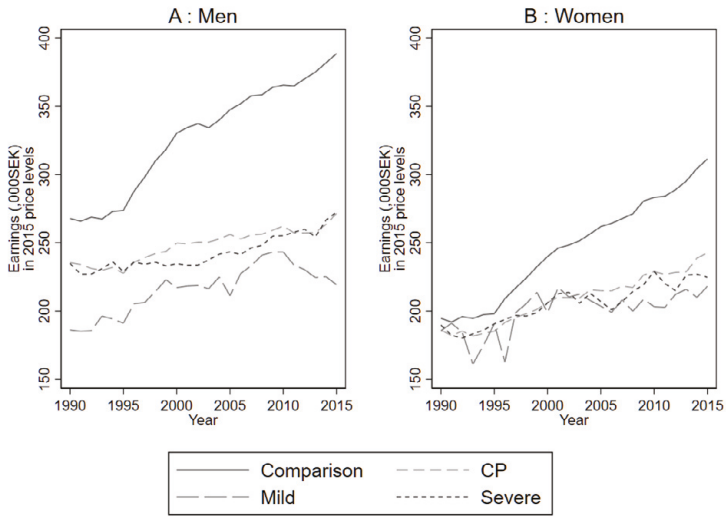


Figure notes: The figure shows the trends in employment and earnings if employed of persons with CP and the comparison group without CP from 1990 to 2015. All monetary values are reported in 1,000 SEK adjusted to 2015 level using the CPI. The trends are crude means for the group of persons included in the sample.

Overall labour market gaps

CP is associated with reduced employment rates and earnings, with variations across sex and severity. Table 1 shows a 47(44)-percentage point difference in employment between persons with CP and the comparison group for men (women). In terms of earnings, men with CP earn 24% less than the comparison group of men without CP, whilst women with CP earn 16% less than the comparison group. The results also show labour market outcomes of persons with CP worsen with age, and that the gaps between persons with CP and the comparison group increased between 1990 and 2015.

Table 1 – Overall labour market gaps

	Total		Mild		Severe	
VARIABLES	Men	Women	Men	Women	Men	Women
Employment						
CP	-0.465***	-0.435***	-0.323***	-0.343***	-0.553***	-0.505***
	(0.006)	(0.006)	(0.013)	(0.012)	(0.011)	(0.011)
Constant	0.465***	0.314***	0.442***	0.297***	0.479***	0.291***
	(0.020)	(0.023)	(0.038)	(0.042)	(0.036)	(0.043)
Observations	541,574	429,285	120,916	103,027	156,301	124,140
R-squared	0.168	0.152	0.130	0.129	0.213	0.182
Earnings						
CP	-0.280***	-0.179***	-0.250***	-0.151***	-0.329***	-0.218***
	(0.010)	(0.010)	(0.017)	(0.017)	(0.024)	(0.023)
Constant	11.033***	10.936***	11.019***	10.963***	10.970***	10.932***
	(0.023)	(0.024)	(0.042)	(0.041)	(0.041)	(0.043)
Observations	354,825	250,197	78,687	58,825	100,687	71,244
R-squared	0.345	0.388	0.329	0.357	0.361	0.393

Table notes: Additional controls include country of birth, parental background, year of birth, region of residence, year, and region-year fixed effects. Robust standard errors in parentheses. Standard errors clustered at individual level *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Pathways between CP and labour market outcomes

Four potential pathways through which CP might affect labour market outcomes were assessed. These pathways were education (years of completed schooling), sector of employment (private vs public sector), having children aged 0 to 6 years, and health status (sickness absence and inpatient care). Cumulatively, the pathways account for 24-32% of the differences in labour outcomes between men with CP and the comparison group, and 17-29% for women, suggesting that the effect of CP on labour outcomes run primarily through direct channels.

Explaining sources and contributions of labour market gaps

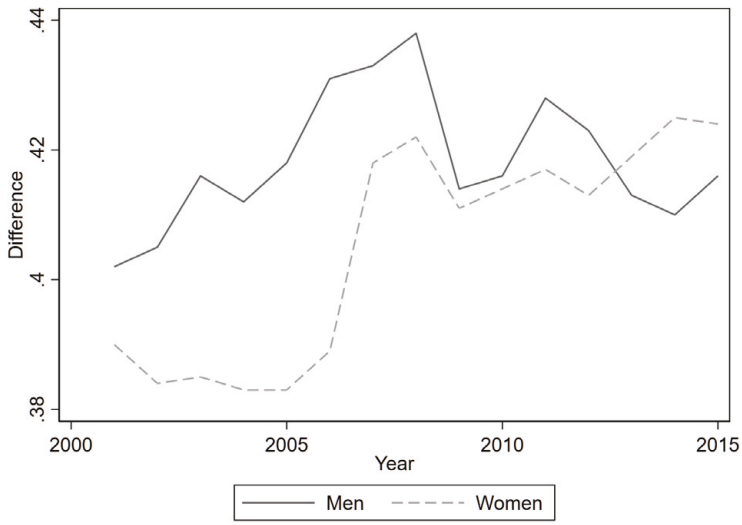
The analyses performed in Paper II showed significant gaps in the employment between persons with and without CP between 2001 and 2015 (Figure 2a). The trends and sources of employment gaps vary between men and women. The employment gap for men increased between 2001 to 2008, and declines thereafter whilst for women, the employment gap increased over the period. Further, the explained gap accounted for about one-third of the employment gap for men (Figure 2b). For women, the contributions of the *explained* component to the total employment gap ranged between 19% to 28% of the gap.

