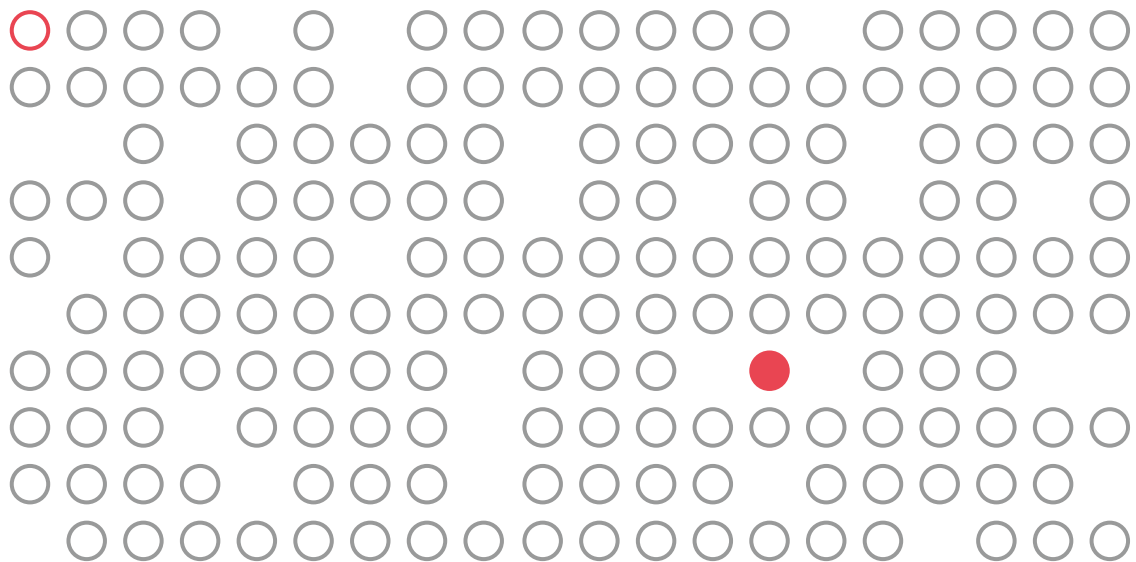

INAUGURAL DISSERTATION 2026

EARLY HETEROGENEITIES IN CHILD DEVELOPMENT

INVESTIGATING THE ROLE OF MATERNAL
CHARACTERISTICS AND LEARNING ENVIRONMENTS
IN GERMANY

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BAMBERG
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Kumulative Dissertation

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**Early Heterogeneities in Child Development:
Investigating the Role of Maternal Characteristics and Learning
Environments in Germany**

Inaugural Dissertation

Zur Erlangung des Doktorgrades

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vorgelegt von

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Early Heterogeneities in Child Development: Investigating the Role of Maternal Characteristics and Learning Environments in Germany

Short Content

Chapter I – Early Heterogeneities in Child Development	1
1. Introduction.....	1
2. Background – Conception of Life Courses and Institutions.....	10
3. Theory.....	13
4. Contribution of Present Studies	38
References.....	46
 Chapter II – The Early Interplay of Childcare Histories and Maternal Work Trajectories: A Multichannel Sequence Analysis	 85
1. Introduction.....	86
2. Theoretical Considerations.....	88
3. Data and Method.....	92
4. Results	94
5. Discussion	101
References.....	105
 Chapter III – The Long-Term Effects of an ECEC Reform on Educational Attainment.....	 113
 Chapter IV – Maternal Occupation-Specific Skills and Cognitive and Non- Cognitive Child Development in Germany	 114
1. Introduction.....	115
2. Theoretical Background.....	119
3. Data and Method.....	122
4. Results	125
5. Discussion and Conclusion.....	130
References.....	133

Chapter V – Advanced Maternal Age and Child Development: New Evidence From Germany138

1. Introduction.....	139
2. Institutional Context: Family Formation in Germany.....	141
3. Theoretical Considerations and Hypotheses.....	142
4. Methods	145
5. Results	149
6. Discussion	156
7. Limitations	159
8. Conclusion	159
References.....	160

Chapter VI: Integrative Discussion and Conclusion166

1. Short Summary of Main Findings	166
2. Integrative Discussion.....	168
3. Limitations	175
4. Outlook.....	176
References.....	180

Appendix Chapter II.....	192
Appendix Chapter III.....	203
Appendix Chapter IV.....	204
Appendix Chapter V.....	220
Appendix Chapter VI.....	234

Full Content

Chapter I – Early Heterogeneities in Child Development	1
1. Introduction	1
1.1 Previous Literature and Research Gaps	3
1.2 The Present Dissertation	6
1.3 What About Fathers?	8
2. Background – Conception of Life Courses and Institutions	10
3. Theory	13
3.1 Maternal Decisions and Child Development	14
3.2 Children’s Learning Environments and Child Development	22
3.3 Summary of Theoretical Considerations	37
4. Contribution of Present Studies	38
4.1 Study 1: The Early Interplay of Childcare Histories and Maternal Work Trajectories: A Multichannel Sequence Analysis	42
4.2 Study 2: The Long-Term Effects of an ECEC Reform on Long-Term Educational Attainment	43
4.3 Study 3: Maternal Occupation-Specific Skills and Cognitive and Non-Cognitive Child Development in Germany	44
4.4 Study 4: Advanced Maternal Age and Child Development: New Evidence From Germany.	45
References	46

Chapter II – The Early Interplay of Childcare Histories and Maternal Work Trajectories: A Multichannel Sequence Analysis.....85

1. Introduction.....	86
2. Theoretical Considerations.....	88
2.1 Conceptional Framing of Life-Courses.....	88
2.2 Childcare and Employment Decisions as Rational Choices.....	89
3. Data and Method.....	92
3.1 Data and Sample.....	92
3.2 Analysis Strategy.....	92
3.3 Operationalization.....	94
4. Results.....	94
4.1 Identifying Childcare-Work Patterns.....	94
4.2 Describing the Families Behind the Patterns.....	99
5. Discussion.....	101
5.1 The Interrelation of Childcare Histories and Maternal Employment Trajectories.....	101
5.2 Socio-Economic Stratification of Childcare-Work Arrangements.....	103
5.3 Limitations.....	104
References.....	105

Chapter III – The Long-Term Effects of an ECEC Reform on Educational Attainment.....113

Chapter IV – Maternal Occupation-Specific Skills and Cognitive and Non-Cognitive Child Development in Germany114

1. Introduction.....	115
2. Theoretical Background.....	119
3. Data and Method.....	122
4. Results.....	125
4.1 Exploring Effect Heterogeneity.....	127
4.2 Robustness Checks.....	129
5. Discussion and Conclusion.....	130
References.....	133

Chapter V – Advanced Maternal Age and Child Development: New Evidence From Germany138

1. Introduction.....	139
2. Institutional Context: Family Formation in Germany.....	141
3. Theoretical Considerations and Hypotheses.....	142
3.1 Maternal Age and Resources.....	143
3.2 Maternal Age and Maturity.....	144
3.3 Maternal Age and Heterogeneity.....	145
4. Methods.....	145
4.1 Data and Sample.....	145
4.2 Variables.....	146
4.3 Analytical Strategy.....	148
5. Results.....	149
5.1 Explaining the Age-Child-Relationship.....	149
5.2 Analyzing Effect Heterogeneity by Maternal Education.....	153
5.3 Robustness Checks.....	155
6. Discussion.....	156
7. Limitations.....	159
8. Conclusion.....	159
References.....	160