The earnings gaps are in favour of the comparison group without CP at the mean and selected quantiles. Notably, the gaps in earnings are higher among men compared to women (Figure 3a). The results show the presence of so-called *sticky floors*, a situation where gaps are largest at the lower tail of the earnings distribution (Christofides et al., 2013). The earnings gap at the mean is driven by differences in explained characteristics for men but not for women (Figure 3b). Along the earnings distribution however, the dominant sources of the earnings gap for men alternated between the *explained* and *unexplained* components. At the 75th quantile, the *explained* component dominates for men. For women, the unexplained component is the dominant source of earnings gaps at the selected quantiles.

The results from a robustness analysis that ensures that the counterfactual of persons with CP have the same characteristics as the comparison group without CP showed that the explained component of the decomposition is the only significant source of the earnings gap between persons with and without CP. This finding therefore suggest the gap in earnings arise from differences in observed characteristics when persons with CP possess the similar labour market characteristics as the non-CP group.

Figure 2 – Employment gap and contributions to the employment gap

(a) Employment gap between persons with and without CP



(b) Share of the explained component of the employment gap

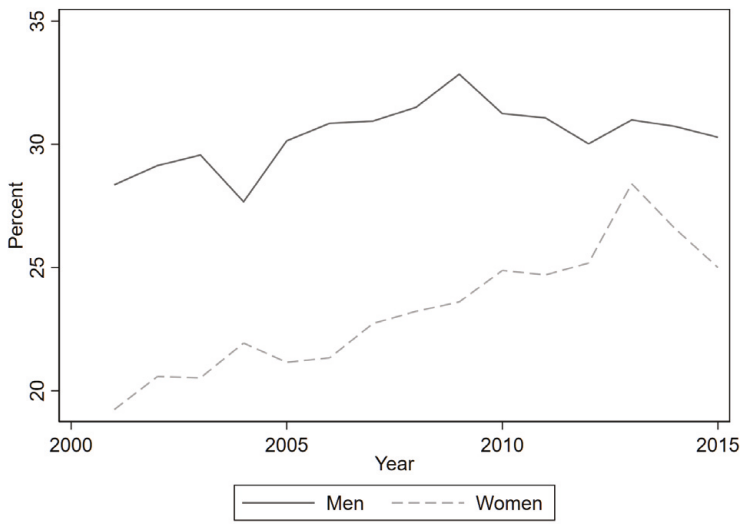
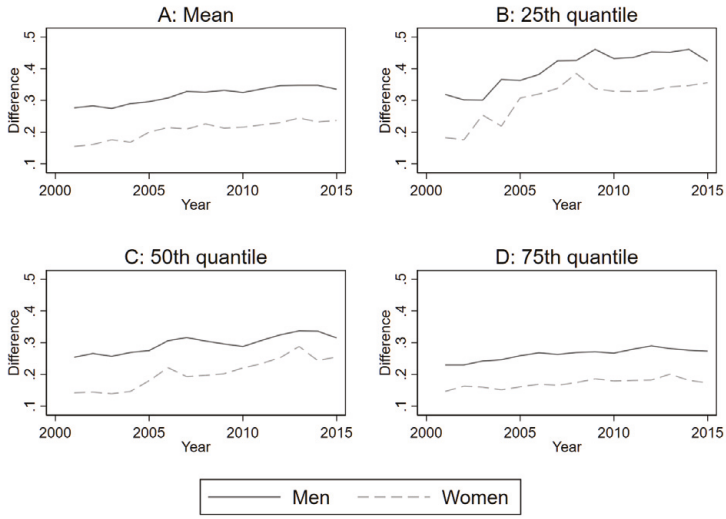


Figure notes: Figure 2a shows the overall employment gap between persons with CP and the comparison group without CP from 2001 to 2015 estimated at an annual income threshold of SEK 100,000. Figure 2b shows the share of the employment gap that is explained by characteristics included in Equation 2. Figures 2a and 2b are based on the Fairlie (2005) decomposition technique.

Figure 3 – Earnings gaps and contribution of explained component

(a) Earnings gap



(b) Share of explained component to earnings gap

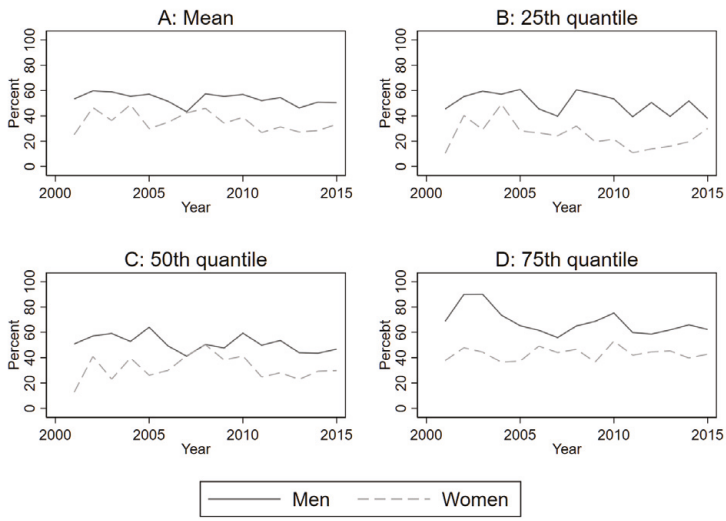


Figure notes: Figure 3a shows the overall earnings gap between persons with CP and the comparison group without CP from 2001 to 2015 estimated at the mean and selected quantiles. Figure 3b shows the share of the earnings gasp that are explained by characteristics included in Equation 2. Figures 3a and 3b are based on the Firpo et al. (2009) quantile decomposition technique.

Next, the thesis uncovered the contributions of characteristics to the employment and earnings gaps between persons with and without CP. The results showed that the contributions to the sources of the gaps differed between sexes and over time. In terms of employment, the analyses showed that characteristics contribute to the two components of the total gap in different directions. For example, whilst differences in educational attainment contributed positively to the explained component, the returns to educational attainment reduced the unexplained gap. The decomposition of the earnings gap at the mean and selected quantiles along the earnings distribution shows that occupation and industrial affiliation are the main contributors to explained component of the earnings gap for both men and women. On the contrary, there are no clear and discernible patterns of the contributions of the various characteristics to the unexplained component of the earnings gaps.

Pain and labour market outcomes of adults with CP

Papers I and II showed adverse labour market outcomes of persons with CP. Paper III explored the potential role of secondary conditions and comorbidities to the labour market outcomes of persons with CP and examined pain, a common secondary condition. Pain was associated with negative labour market outcomes among persons with CP, with the largest association observed among persons with severe CP (Table 2). Pain was associated with a 7% decrease in employment and a 3% decrease in earnings (equivalent to SEK 7,566 at 2015 price levels) during the study period. The association between pain and labour market outcomes varied across CP severity. Pain was associated with a 9% (12%) reduction in employment for persons with mild (severe) CP, and a 2%; ≈ SEK 5,341.36 (4%, ≈ SEK 10,783) reduction in earnings for persons with mild (severe) CP. Stratified by sex, pain reduced the employment by 7% for men and women. Further, pain reduced earnings by 4% (≈ SEK 10,398) for men and 2% (≈ SEK 3,948) for women.

Table 2 – The effect of pain on employment and earnings of adults with CP

		Employment			Earnings		
		Total	Mild	Severe	Total	Mild	Severe
All							
	Pain	-0.021***	-0.033***	-0.025***	-0.029***	-0.021**	-0.044***
		(0.003)	(0.007)	(0.005)	(0.005)	(0.009)	(0.012)
	Constant	0.311***	0.329***	0.232***	11.929***	12.205***	12.504***
		(0.017)	(0.031)	(0.028)	(0.288)	(0.118)	(0.129)
	Observations	53,657	16,464	13,919	14,220	5,240	2,629
	R-squared	0.019	0.038	0.026	0.200	0.250	0.216
	Mean dep. var.	0.296	0.365	0.208	252,195.89	254,350.28	245,069.40
	Individuals	6,899	2,288	1,732	2,532	1,023	461
Men							
	Pain	-0.021***	-0.038***	-0.034***	-0.039***	-0.037***	-0.073***
		(0.004)	(0.010)	(0.007)	(0.007)	(0.012)	(0.016)
	Constant	0.305***	0.394***	0.147***	11.928***	12.316***	12.344***
		(0.022)	(0.042)	(0.037)	(0.290)	(0.131)	(0.138)
	Observations	29,142	8,902	7,464	8,254	3,139	1,508
	R-squared	0.019	0.043	0.041	0.179	0.247	0.228
	Mean dep. var.	0.321	0.411	0.225	266,634.89	270,364.27	263,370.76
	Individuals	3,813	1,276	944	1,429	590	256
Women							
	Pain	-0.019***	-0.025**	-0.017**	-0.017**	0.001	-0.015
		(0.005)	(0.010)	(0.008)	(0.008)	(0.014)	(0.017)
	Constant	0.310***	0.257***	0.385***	12.409***	12.124***	12.431***
		(0.025)	(0.047)	(0.045)	(0.095)	(0.115)	(0.242)
	Observations	24,515	7,562	6,455	5,966	2,101	1,121
	R-squared	0.042	0.058	0.062	0.262	0.301 2	0.259
	Mean dep. var.	0.266	0.312	0.188	232,219.44	230,424.57	220,449.91
	Individuals	3,086	1,012	788	1,103	433	205

Table notes: We controlled for educational attainment, marital status and presence of children aged 0-3 years, 4-6 years, 7-10 years, and 11-15 years, year, and region of residence in all regressions. Occupational status and industry affiliation are included the regressions for earnings. *Mean dependent variable* is the average of the dependent variable over the period 2006-2015. All regressions were estimated by an individual fixed effects specified. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Parental labour market response to having a child with CP

So far, the analysis have focused on the labour market outcomes of persons with CP. This section presents some evidence of the spillover effects of CP by examining the labour market response of parents of children with CP.