Chapter VI: Integrative Discussion and Conclusion166

1. Short Summary of Main Findings.....	166
2. Integrative Discussion.....	168
2.1 The Relevance of Maternal Employment for Child Development.....	168
2.2 The Relevance of Childcare for Child Development.....	171
2.3 The Relevance of Maternal Age at Birth for Child Development.....	173
3. Limitations.....	175
4. Outlook.....	176
References.....	180

Appendix Chapter II.....	192
Appendix Chapter III.....	203
Appendix Chapter IV.....	204
Appendix Chapter V.....	220
Appendix Chapter VI.....	234

List of Tables

Table I.1: Overview of Individual Articles and their Publication Status	39
Table II.1: Descriptive Statistics for Six Childcare-Work Clusters.....	96
Table IV.1: Examples of Occupational Tasks	120
Table IV.2: Mothers' Occupational Tasks and Child Development: Theoretical Expectations	122

List of Figures

Figure I.1: Key Phases of Childhood	2
Figure I.2: Schematic Representation of the Overarching Research Questions and their Subdimensions	7
Figure I.3: The Parent Socialization Model (Panel A) and the Concept of Home Learning Environments (Panel B).....	25
Figure I.4: Joint Perspective of the Family Investment Model (FIM) and the Family Stress Model (FSM)	33
Figure II.1: Relative Frequency Plots of Childcare-Work Patterns by Cluster	95
Figure II.2: State Distribution Plot of Childcare-Work Patterns by Cluster	98
Figure II.3: Coefplot of Cluster Affiliation.....	101
Figure IV.1: Examples for occupational groups (KldB 2010, 3-digits) with distinct task compositions	124
Figure IV.2: Main Specification: Maternal Task Composition and Child Development	126
Figure IV.3: Mechanism Model: Maternal Task Composition and Child Development	127
Figure IV.4: Effect Heterogeneity in Task Composition and Child Development by Maternal Education	128
Figure IV.5: Effect Heterogeneity in Task Composition and Child Development by Child Gender	129
Figure V.1: Mean Maternal Age at First Birth in Germany (1990 - 2022)	142
Figure V.2: Sample Distribution of Maternal Age at Birth of Focal Child	146
Figure V.3: Descriptive Evidence – Maternal Age and Child Development	150
Figure V.4: Main Results – Maternal Age at Birth and Child Development	151
Figure V.5: Effect Heterogeneity by Tertiary Education: Maternal Age and Child Development.....	154

Chapter I – Early Heterogeneities in Child Development

1. Introduction

Early childhood represents a critical period for long-term child development, where early disparities by families are established and social inequalities begin to emerge. A large body of research demonstrates substantial discrepancies in child outcomes well before formal schooling begins, highlighting the early transmission of inequalities within the family with long-term consequences (Cunha & Heckman, 2010; Currie & Almond, 2011; Helbig et al., 2026; Letourneau et al., 2013; Shepherd-Banigan et al., 2019; Skopek & Passaretta, 2021). Family life in Europe and in Germany has undergone profound transformations, particularly for women. Long-term demographic shifts, including rising educational attainment, intensified female labor force participation, increasingly egalitarian gender norms, and postponed family formation (Coltrane, 1998; Guzzo & Hayford, 2020; van de Kaa, 1987), have altered traditional family structures and parental roles. More recently, these trends have been reinforced by social policy reforms that strengthened incentives for early maternal employment and expanded access to early childhood education and care (ECEC) institutions – shifting from a traditional family-centered model towards a more institutionalized system. For example, employment of mothers with one-year-olds rose from 30% to 46% within about 20 years (Statistisches Bundesamt, 2023a).

Against this background, children's early learning environments are increasingly shaped by the rise and nature of dual-earner families and its consequences. Mothers need to navigate work and childcare responsibilities, increasing time pressure and work-family conflict (e.g., Bastian & Lochner, 2022; Cho et al., 2024; Luhr et al., 2022). Particularly during infancy, mothers have to juggle the challenges of organizing childcare, household chores, and the demands of advancing their professional careers (Panova et al., 2017). This intense phase is often referred to as *rush hour of life* in Germany. The arising challenges are especially pronounced for mothers, who face higher pressure to reconcile work and family life for a longer time span (Panova et al., 2017), which diversifies mothers' life courses regarding the variation in timing of childbirth, employment trajectories, and occupational profiles. These developments have altered the range of resources, constraints, and opportunities that reshape how families organize childcare and, thus, affect children's early environments. As a result, children today grow up in increasingly diverse constellations of childcare arrangements, maternal employment, and other maternal resources, *raising important questions about how these changing conditions contribute to differences in maternal characteristics and early heterogeneities in learning environments and, thus, result in disparate developmental outcomes.*

Given that these societal developments are closely intertwined with family life, investigating their consequences for *early* inequalities in child development is of central scientific and societal

importance. This dissertation primarily focuses on infancy and early childhood as life stages when children’s competencies are most malleable and especially sensitive to environmental influences (e.g., Cunha & Heckman, 2010; Currie & Almond, 2011; Guralnick, 2011), while also addressing subsequent developmental stages (see Figure I.1). Since institutional settings often do not gain relevance until age two or older, the family remains the primary influence during a child’s most formative first years. As such, it constitutes the critical *starting point* of social stratification affected by mothers’ socio-economic status (SES). A large literature demonstrates that family background fundamentally structures children’s cognitive and non-cognitive skills, health, well-being, academic achievement, and later career prospects, among many others relevant outcomes (e.g., Cattani et al., 2024; Grüning Parache et al., 2024; D. Lee & Jackson, 2017; Letourneau et al., 2013; Manning et al., 2014; McAuley & Layte, 2012; Mönkediek et al., 2023; Skopek & Passaretta, 2021; Tompsett & Knoester, 2023; Vidal et al., 2020). These early differences can have long-term implications through mechanisms of cumulative disadvantage (Cunha & Heckman, 2010; DiPrete & Eirich, 2006). Consequently, early inequalities clearly translate into persistent and systematic social and economic disparities over the life course.

Such systematic inequalities stand in direct contradiction to the meritocratic ideal of equal educational opportunity, highlighting the urgency of a deeper understanding of relevant determinants that generate early disparities to adequately design effective social policy. Evidence from intervention studies consistently shows that policies targeting early childhood are most effective in promoting child development and yield the highest economic returns compared to interventions at older ages (e.g., Campbell et al., 2012; Fritschi & Oesch, 2008; García et al., 2021; Guralnick, 2011). Shifting the focus towards the integration of ongoing societal trends that shape early childhood conditions is, therefore, key to understand contemporary inequality dynamics. Although the literature on early child development is extensive, important gaps remain regarding how changing institutional contexts in Germany interact with family dynamics to produce heterogeneous child outcomes. The following subchapter addresses the remaining gaps in detail.