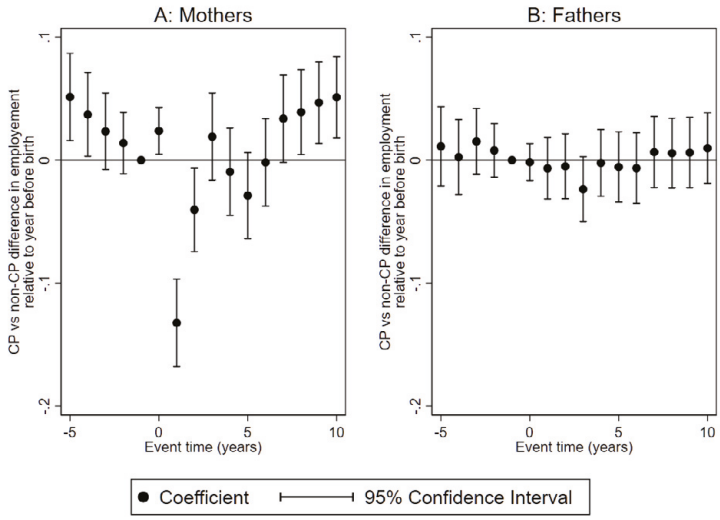
Effect on employment and earnings

The results presented here at based on labour market outcomes of parents at the intensive margin. Figure 4a show that employment of mothers of children with CP is reduced by 13 and 4 percentage points in the first and second years after the birth of the child. By the eighth year however, mothers of typically developing children lag behind mothers of children with CP, with difference in employment between 3-5 percentage points. For fathers, there are no detectable differences in employment.

Parents appear to be comparable in terms prior to the birth of the child (Figure 4b). Mothers of children with CP earn approximately SEK 16,700 and SEK 9600 less than mothers of typically developing children in the first and second years after the birth of the child. By the seventh year after the birth, the difference in earnings turns in favour of mothers of children with CP, earning SEK 14,700 to SEK 20,500 more than mothers of typically developing chidlren. Fathers of children with CP earn about SEK 11,500 less in the third year and SEK 9,400 less in the fifth year after the birth of the child compared to fathers of typicall developing children.

Figure 4 – Parental labour market response to having a child with CP

(a) Employment at intensive margin



(b) Earnings at intensive margin

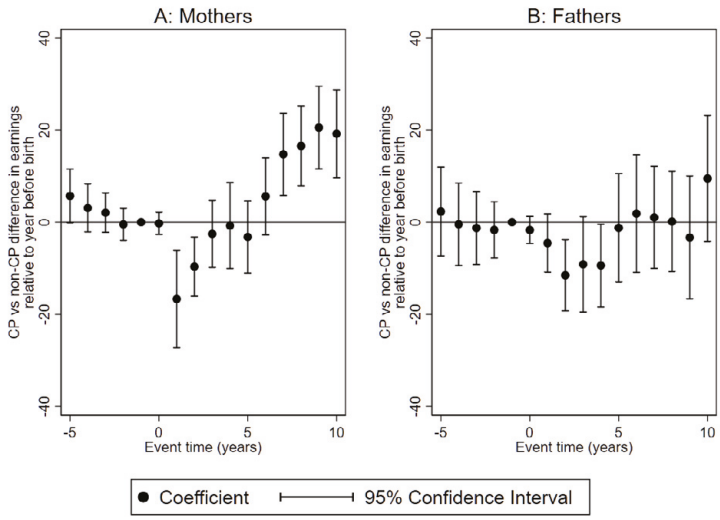


Figure notes: The figure shows the estimates of the child disability penalty for mothers and fathers, and 95% confidence intervals. Event time = 0 is the year of birth of the child.

Effect on disposable income

The results showed statistically significant and economically meaningful impacts on disposable incomes of mothers (Figure 5). However, no impacts are found for fathers. From the second year after birth, mothers of children with CP report higher disposable income compared to mothers of typically developing children. The difference increases over time, from SEK 10,000 to SEK 32,500 in the tenth year after the birth of the child.

Figure 5 – Parental disposable income response to having a child with CP

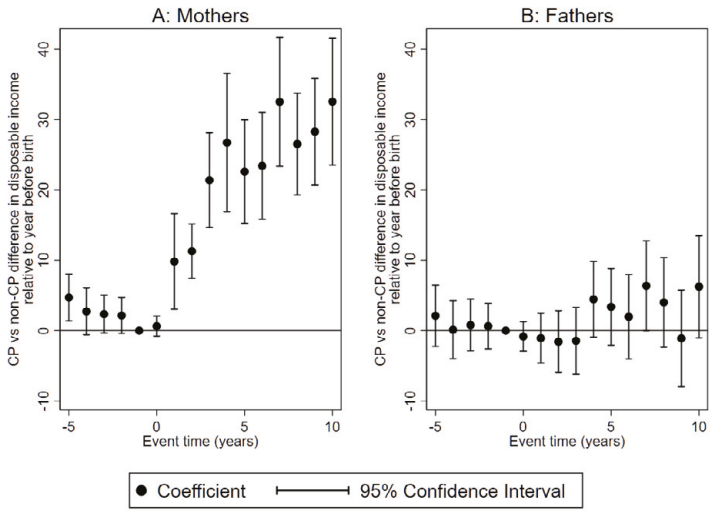


Figure notes: The figure shows the estimates of the child disability penalty for mothers and fathers, and 95% confidence intervals. All monetary values are reported in 1,000 SEK. Event time = 0 is the year of birth of the child.

Social insurance and the labour market consequences of CP

Paper I assessed the compensating effect of the social insurance system on the labour market losses experienced by persons with CP (see Table 3). The results show that the earnings gap is not quantitatively different from the effect of CP on earnings from employment only (see Table 1) when earnings is expanded to include work-related benefits. On the other hand, the disposable income gap is lower i.e. 16% for men and 9% for women, suggesting that the social insurance system primarily compensates for lost earnings through non work-related benefits and allowances.

Table 3 – Social insurance and overall labour market gaps

	Total		Mild		Severe	
VARIABLES	Men	Women	Men	Women	Men	Women
Earnings & benefits						
CP	-0.267***	-0.171***	-0.243***	-0.148***	-0.310***	-0.212***
	(0.010)	(0.010)	(0.016)	(0.017)	(0.024)	(0.024)
Constant	11.063***	10.975***	11.051***	10.988***	10.996***	10.977***
	(0.023)	(0.023)	(0.041)	(0.040)	(0.041)	(0.042)
Observations	354,825	250,197	78,687	58,825	100,687	71,244
R-squared	0.355	0.421	0.342	0.394	0.373	0.429
Disposable income						
CP	-0.178***	-0.095***	-0.178***	-0.088***	-0.191***	-0.104***
	(0.008)	(0.008)	(0.013)	(0.013)	(0.017)	(0.018)
Constant	10.723***	10.736***	10.703***	10.718***	10.682***	10.748***
	(0.020)	(0.020)	(0.035)	(0.035)	(0.036)	(0.036)
Observations	354,642	250,108	78,649	58,806	100,639	71,219
R-squared	0.433	0.494	0.428	0.473	0.449	0.492

Table notes: Additional controls include country of birth, parental background, year of birth, region of residence, year, and region-year fixed effects. Robust standard errors in parentheses. Standard errors clustered at individual level *** $p<0.01$, ** $p<0.05$, * $p<0.1$

The use of social insurance system might mitigate the reductions in labour market outcomes of persons with CP due to pain. To this end, the association between pain and use of social welfare systems were assessed (Paper III). Pain was found to increase the likelihood of sickness leave by 93% among individuals with CP, compared to those without pain. When restricted to persons with CP who were employed, pain was associated with a larger increase sickness leave (106%). Further, pain marginally increased likelihood of disability pension (1%) for persons with CP, and reduced the likelihood of unemployment benefits by 15%.

Parents of children with CP qualify for some disability-specific benefits and allowances. Two of such transfers - parental leave income and care allowance, were assessed in Paper IV to investigate the responses of the social insurance system to parents of children with CP. In the years after the childbirth, parents of children with CP received on average more in parental leave income and care allowance than parents of children without CP. However, the magnitude of allowances/benefits received by fathers are lower compared to mothers. For example, mothers of children with CP received on average SEK 31,500 more in income prompted by parental leave compared to fathers of children with CP who receive average SEK 6,000 in parental leave income.

Discussions

This thesis contributes to the literature on the economic consequences of disabilities, particularly congenital and early-onset disabilities. This chapter provides a context within which the results may be interpreted and understood.

Labour market consequences of CP

Papers I and II assessed the labour market outcomes of persons with CP relative to a comparison group without CP. The findings reported are in line with expectations and previous studies on disability (Lechner and Vazquez-Alvarez, 2011; Cervini-Plá et al., 2016) and similar to previous studies that have shown that the the gap in labour market outcomes between persons with CP and the comparison group without CP has increased over time (Törnbom et al., 2014; Benner et al., 2017). The worsening of the labour market outcomes of persons with CP were contrary to expectations given recent developments in technology and labour market conditions. Particularly, enhancements in assistive technologies and flexible employment schemes have improved labour market participation of persons with disabilities (Sauer et al., 2010; Giovanis and Ozdamar, 2020); it is therefore unclear why labour market outcomes of persons with CP in Sweden have worsened.

The findings in Paper II are consistent with previous studies (Jones, 2006; Malo and Pagán, 2012; Baldwin and Choe, 2014; Longhi, 2017) that have found significant disability-related labour market gaps across Europe. The magnitude of labour markets gaps noted in Papers I and II may be considered very high, given the overall high labour market participation in Sweden. However, O'Brien (2015) and van der Zwan and de Beer (2021) posits that disability employment gaps are generally higher in countries with generous welfare benefits and high employment rates like Sweden.

Taken together, the findings suggest that CP affects labour outcomes run primarily through direct and unexplained channels. Importantly, the findings of Paper I

implies that persons with CP will continue to face significant negative labour market consequences even when they have similar mediators as persons without CP.

On the supply side, receipt of disability-related benefits have been found to reduce the incentive for persons with disabilities to seek employment (Maestas et al., 2013; French and Song, 2014) whilst education have also been found to be a key driver of disability-related labour market gaps (Jones et al., 2006; Jones, 2008; Kruse et al., 2018). However, controlling for educational attainment and other relevant characteristics including access to social and disability-related benefits, substantial labour market gaps against persons with CP were observed in Paper II.