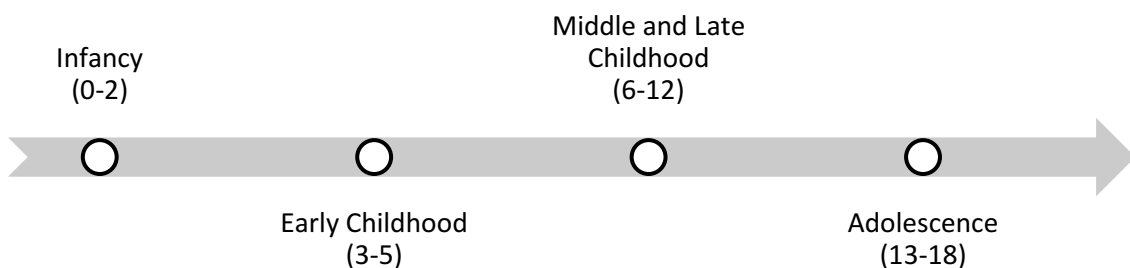


Figure I.1: Key Phases of Childhood

Note: Author’s own categorization adapted from Erikson’s (1974) stages of psychosocial development.

1.1 Previous Literature and Research Gaps

Focusing on the three most important developments for family environments, addressing increased maternal employment, external childcare usage¹, and older maternal age at birth, the literature seems large, but several key aspects are still underexamined. Firstly, the relevance of maternal employment for child development has been assessed in many facets. While some studies reveal a negative impact of early maternal employment, these detrimental implications are rather small and restricted to the first year after childbirth (Baum, 2003; L. Berger et al., 2008; Brooks-Gunn et al., 2010; Hill et al., 2005; Kopp et al., 2024; Lombardi, 2023). However, employment at later child life-course stages can benefit children. Depending on the exact workplace characteristics, mothers working in jobs experiencing higher-quality in terms of job security, stability, autonomy, and schedule control often benefit children's cognitive and non-cognitive development (e.g., Johnson et al., 2012; Lombardi McPherran & Coley, 2013; Pilarz, 2021; Pilkauskas et al., 2018; Schneider & Harknett, 2022; Walther & Pilarz, 2024). Particularly family-friendly workplaces that offer higher degrees of flexibility and family support can unfold a positive impact on both mother and the child (Bächmann & Frodermann, 2020; Carstensen, 2020; Guedes et al., 2023; Herman & Perry-Jenkins, 2020; Hotz et al., 2018; Lauber & Storck, 2019; S. Lee et al., 2019; McCredie et al., 2025). In contrast, longer working hours and non-standard schedules, which more likely occur among lower SES groups (e.g., Gracia et al., 2021), can conflict with childcare and parental time for their children (e.g., Luhr et al., 2022; Pilarz & Awkward-Rich, 2024), resulting in negative associations with child development (Dunifon et al., 2013; Kopp et al., 2024; Li et al., 2014). The association between maternal workplaces and child outcomes are mostly mediated by enhanced maternal well-being, parenting time and quality with advantageous workplaces and vice versa (Bass et al., 2009; Cho et al., 2024; Hokke et al., 2024; Hook et al., 2022; Jaeseung Kim, 2020; McCredie et al., 2025; Roeters et al., 2012; Tammelin et al., 2017).

While research extensively covers how maternal employment fosters child development through rather structural quality aspects of employment that transmit into improved home environments, the more content-specific role of occupations, such as job demands and work-related skill acquisition, remains under-researched in the context of intergenerational transmission of inequalities. The literature acknowledges the relevance of general maternal skills, showing direct links between mother and child competencies (e.g., Attanasio et al., 2024; Hanushek et al., 2022). But with regard to mother's occupational skill endowment, to date, only two studies have investigated how occupational inequalities impact child development, showing small but significant relations (Barg & Klein, 2024; García-Sierra, 2025). However, these studies rely on limited measures that cannot grasp the full complexity of both child development and occupational skill sets. *By overlooking these specific micro-*

¹ The term "external childcare" refers to any kind of non-parental childcare, i.e., *formal* and *informal* childcare. If not stated differently, formal childcare is understood as paid care provided in professional facilities (ECEC) or by childminders (*Tagesmütter*) in home settings. Informal childcare includes other paid private childminders like nannies and au-pairs, which are more in line with international perspectives on childminders, as well as members of the extended family, friends, or other social contacts, who can be paid or not.

processes and their mechanisms, the current literature fails to capture how a mother's professional development directly transmit to child development the promotional potential of the home learning environment, leaving significant gaps in the understanding of these mechanisms, particularly for the German context (see Chapter IV).

Secondly, when mothers return to employment, the impact on children extends beyond their own professional sphere – it inevitably reshapes the child's daily life and routines by necessitating the outsourcing of care. A large body of research examines the short-term effects of childcare attendance on cognitive and non-cognitive child outcomes. Yet, findings remain mixed, even when focusing on studies using advanced and quasi-experimental research designs that provide more likely causal effects. Much of the research shows beneficial effects of earlier childcare enrolment or longer childcare attendance on cognitive child outcomes – most often literacy and numeracy – across Europe (Almås et al., 2026; L. M. Berger et al., 2026; Cebolla-Boado et al., 2017; Drange & Havnes, 2019; Felfe & Lalive, 2018; Felfe et al., 2015; Fort et al., 2020; Gørtz et al., 2024; Kühnle & Oberfichtner, 2020; Peter et al., 2016), the US (Ansari et al., 2019; Atteberry et al., 2019; Dearing et al., 2009; Hustedt et al., 2021; Lamy et al., 2005; McCormick et al., 2021; Ou et al., 2019; Watts et al., 2023; Zachrisson et al., 2024), and other contexts (e.g., Bojorque et al., 2018; S. Chen et al., 2022; Cortázar, 2015; Sun et al., 2018). However, evidence remains mixed, as several studies find no significant impact (Garon-Carrier & Bégin, 2021; Jaffee et al., 2011; Miller & Bassok, 2019), or results vary by the specific developmental or educational outcome analyzed (Ansari et al., 2019; L. M. Berger et al., 2021; Fort et al., 2020). Particularly for non-cognitive child outcomes, the evidence is smaller and even more inconsistent in demonstrating beneficial effects (Dearing et al., 2009; Ou et al., 2019; Peter et al., 2016; Rey-Guerra et al., 2023). Accordingly, an evolving literature investigates the nature of child skills promoted by ECEC attendance, as *constrained skills* have a defined ceiling and children often master them regardless of promotion and therefore might yield less impact on child development (Abenavoli, 2019; Ansari et al., 2020; Burchinal et al., 2022; Dietrichson et al., 2026; McCormick et al., 2021). These affect cognitive skills, like alphabet knowledge, or non-cognitive competencies, e.g., procedural knowledge on correct behavior in a morning seating circle in childcare. However, despite the inconsistent findings regarding global effects of childcare, a consistent pattern emerges in showing benefits for socioeconomically disadvantaged children (Blau, 2021; Ghirardi et al., 2023; Ghirardi & Gioachin, 2025; Kulic et al., 2019; Schmutz, 2024).

Another possibility to identify whether beneficial ECEC impacts are long-lasting, is to focus on long-term outcomes like educational attainment, that should be impacted by child skills without the arising problems of skill measurement. Long-term studies are, however, driven by the US and similar childcare contexts, mainly investigating small-scale programs targeted at disadvantaged children, often from for-profit providers (e.g., Bustamante et al., 2022; Campbell et al., 2012; Gray-Lobe et al., 2023; Molina Millán et al., 2020; Schweinhart, 2013; Schweinhart et al., 2005). These regimes strongly differ from the universal childcare by non-profit providers in Germany, limiting transferability of findings. The

small literature from Europe better applies to the German context, revealing a positive relation between childcare attendance and adult social skills, educational attainment, and employment, despite remaining institutional differences (e.g., Fessler & Schneebaum, 2019; Silliman & Mäkinen, 2026). For Germany in particular, only few studies address short- or medium-term outcomes with mixed evidence (Cornelissen et al., 2018; Dustmann et al., 2013; Felfe & Lalive, 2010, 2013, 2018; Fritschi & Oesch, 2008; Kratzmann & Schneider, 2009; Kühnle & Oberfichtner, 2020; Landoigt et al., 2007; Seyda, 2009), leaving the long-term effects of childcare on educational attainment largely underexplored. *Therefore, further research from Germany is crucial to shed light on the context-specific role of universal ECEC for long-term consequences of children to improve the understanding of how early childcare shapes educational trajectories over the life course* (see Chapter III).

Bringing together the two main societal developments in the domains of risen maternal employment and ECEC utilization, their joint long-term development over time is underexamined, as existing studies often examine these domains in isolation. The positive relationship between formal childcare supply and maternal employment is well-established, demonstrating higher employment levels and shorter employment interruptions with greater supply (e.g., Bauernschuster & Schlotter, 2015; Boll & Lagemann, 2019; Bousselin, 2022; Dujardin et al., 2018; Fauser et al., 2025; Ferragina & Magalini, 2023; Müller & Wrohlich, 2020; Neimanns, 2021; Thil et al., 2023; Zoch, 2020). However, life courses are not linear and decisions on employment and childcare are most likely ongoing processes that are continuously adapted according to maternal needs, e.g., with regard to working hours or childcare arrangement. Both domains are mutual dependent, as childcare is a prerequisite for employment, while professional activity is often a formal requirement for securing a childcare slot (Steinberg et al., 2024). When inactive, mothers may have to rely on informal childcare that often have lower access barriers, although the use is more and more crowded out by formal supply (Thil et al., 2023). In this context, the literature neglects the relevance of the multiple evolving childcare arrangements for employment (e.g., Cabello-Hutt, 2020; Firat et al., 2023; Killewald & Zhuo, 2019), with few exceptions (Shattuck, 2022; Steinberg, 2025). *Thus, the interplay of these two domains is not as simple as currently indicated by the unidirectional literature and warrants a joint examination to capture the mutual, ongoing development of maternal employment and childcare trajectories* (see Chapter II).

Finally, the third major social trend is the postponement of childbirth, resulting in a higher maternal age at birth and potential consequences for child development. From a medical perspective, disadvantages of advanced maternal age are well documented: declining maternal health reduces fertility, while risks of fetal loss, delivery complications like cesarean sections, low birth weight, genetic mutations, child morbidity, and other child health conditions increase (Attali & Yogev, 2021; Ratiu et al., 2023; Su et al., 2025). Conversely, social science presents a more ambiguous picture demonstrating possible beneficial implications with older age, lacking clarity on the mechanisms and that lead to advantageous effects. Opposing the medical evidence, US-driven literature on unintended teenage motherhood emphasizes the detrimental effects of early childbearing (e.g., Gorro, 2023) and suggests

advantages of older maternal age for children's cognitive and non-cognitive skills (Duncan et al., 2018; Fishman & Min, 2018; Goisis et al., 2017; Trillingsgaard & Sommer, 2018; Yu & Yan, 2022) as well as educational attainment (Addo et al., 2016; Kalmijn & Kraaykamp, 2005). However, other studies find limited or even negative impact of maternal age once family background is controlled (Alvik, 2014; Augustine et al., 2015; Barclay & Myrskylä, 2016; Fredriksson et al., 2022; Goisis et al., 2017; Grätz, 2018; Torres, 2015). Overall, evidence remains mixed without clear understanding of the mechanisms underlying this complex biological and social interplay. Only few studies explicitly elaborate on these mechanisms (Duncan et al., 2018; Yu & Yan, 2022), often with limited consideration of children's early learning environments. Moreover, empirical research is frequently constrained by small samples of older mothers, and particularly for Germany the evidence is scarce and inconclusive (Grätz, 2018; Grätz & Wiborg, 2024), despite the intense trend toward advanced maternal age (Eurostat, 2026). *Given these inconsistent empirical findings and limited insights into relevant mechanisms, it remains unclear whether and through which channels advanced maternal age affects child development in Germany, warranting further research* (see Chapter V).

1.2 The Present Dissertation

The present dissertation addresses these gaps by adopting an integrated perspective on infancy and childhood that brings together maternal characteristics, learning environments, and child development in a unifying framework. It examines from a new perspective the most crucial changes in families' life that underwent major societal change: increased maternal employment, rising usage of external childcare, and advanced maternal age at birth. From birth onwards, these trends potentially shape children's learning environments, which also depend on mothers' decisions driven by their SES. I thereby focus on infancy and early childhood, the most consequential stages where social inequalities become embedded and reproduced (Cunha & Heckman, 2010; Currie & Almond, 2011).

Against this background, the overarching research question guiding this dissertation is: **How do maternal characteristics and early learning environments contribute to early heterogeneities in children's developmental outcomes in Germany?** This overarching research question can be divided into four separate parts in accordance to Figure I.2: The dissertation sets its ground by asking (a) *How do maternal characteristics, i.e., employment, occupational skills, and life-course timing, shape early heterogeneities in home and institutional learning environments?* Then it precedes asking (b) *how do home and institutional learning environments shape child development?* The third part of the research question investigates (c) *how maternal characteristics, i.e., employment, occupational skills, and life-course timing, shape child development?* This research question is examined in more detail by additionally asking (d) *to which extent the relationship between maternal characteristics and child development is mediated by learning environments?*

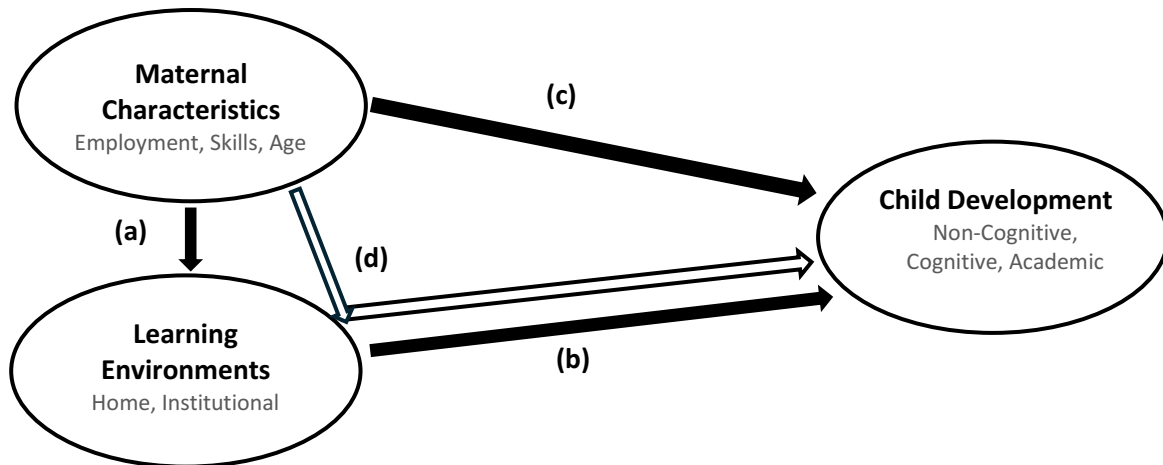


Figure I.2: Schematic Representation of the Overarching Research Questions and their Subdimensions

Note: Own Illustration.