On the demand side, labour market gaps against persons with disabilities may be driven by employer discrimination and prejudice against persons with disabilities (Ameri et al., 2018; Bjørnshagen and Ugreninov, 2021; Baert, 2016; Bellemare et al., 2019) as well as cost associated with modifications to the workplace (Gunderson and Hyatt, 1996) and medical and rehabilitation (Schur, 2003). In addition to a universal healthcare system In Sweden, firms and employees with disabilities qualify for a subsidized wage employment, and in-work aids (Angelov and Eliason, 2018). As such, the cost of hiring a person with a disability is expected to be lower compared to settings where such support do not exist. Thus, it is possible that perceived lower productivity and discrimination against persons with CP persist within the Swedish labour market.

Indeed, the direct/unexplained components of the gap possibly include discrimination against persons with CP and other unmeasured mediators that affect labour market outcomes. It However, attributing this component of the gaps to discrimination is not straightforward, and should be done with great caution. Baldwin and Johnson (2006) points out that discrimination occurs only when groups of workers with equal productivity receive different outcomes on average. In this context, CP may affect characteristics valued in the labour market that may not be accounted for or well captured by personal and job characteristics (Malo and Pagán, 2012). Many impairments linked to CP may affect a workers productivity. As such, the direct/unexplained component may include the mixed effects of employer discrimination and unobserved productivity differences (Malo and Pagán, 2012).

Pain and labour market outcomes of adults with CP

The consequences of CP could be due to health that arises from secondary conditions and comorbidities. Equally, health may drive differences in outcomes within the population with CP. Pain, a common condition among persons with CP, provides a

potential health-related pathway through which CP affects labour market outcomes, and could form part of the direct/unexplained gaps. The results showed low to moderate association between pain and labour market outcomes, with relatively larger effect among persons with severe CP. Individuals with CP who experienced pain were found to have increased absence from work due to sickness compared to those without pain. Such disruptions might be expected to negatively affect employment and earnings. Pain is associated with increased psychological distress and functional impairments (Hardt et al., 2008; Nahin, 2015), increased mental fatigue and sleep disturbance (Jarl et al., 2019; Jacobson et al., 2020) resulting in reduced quality of life (Wensink-Boonstra and Marij, 2010; Morgan et al., 2014; Salie et al., 2021) and social and economic limitations (Engel et al., 2003; Hilberink et al., 2007). These findings highlight the importance of pain management and prevention to improve the labour market outcomes of persons with CP.

Pain was measured from administrative medical sources, a departure from most previous studies that have relied on self-reported incidences of pain. However, this approach is not without its own challenges, especially for the interpretation of the results. Previous studies such as Hodgkinson et al. (2001) and Engel et al. (2003) have shown that only a small percentage of adults with CP seek medical care for pain, i.e. those with more severe pain. However, García Jalón et al. (2021) has shown pain medication to be a valid proxy for experienced pain among persons with CP.Also, it is possible that labour market outcomes might be already limited by motor and cognitive impairments, especially among those with severe CP (Vogtle, 2009). The results could be considered a lower bound measure, as the indicator for pain only captures individuals who sought medical attention.

Parental labour market response to having a child with CP

The thesis also presents evidence on the spillover effects of early-onset disabilities and estimate the dynamic responses of labour market outcomes of parents after having a child with CP. The response of fathers and mothers differ after the birth of a CP with CP. Employment and earnings of mothers are negatively affected by the birth of a child with CP in the short-run, whereas in the long-run however, mothers of children with CP have higher employment and earnings compared to mothers of typically developing children. For fathers however, only short-term decline in earnings is observed.

The results are contrary to Gunnsteinsson and Steingrimsdottir (2019) and Adhvaryu et al. (2023) who report negative long-run consequences in Denmark of having a child with a disability and cancer. On the other hand, Öhman et al. (2021) find

a positive trajectory for maternal earnings following the child being diagnosed with cancer in Sweden. The long-term increases in maternal labour market outcomes are driven primarily by mothers of children with severe CP, contrary to Wasi et al. (2012) who finds that severe childhood disabilities lead to large reductions in maternal labour supply.

Parents of children with disabilities qualify for several benefits from the Swedish social insurance system including personal assistance. Access to personal assistants can affect parental labour market outcomes through releasing parental time input in childcare and increases the opportunities in extensive labour market activities. Second, parents of children with CP have the option to be paid personal assistants to their children (Eriksen et al., 2021), or work extra hours as personal assistants in addition to their full-time employment.

Although the results indicate a long-run increase in labour market outcomes of mothers of children with CP, negative impacts of having a child with a severe disability may manifest in other ways. Parents of children with CP have been reported to have higher levels of stress, depression and lower quality of life (Aktan et al., 2020; Farajzadeh et al., 2020; Fritz and Sewell-Roberts, 2020). It must be noted that the long-run increase in labour market outcomes for mothers do not necessarily imply better career trajectories, and must be viewed in connection with possible negative consequences on family-work balance, life satisfaction, and mental and physical health.