To answer these questions, this dissertation takes on an interdisciplinary perspective regarding theory and empiricism by integrating theoretical considerations from sociology, economics, and developmental psychology. While there exists a large multidisciplinary research that investigates the subjects of mothers, learning environments, and child development, several key gaps remain in the literature, where the present dissertation contributes. The first study descriptively examines the simultaneous interplay of maternal employment trajectories and childcare histories and identifies typical patterns to provide a solid foundation of the emerging patterns across Germany and their socioeconomic drivers (Chapter I/4.1 and II). Therefore, it contributes to research question (a) on how maternal employment shapes early heterogeneities through decisions about learning environments of alternative caregivers. The second study complements this perspective by focusing more specifically on institutional childcare between ages three and six to assess the causal long-term effects of longer ECEC attendance on children's educational attainment by using an instrumental variable approach (Chapter I/4.2 and III). Thereby, research question (b) is addressed on how institutional learning environments affect child development. The remaining two studies contribute to answering research question (c) and (d). The third study examines (c) how maternal occupational skills affect children's cognitive and non-cognitive development and thereby (d) explicitly investigates the role of home learning environments (Chapter IV). The final study 4 takes a different perspective by focusing on the implications of (c) advanced maternal age at birth and its consequences for child development. Against the background of postponed family formation, this study contributes to understanding (d) how older age at birth accounts for differences in early learning environments and, thus, for heterogeneities in child development (see Chapter I/4.4 and V). By combining evidence from four empirical studies, this dissertation moves beyond single-factor explanations and instead conceptualizes early childhood as a multidimensional process shaped by both family strategies and institutional structures. In doing so, this dissertation contributes to a more nuanced understanding of how early inequalities in child development emerge and persist in contemporary society.

All four studies rely on high-quality German data, i.e. the Germany National Educational Panel Study (NEPS), whose richness contributes to this dissertation. The majority of analyses rely on the NEPS Newborn Starting Cohort (SC1), which surveyed infants and their mothers from shortly after birth onward. Therefore, this data offers exceptional depth on maternal characteristics, family dynamics, learning environments, and developmental outcomes across multiple stages of infancy and early childhood – enabling the detailed analysis of the emergence of inequalities. The early sampling is particularly valuable, as it allows for the joint examination of maternal employment and childcare histories from birth to preschool age in a longitudinal, trajectory-based perspective with high precision on care and work arrangements, that has been largely absent in previous research (Chapter II). Moreover, the utilization of recent cohorts ensures that the results reflect contemporary societal developments in maternal employment, childcare usage, and delayed family formation, improving upon studies based on older data, where present trends are underrepresented (e.g., Duncan et al., 2018) (Chapters IV and V). Two studies (Chapters II and IV) further benefit from unique linkages to administrative employment records from social security, providing a highly precise and accurate information. Lastly, study 2 draws on NEPS SC3 and SC4, which surveyed fifth- and ninth-graders and mainly their mothers, resulting in the only German data that includes detailed information on ECEC attendance as well as the actual educational attainment, allowing for an exclusive investigation of their causal relationship (Chapter III).

The remainder of this dissertation is structured as follows: Chapter I introduces the subject of this thesis and the next subchapter briefly rationalizes the focus on mothers despite the relevance of fathers in children's lives (Chapter I/1.3). The life-course framework provides the conceptual guidance, while discussing the most relevant institutional settings in Germany (Chapter I/2). Chapter I/3 covers major theoretical concepts regarding maternal decisions, child human capital accumulation, and learning environments at home and in external care settings, while reflecting on socio-economic differences. Before detailing the empirical studies, I briefly summarize them and point out their contributions (Chapter I/4). The empirical Chapters II to V present the individual articles of the cumulative dissertation, each including a review of relevant literature, theoretical considerations, analysis strategy, methodological framework, empirical findings, and a detailed discussion. Finally, Chapter VI provides a concluding summary, critically discusses the main results and their limitations, outlines promising avenues for future research and the social policy implications of this thesis.

1.3 What About Fathers?

One of the most pertinent questions that arises when studying the role of mothers for child development seems to be, ironically, the question about the role of fathers. In recent decades, trends towards an active fatherhood have emerged, that impose fathers with a higher degree of commitment and responsibility in their children's lives (e.g., Joshi, 2021; Zerle-Elsäßer & Li, 2017). Additionally, fathers are subject to similar trends like mothers, e.g., postponed family formation, although with

sometimes different implications, such as in terms of employment. The trend of postponed family formation affects paternal ages at childbirth in similar ways, as they get increasingly older at time of birth. This development is reflected in similar negative health- and behavior-related consequences (Couture et al., 2021; Lysons & Jadv, 2023; Myrskylä et al., 2014; Wan et al., 2024; Willführ & Klüsener, 2024), and beneficial cognitive outcomes for children (Gajos & Beaver, 2017; Veldkamp et al., 2021).

Moreover, while mothers increased their employment, the opposite is true for fathers, who increasingly take more parental leave, even for longer durations (Frodermann et al., 2023), despite anticipated negative career consequences due to employment interruption and stigma (Samtleben et al., 2019). This not only contributes to a more equal division of paid and unpaid work within the family, as men progressively increase their engagement in unpaid work (Kan et al., 2022; Schober & Zoch, 2019; O. Sullivan et al., 2018; Tamm, 2019), but also benefits paternal time with children, potentially providing distinct developmental benefits. A close father-child relationship as well as joint educational activities can benefit child competencies (e.g., Cano et al., 2019; Ding & Leung, 2025). Research suggests that fathers often have gendered personal interests that differ from mothers, which is, for example, reflected in higher paternal math self-efficacy (Feige et al., 2025; Mues et al., 2022). When fathers prioritize math skills, they perform more math-related activities, thus, fostering children's numeracy competencies (Mues et al., 2022). However, in direct comparison to mothers, some studies attribute father's time with their children a lower relevance for child development (Hook et al., 2022).

Moreover, fathers contribute to the family's resource endowment (e.g., Morelli et al., 2022). The *modernized male breadwinner model* is prevailing in many European countries, where fathers remain to be the primary earner and mothers supplementing family income through part-time employment (e.g., Berghammer, 2014). These patterns shape household financial resources, and, in turn, parenting and children's learning environments, which are sensitive to income fluctuations and financial hardship (Ponnet, 2014; Votruba-Drzal, 2003). Nevertheless, employment can cause work-family conflict for fathers, too, potentially reducing paternal parenting quality (Cooklin et al., 2016).

Despite the increasingly egalitarian developments between mothers and fathers that emphasize the importance of fathers in children's lives, this dissertation focuses on mothers' role for child development. Mothers not only remain to be the primary caregiver, particularly during infancy, and carry the main burden and mental load of reconciling employment and family life in Germany (Dean et al., 2022; Felfe, 2012; Haupt & Gelbgiser, 2024; Hobler et al., 2017; OECD, 2016; Zoch & Heyne, 2023), but who are also affected most by ongoing trends and family formation. For biological reasons, mothers are facing the health consequences after childbirth (e.g., Ratiu et al., 2023) and are more strongly tied to the home environment, particularly during their longer parental leave spells (Frodermann et al., 2023). After return into employment, maternal trajectories are more likely affected by parenthood, as mothers adjust their employment to part-time and more flexible, family-friendly work arrangements to reconcile work with childcare (Bächmann & Frodermann, 2020; Berniell et al.,

2025; Hook & Pettit, 2016; Messenger, 2018; OECD, 2022; Vargha, 2025). Some evidence points out that this kind of sorting already happens prior to childbirth (Coskun et al., 2026). In contrast, fathers follow quite stable employment trajectories (Biemann et al., 2012; McMunn et al., 2015; Reichert et al., 2024; Struffolino et al., 2016) and are generally less affected by transitions into parenthood (Dechant et al., 2014; Kühhirt, 2012). Overall, mothers spend more time with their children compared to fathers (Connelly & Kimmel, 2015; Gracia & Esping-Andersen, 2015; Kan et al., 2022; Pailhé et al., 2021; O. Sullivan et al., 2018), and are still expected to be the main caregiver (BMFSFJ, 2020; Zoch & Heyne, 2023), making their lives – including their employment activities – more closely intertwined with children’s lives. Moreover, data on fathers is scarce, particularly in the context of this thesis, limiting the possibilities of paternal research. Despite the long tradition of research on the role of mothers, compared to the rather recently evolving field of research on fathers, there is still limited understanding of the processes that contribute to disparities in early child development. Thus, this thesis focuses on mothers’ characteristics and their roles in shaping early child learning environments.

2. Background – Conception of Life Courses and Institutions

The life course framework (Elder et al., 2003; K. U. Mayer, 2004) provides the conceptual foundation for this dissertation, investigating the role of mothers for child development. Rather than point-in-time evaluations, this framework emphasizes a comprehensive trajectory-based perspective, where individuals are rooted in social structures that order their life courses. Trajectories are embedded in life courses and describe the duration and timing of specific states, contrasting transitions from one role to another, e.g., motherhood, employment changes, or childcare enrolment. These life courses are *self-referential processes* that are affected by past trajectories, while also shaping future ones (K. U. Mayer, 2004). In the following, I elaborate on the principles that shape life courses.

The central *linked-lives* principle (Elder et al., 2003) stresses the interdependence of life trajectories within the family. Mothers’ life decisions directly shape their children’s lives. For example, when mothers decide to postpone a further pregnancy, it affects maternal time resources, as mothers can exclusively focus on the one child. Similarly, mothers remaining longer in parental leave, will most likely use external childcare later. Thus, their trajectories are mutually dependent. Although this dissertation focuses on the linked lives of mother and child, other linked lives emerge in childhood that potentially affect both. For example, when parents are cohabiting, fathers are present and affect family life: more supportive partners have been shown to enable mothers to pursue employment earlier, leading simultaneously to earlier external childcare for the child (e.g., Ingenfeld, 2021; also see Chapter I/1.3). Likewise, when grandparents live nearby and are retired, they can support mothers’ employment by providing childcare (Barschkett et al., 2022; Seilbeck & Langmeyer, 2018). This example illustrates triple linked lives, as grandparental care additionally affects children’s learning environments that likely differ from the one mothers provide.

Similarly, life courses are *multidimensional* (K. U. Mayer, 2004), as they are composed of different life domains, such as nuclear and extended family, social networks, employment, education, and external childcare, which are also mutually interdependent. Often, life domains compete with each other for time or other resources and pose challenges on mothers to reconcile them (K. U. Mayer, 2004). For example, after childbearing, mothers require a withdrawal from the labor market or accessible non-parental childcare, as working and caregiving at the same time is not feasible. In this context, resources compete with each other, given that, depending on maternal income, childcare might be more costly compared to formal care.

Moreover, life courses are *multilevel processes* (K. U. Mayer, 2004), where macro-level structures, e.g., historical, cultural, social, and institutional, directly influence behavior and norms on the micro-level that shape standardized biographies (referred to as "times and places" by Elder et al. (2003)). Evidence suggests that social policy frameworks supporting families and gender equity on the macro level significantly increase individual egalitarian beliefs and gender ideologies (Edlund & Öun, 2023; Lomazzi et al., 2019; Schober & Zoch, 2019; Zoch & Schober, 2018). In Germany, recent reforms of the welfare regime have targeted gender equality by promoting maternal employment through facilitated work-family reconciliation, fundamentally altering family structures. While mothers are still entitled with employment-protected unpaid parental leave for up to three years, its 2007 reform replaced long-term, low-payment parental leave with a 14 month model providing up to 67% of previous income. As a result, most mothers now utilize 12 months of leave and fathers take the remaining two (Frodermann et al., 2023). Such shifts mirror evolving normative perceptions of feasible options, as prior to the reform, fathers rarely utilized parental leave. However, it has since become increasingly normalized, thereby supporting earlier returns of mothers to employment (Frodermann et al., 2023).

Moreover, the institutional and cultural state regimes at the macro level profoundly shape prevailing norms and views on the micro level. This influence is particularly evident in the historically persistent disparities between West and East Germany, where the former division established diverging gender roles. In East Germany, more egalitarian views with stronger female labor market attachment have prevailed, while maternal employment in the West has been traditionally low. In combination with the persistent joint taxation of spouses, current regulations continue to incentivize the *modernized male breadwinner model* especially in the West, where mothers remain to be mainly part-time working secondary-earners (e.g., Aisenbrey et al., 2009; Bauernschuster & Rainer, 2012; Bozoyan & Schmiedeberg, 2024; Simonson et al., 2011; Statistisches Bundesamt, 2023b; Zoch, 2021). Although these norms are not static and recent years have seen some convergence, regional differences continue to shape individual life paths accordingly (Fauser et al., 2025).

In addition, legal entitlements for institutional childcare have shifted both opportunity structures and social norms. These regulations not only facilitate access to low-cost childcare and mother's earlier return to employment (e.g., Bauernschuster & Schlotter, 2015; Boll & Lagemann, 2019; Huber &

Rolvering; Müller & Wrohlich, 2020; OECD, 2023; Zoch, 2020), they potentially redefine "adequate" behavior through internalized structures. For example, following the 1996 entitlement to *Kindergarten* for three-year-olds, the average enrollment age dropped from four to three (Cornelissen et al., 2018; see Chapter III), indicating a shift in maternal preferences. Similarly, the rising usage of childcare for one-year-olds since the 2013 reform suggests again a greater acceptance of earlier ECEC enrollment (Statistisches Bundesamt, 2022). Such shifts emphasize that individuals can contribute to changing structures (K. U. Mayer, 2004), as mothers increasingly internalize these newly defined institutional benchmarks. However, the progress from social policy reforms and individual efforts to change the structure is hindered and can reinforce the status quo (Bujard & Lück, 2015; K. U. Mayer, 2004; Steinberg, 2025) when maternal needs are unmet by institutional structures, such as the ongoing shortages in full-day childcare supply (e.g., BMFSFJ, 2023). Moreover, mothers still have their personal preferences that might stand in contrast to societal perspectives. For example, norms about *intensive mothering* emphasize the importance of prioritizing children's needs, which are ideally fulfilled by mothers (Hays, 1996). These mothers likely favor family-provided childcare in contrast to institutional care (e.g., Jappens & van Bavel, 2012), thereby affecting the life courses of both mother and child regardless of macro-level structures (see Chapter II for more details on mothering ideals).