Social insurance and the labour market consequences of CP

One of the themes of this thesis is to investigate the role of the social insurance in mitigating the consequences of CP. Sweden is well known for its expansive social welfare systems that provide significant safety nets to its population, and egalitarian principles that promote equality of opportunity and inclusion. In this context, the social insurance setting may play an important role in mitigate the consequences for persons with CP, as well as parents of children with CP.

The analysis in Paper I showed that the Swedish social insurance system compensates for a part of the earnings losses associated with CP and thereby reduces the socioeconomic consequences of CP, similar to what has been noted in Germany (Lechner and Vazquez-Alvarez, 2011). The compensating effect appears to be mainly through non-work related benefits such as disability pensions, family welfare and housing benefits. However, significant income losses remain, as the social insurance systems are not intended to fully compensate for losses due to disability (Wiberg

et al., 2015; Levere, 2021). For example, labour market losses that arise from reduced education and selection to low-wage occupations are not compensated by the social insurance system.

In Paper IV, the results show that the Swedish social welfare system compensates parents through transfers. Parental leave income and care allowance appear to compensate mothers with CP for the excess lost labour earnings compared to mothers with typically developing children. Theoretically, the childcare allowances should also reimburse parents for disability-specific cost. However, the share of the share of the extra cost that is offset by the social insurance system through transfers to parents could not be estimated due to the lack of data. During the period covered in this thesis, disability-related benefits were paid to the parent registered as the primary caregiver of the child. The differences in transfers to parents between mothers and fathers of children with CP may reflect the gendered division of household labour where women take a larger responsibility in childcare.

Methodological considerations

Strengths and limitations

CP provides a unique setting to examine the labour market consequences of an early-onset disability. The labour consequences of disability, as well as the mechanism by which disability affects labour outcomes, may differ by type, severity, duration, and common comorbidities and secondary conditions. The focus on CP, a relatively common disability, differentiates this thesis and the papers included, from previous studies that have treated disabilities as a homogeneous group.

A major strength of this data is use of administrative data that covers a significant proportion of the population living with CP. Most of the previous studies have been limited by small sample sizes based on selective populations of persons with CP, which risk to cause bias compared to using national population samples. Given that CP may be considered a severe condition and universal healthcare coverage in Sweden, persons with CP are unlikely to be undiagnosed. The use of national register data for CP diagnosis enables the papers included in this thesis to provide a population level estimate of the labour outcomes of persons with CP.

Also, most studies have been unable to examine possible heterogeneities in labour market consequences of CP due to limited samples. With a large sample coupled with information on severity and CP subtypes, the evidence presented in this thesis examined variations in the labour market consequences due to severity of CP

compared to the general population within CP, as well as intra-disability variations among persons with CP.

From an empirical perspective, the focus on CP provided opportunities and challenges in the design and estimation strategies adopted in the papers that form the thesis. In Paper IV for example, CP offers unique features that are well suited to overcome some of the challenges of identification in previous studies that have examined the impact of child disability on parental outcomes. Particularly, because CP can not be detected *in utero* and thus avoid the problem of anticipatory behaviour of parents, the results can be interpreted as causal.

In Paper III, an individual fixed effects (FE) approach was employed to assess the association between pain and labour market outcomes of adults with CP. The individual fixed effects approach minimizes the influence of time-invariant unobservable factors that affect both pain and labour market outcomes. Though the results are not interpreted as causal, the individual fixed-effects estimation may be seen as an improvement over the standard ordinary least squares and logistic regressions in prior studies, as fixed-effect estimation accounts for time-invariant individual characteristics.

A key methodological challenge is the fact that CP occurs at an early age, before entry into the labour market and remains fixed over the lifetime. As a consequence, it is not possible to estimate the causal effect of CP diagnosis on labour market outcomes with individual fixed effects regression or alternative empirical designs which rely on variation within individuals across time. In Paper I, the estimation relies on the assumption that conditioning on personal and parental characteristics, the occurrence of CP is random. However, there may exist unobservable and unmeasured factors that affect the onset of CP, mediators, and outcomes. In the presence of such omitted variables, the results may therefore be biased.

Some general limitations must also be noted. The papers in this thesis use CP diagnosis from administrative registers, which may contain persons who have incorrectly been diagnosed as having CP, and/or received incorrect sub-types. A strict criteria was applied to exclude misdiagnosed individuals, although the final sample can not be validated. Further, the severity of CP was classified based on gross motor function, and where information on gross motor function was unavailable, expected gross motor function based on CP subtype was used. Although some CP subtypes are strongly correlated with motor function, the relationship is not straightforward for all CP sub-types. It is possible that severity may be misclassified from subtypes and the results based on severity should be interpreted with caution. Also, there are many different ways severity of CP can be defined and it is possible that the results would change with a different definition. The Manual Ability Classification System

(MACS) and the Communication Function Classification System (CFCS) would be interesting in this context, as would cognitive function.

Generalizability of findings

An important question that arises is the generalizability of the findings of this thesis i.e., to what extent can the findings be generalized to other disabilities and settings. As pointed out earlier, disabilities manifest in different forms. As such, the magnitude of impact and mechanisms through which these consequences operate might differ from one condition to the other. CP has been described as representative of congenital or early-onset disabilities (Michelsen et al., 2015) given the substantial variations in severity and function within the population with CP. In this light, the findings of this thesis may be generalized to other congenital or early-onset disabilities that affects posture and movement such as spina bifida and Aicardi-Goutieres Syndrome (AGS).