The principle of *timing* (Elder et al., 2003) highlights that identical transitions over the life course are assessed differently. Prior to the demographic shift, postponed family formation was less common and associated with rather detrimental maternal characteristics, whereas nowadays postponed motherhood has become well-established and normalized, particularly among higher-educated women (e.g., Goisis et al., 2017; see Chapter V). This fertility timing can also have important implications for mothers' career trajectories, personal skill acquisition, and overall *life-span development* – a principle positing that individuals undergo constant development (Elder et al., 2003). Women who become mothers early-on in their lives have less time to finalize their education and to establish a career, which can have long-term consequences for their resource endowment (Doepke et al., 2022; Fulco et al., 2020; Kaplan et al., 2004). Although many studies show that the consequences of teenage motherhood are rather short-lived (e.g., Hotz et al., 2005; Kalil & Kunz, 2002; Kaplan et al., 2004), the evidence is very consistent regarding the detrimental effects of childbirth for mothers' careers: mothers' depreciation of skills and qualification, discrimination due to feared incompatibility between motherhood and work performance, and, most importantly, the lower wages and occupational status caused by employment interruptions (Abendroth et al., 2014; Adda et al., 2017; Cukrowska-Torzewska & Matysiak, 2020; Ishizuka, 2021; Jones et al., 2023; Mari & Cutuli, 2021). It stands to reason that the impact of employment interruptions are more severe for less progressed early careers and can divert entire career trajectories. Thus, they can lead to a process of cumulative disadvantage for mothers' life-span development (Cunha & Heckman, 2010; see Chapter I/3.1.3), demonstrating the relevance of timing. However, stressing the linked lives principle again, shorter employment interruptions are beneficial for maternal careers, but the literature suggests possible

negative impacts on child development when mothers return too early (e.g., Brooks-Gunn et al., 2010; Lombardi, 2023).

Accordingly, maternal decisions also affect the life-course *timing* of their children, contributing to *life-span child development* (Elder et al., 2003). Given that mothers generally place highest value on parental care when children are youngest (Mincer & Polachek, 1974), non-parental childcare is rather rare during the first year. Afterwards, about 36% of children between the ages of one and three are in formal childcare in Germany, with larger regional differences showing 32% usage in West Germany and 53% in the East Germany; see Chapter II and III). The timing of childcare enrolment shapes children's learning environments (see Chapter I/3.2.4) and subsequent child development (see Chapter I/3.1.3). Previous literature indicates that earlier enrolment into formal childcare benefits child development more strongly due to cumulative advantages of beneficial learning environments, given that quality is high (e.g., Campbell et al., 2012; García et al., 2021). This necessity was addressed by the German 2019 *Childcare Quality Act* ("Gute-KiTa-Gesetz") that aims to enhance childcare quality with possible long-term implications for child development. Recent evaluations already demonstrate improvements in structural quality following this legislation (Fackler et al., 2024). Higher quality also increases maternal confidence and willingness to utilize formal care. Moreover, maternal fertility timing has also been shown to affect life-span development of children: motherhood during teenage years can have negative consequences for child development, whereas later timing of family formation often reveals benefits for children (see Chapter I/3.2.3 and V).

Overall, the life-course approach demonstrates that life courses are socially pre-structured and affected by the presented principles. Nevertheless, mothers can actively shape life courses through *human agency* (Elder et al., 2003), as individuals have decision-making power and are able to defy pre-structured life paths. However, as the life-course framework remains open about how such decisions are made, I provide further theoretical perspectives on agency in the following chapters, particularly focusing on the nature of maternal decision-making, socioeconomic disparities in these processes, and the resulting learning environments that affect child development.

3. Theory

The theoretical considerations in this chapter aim at explaining how maternal characteristics and early learning environments contribute to child development. Therefore, this thesis considers the drivers of maternal decision-making by presenting the Rational Choice (RC) framework (G. S. Becker, 1990; Esser, 1991; Fishburn, 1981; Opp, 1999). I provide a baseline schematic rationality for maternal considerations behind decision-making processes in family contexts, including parenting investments, mode of childcare, educational decisions, duration of employment interruptions, and many more maternal choices that potentially shape child development (Chapter I/3.1.1). With the frameworks of Boudon (1974) and the status attainment model (Breen & Goldthorpe, 1997), I further discuss the

importance of the socioeconomic background of the family in shaping these smaller, early educational decisions (see Chapter I/3.1.2). These finally affect child development (Bourdieu, 1983, 1987; Cunha & Heckman, 2010), i.e., children’s human capital composition, which is elaborated in Chapter I/3.1.3. Chapter I/3.2 continues to demonstrate how learning environments during infancy and early childhood depend on mothers decisions. To theoretically explain the constitution of a beneficial home learning environment and its characteristics, I elaborate on the parent socialization model in Chapter I/3.2.1 and define criteria of high-quality home learning environments in Chapter I/3.2.2, which often depends on the socioeconomic background of the child (Chapter I/3.2.3). Lastly, in Chapter 3.2.4, I shed light on how external learning environments, e.g., in institutional childcare or grandparents, potentially affect child development.

3.1 Maternal Decisions and Child Development

Mothers decisions not only affect their very own lives but also impact how the lives of their children are characterized and shaped, attributing them a “gatekeeper” position regarding their child’s development. Therefore, this thesis constitutes an interesting case, as it investigates – one may call following the linked lives principle (Elder et al., 2003) – *linked rational choices*, where mothers have to weigh the options carefully to realize her own interests but also the child’s. While “big life decisions” are regularly discussed in the light of rational choices (e.g., Doepke et al., 2022), smaller decisions that potentially affect child development, such as joint family meals, home activities, and what book to read to child, play a minor role in the RC literature. Given the empirically proven relevance of these smaller decisions for child development (Hoyne & Egan, 2022; Lucendo-Noriega et al., 2026; Selman & Dilworth-Bart, 2024), this thesis considers both. The following subchapter briefly introduces a rather technical perspective of maternal decision-making, before addressing the socioeconomic disparities in these choices and their impact on child development.

3.1.1 The Technicalities of Maternal Decisions

The RC theory is one of the most broadly used theories in social science to explain individuals actions and decisions on the micro-level (Braun, 2009; Wittek et al., 2013). While this theory is quite fragmented with stark differences in modeling and implementation among different fields (e.g., Akerlof & Kranton, 2000; G. S. Becker, 1990; J. S. Coleman, 1990; Fishburn, 1981; Lindenberg, 1990; Simon, 1990), this work will focus on unifying core assumptions that explain mother’s decisions and the consequences for their children to provide a heuristic framework (Wittek et al., 2013). Broadly speaking, RC theory states that individual decision-making is affected by given *costs* and the anticipated *utility* with the aim to *maximize net utility* (Diekmann & Voss, 2004; Opp, 1999). Based on these core assumptions, there exist multiple RC models stating additional assumptions and decision rules, which can explain or predict individual choices. Opp (1999) introduced a valuable differentiation between the abundant RC models: narrow and wide concepts. Narrow concepts refer to the more

classical approaches, where individuals are self-regarding, have full information on all action alternatives, and objective constraints are the core explanation for decision-making. Given that some of these assumptions are quite strict and sometimes even empirically rejected (e.g., Doepke & Zilibotti, 2017; Vyrastekova et al., 2014), the wider versions find greater empirical resonance: they loosen these strict assumptions, opening up the possibility of altruism and less cost-intensive decision-making, while also incorporating subjectively perceived costs and utility, as well as beliefs about the probability of occurrence (Opp, 1999). For the present work it seems promising to rely on broader versions: Given that it is not the aim of this work to actually test derived rational choice assumptions but rather to explain observed maternal behavior that affects their own lives as well as those of their children, the rational choice theory serves as a valuable heuristic (Diekmann & Voss, 2004).