The analyses and findings in this thesis are based on administrative data from Sweden, a country noted for its expansive welfare system. The Swedish healthcare system is tax-funded, with low levels of direct costs to users. In addition, health insurance is not tied to employment. Persons with disabilities, as well as their parents and guardians qualify for several benefits and allowances that are based on needs and socioeconomic status. Thus, the findings of this thesis are likely contextual and unclear to what extent the results can be generalized to other countries where such support and healthcare systems do not exist.

Policy implications

The findings presented in this thesis raise a number of policy-relevant questions. An important question raised by the findings of Paper I is to what extent the social insurance systems should compensate for labour market losses owing to early onset disabilities. Social insurance systems are not intended to fully compensate for losses due to disability. Early-onset disabilities affect human capital investments and occupation choice that might negatively affect such persons. Such labour market losses are not compensated by the social insurance system. This arises questions about the extent the social insurance system compensate for labour market losses owing to early-onset disabilities, especially losses that arise from indirect factors.

The findings in Paper II suggest that to reduce disability gaps in labour market outcomes, it is crucial to enforce anti-discrimination laws and implement measures that promote equal opportunities for persons with early-onset disabilities. In addition,

policies to increase labour market participation and enhance the productivity of persons with disabilities such as flexible working arrangements and wage subsidies will be important to close the disability gaps in labour market outcomes from both supply and demand sides.

The findings in Paper III indicate that pain reduction in adults with CP holds promise to enable more individuals to stay active in the labor force. Pain treatment and management is important to improve quality of life and pain and should be screened from an early age and actively managed throughout the life course for persons with CP to mitigate the negative labour market consequences. Also, access to pain medication for persons with CP should be considered a priority, in light of recent efforts to constrain access to some types of pain medication in order to address illicit substance use.

Paper IV finds in the long-term, labour markets of mothers of children with CP increases relative to mothers of children without CP. The findings point to the potential role of the limited access to personal assistants, that forces parents especially mothers to take up responsibilities as caregivers in addition to their regular labour market activities. Thus, cutbacks in the provision of personal assistants to parents of children with disabilities would likely have negative consequences of other outcomes such quality of life, family-life balance, physical and mental health, and social participation. Equally, reductions in financial support to parents/guardians of children will likely increase susceptibility to financial hardships and negatively affect the development of the child.

Conclusion

The findings from this thesis provide evidence on the labour market consequences of CP, a lifelong early-onset disability, on persons living with CP as well as spill over effects on parents. The thesis also explored the how of the Swedish social insurance system mitigates labour market losses due to CP. The main conclusions from this thesis are:

- CP has significant negative consequences on labour outcomes for persons living with CP, with the consequences increasing over time. The consequences vary substantial across CP severity.
- CP affects labour market outcomes through direct channels, rather than mediators that lie in the path between CP and labour market outcomes such as educational attainment, healthcare use, and family formation.
- Pain, a common secondary condition associated with CP, provides a potential health-related pathway to improve the labour market outcomes of persons with CP and improve their quality of life and participation.
- The labour market responses of parents to having a child with CP differ between mothers and fathers. In the short-run, mothers of children with CP experience a drop in labour market outcomes whilst the long-run labour market outcomes are higher for mothers of children with CP compared to mothers of typically developing children. For fathers, there are only marginal short-run declines in labour market outcomes.
- The social insurance compensates part of the labour market losses experienced by persons with CP, as well as offset part of the extra cost of having a child with CP through transfer payments. However. significant losses remain, especially for persons with CP.

Appendix

Table A1 – Sources of pain information

ICD 10 diagnostic codes	
	Acute pain (R520), Chronic intractable pain (R521), Other chronic pain (R522) Unspecified pain (R529), Headache (R51), Migraine and other headache syndromes (G43-G44), Trigeminal neuralgia (G500), Pain in abdomen (R10) Back (M549), Breast (N644), Chest and throat (R07), Ear (H920), Eye (H571) Joint (M255), Limb (M796), Lumbar region (M545), Pelvic and perineal (R102) Shoulder (M255), Spine (M54), Tongue (K146) and Tooth (K088).
ATC diagnostic codes	
	Natural opium alkaloids (N02AA), Phenylpiperidine derivatives(N02AB) Oripavine derivatives (N02AE), Opioids in combination with antispasmodics (N02AG) Opioids in combination with non-opioid analgesics (N02AJ), Other opioids (N02AX) Salicylic acid and derivatives (N02BA), Pyrazolones (N02BB), Anilides (N02BE) Other analgesics and antipyretics (N02BG), Selective serotonin (5HT1) Agonists (N02CC), Calcitonin generelated peptide (CGRP) Antagonists (N02CD) Other antimigraine preparations (N02CX) Acetic acid derivatives and related substances (M01AB) Oxicams (M01AC), Propionic acid derivatives (M01AE), Fenamates (M01AG) Other antiinflammatory and antirheumatic agents non-steroids (M01AX) Coxibs (M01AH), Tropical products for joint and muscular pain (M02A), Other muscle relaxants, peripherally acting agents (M03AX) Other centrally acting agents (M03BX).

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