The *Subjective Expected Utility* (SEU) theory (Fishburn, 1981; Savage, 1954) is a promising starting point to explain mother's decision-making and its consequences for child development. In line with wider versions, it integrates *subjective* perspectives compared to classical approaches emphasizing objectivity that is unlikely to exist, particularly in private family life. Technically speaking, SEU states under uncertainty the consequences of decision opportunities (O), with a utility function (U) of several alternatives of actions (A) and their *subjective* probability (p): $SEU(O) = p \cdot U(A)$ (Esser, 1991; Fishburn, 1981; Kroneberg, 2011). It further drops the notion of exclusive egoistic attitudes in favor of self-interested preferences, where mother's altruistically prioritize the child's welfare, maximizing mothers utility even though the act is not self-regarding (e.g., Doepke & Zilibotti, 2017; Gächter, 2013). However, the SEU assumes *perfect information* on a subjective level and *strict utility maximization* – conditions that rather belong to narrow versions. Perfect information implies that mothers consider *all* available options and their subjective probabilities to their respective consequences when, for example, deciding about the timing of family formation, necessary employment interruptions and children's childcare arrangements afterwards. In practice, this seems barely feasible, as individuals face cognitive limitations and mothers returning to work after childbirth typically consider only a limited subset of options, such as the ten nearest childcare centers, while remaining unaware of other feasible arrangements, such as moving closer to other childcare facilities. Such unreasonable assumptions have already been criticized by many scholars (e.g., Opp, 1999; Simon, 1990), stressing that the implementation of SEU only serves as an heuristic benchmark while using the decision rule of *bounded rationality* (Simon, 1990). The main arguments of bounded rationality are that individuals are not able to evaluate the endless alternatives for each decision, as this is a time-consuming and effortful process. The future is uncertain and dynamic, making it hard to forecast, particularly in family life. Thus, instead of implying full optimization, Simon (1979) postulates a more realistic *satisficing* strategy, where individuals chose a sufficiently satisfactory alternative that is "good enough" without exhaustive search for the objectively best, maximizing solution.

Overall, I assume that mothers have preferences with *subjective* probabilities in situations with uncertain action alternatives, in which they act self-interested to obtain a good enough utility. These

remarks form the basis for the following considerations on maternal decisions that affect children's life course development through early learning environments during infancy and early childhood.

3.1.2 Socioeconomic Disparities in Educational Decisions

Closely related to the RC theory, Boudon's (1974) theory explains how educational inequalities emerge through disparities in decision-making based on SES. Two important mechanisms are distinguished: primary and secondary effects.² (1) The primary effects describe disadvantages in children's actual educational performance that are rooted in the family's lower SES and develop through differences in socialization, i.e., a varying access to cultural and material resources during childhood.³ Jackson (2021) identifies the most relevant mechanisms that contribute to primary effects, i.e., educational institutions like childcare and schools, the home learning environment and its resources, as well as genetic dispositions, which differ in the extent to which mothers can shape them.

Educational institutions can improve child development, provided that their quality is high (e.g., Howard et al., 2024). Although mothers can often choose the institutions in which they enroll their children, they have limited influence on the quality of institutions and their curricula.⁴ On the one side, previous studies have demonstrated that mothers' ability to assess institutional quality is often limited (see Chapter I/3.2.4). On the other side, provision high-quality childcare and schools is rather rare, as quality levels in Germany are predominantly mediocre for both (B. Becker & Schober, 2017; Camehl et al., 2018; Dederich & Müller, 2011).

Therefore, mothers' main latitude to address primary effects lies in the home learning environment they create for their children, which is interpreted as a daily maternal decision on how to raise and foster the child. Higher-status mothers often provide a more intensive promotion of children's academic skills and show more beneficial parenting behavior (see Chapter I/3.2 for a detailed discussion of home learning environments). Similarly, although genetic dispositions lie beyond a mother's direct influence, an emerging literature demonstrates the relevance of genes, which

² A more recent extensions of Boudon's theory introduces *tertiary effects* that describe the independent role of educational institutions in perpetuating inequalities (Esser, 2016). Tertiary effects refer to institutional "filters", such as teacher assessments or track recommendations, that operate independently of a pupil's actual performance (Esser, 2016; Gresch, 2012). Tertiary effects often stem from educators' biased anticipations regarding a child's ability, expected parental involvement, and support (Blossfeld et al., 2015). The current literature frequently highlights how the family SES drives these institutional assessments instead of children's actual competencies (e.g., Helbig et al., 2026; Helbig & Morar, 2017; Malouff & Thorsteinsson, 2016; Olczyk et al., 2023; Perinetti Casoni & Barg, 2026). However, tertiary effects remain peripheral to the present thesis focusing on maternal decision-making and home-based socialization, as their impact originates within the institutional rather than the familial sphere. Nevertheless, I acknowledge them as a significant dimension of inequality.

³ The theories incorporate a whole-family perspective using parent-neutral language. While the original terminology is retained throughout this thesis, I specifically examine the role of mothers and adapt these parental frameworks to focus on them.

⁴ Free choice is possible for childcare institutions and secondary schooling, whereas primary school often have determined catchment areas.

constantly interact with environments: Families provide environments that match their genetic makeup (Plomin et al., 1977; Starr et al., 2024), which in turn affects the realization of a child's full genetic potential. These gene-environment interactions can exert their impact on child development via three pathways: (1) parental genes, which determine child genes, indirectly impact child development via parenting behavior; (2) child genes directly impact parenting behavior through which they affect child development; and (3) child genes directly shape child abilities and their skill development, also providing an isolated gene-effect (Cattan et al., 2024). The body of research shows that the implications of pure genetic dispositions are smaller compared to their joint interplay with environments, where strong correlations between advantageous genes and beneficial family characteristics and learning environments are demonstrated, and vice versa (Attanasio et al., 2025; Baier et al., 2022; Cattan et al., 2024; Nivard et al., 2024; Starr et al., 2024).⁵

In summary, primary effects emerge from the specific social contexts and structural constraints that lead to a different quality of home learning environments, rather than reflecting individual capability. Given that socially selective skill endowment of children before school age are identified very consistently across the literature (e.g., Anders et al., 2012; Black et al., 2017; Cattan et al., 2024; Cuartas, 2022; Schmitz et al., 2026), primary effects are a crucial mechanism in childhood to explain early disparities.

In contrast, (2) secondary effects are not solely dependent on child performance and refer to the socially stratified choices of families. Boudon (1974) employs an educational RC model, in line with previous wide assumptions (see Chapter I/3.1.1), that attaches greatest net utility of further education to high-SES families, making choices for further education more likely. These children face lower monetary and social costs due to larger financial resources and stronger familial support systems (Boudon, 1974). Thus, even when the absolute costs of educational decisions are identical, their relative size varies by SES, making further education less likely for low-status children (Kristen, 1999).

A key mechanism of secondary effects provides the status attainment model (Breen & Goldthorpe, 1997; Kahnemann & Tversky, 1979), which describes parental aims to maximize their children's chances of attaining at least the same SES or higher. While the role of family resources is already covered in Boudon's (1974) work, maternal *risk aversion* and child abilities offer additional insights.

⁵ The influence of genes has a long research tradition in sociology, also known under "nature or nurture" (Galton, 1874). Two main theoretical perspectives emerge in the literature: Supportive environments that provide stimulating learning opportunities, sensitive parenting, and routine (see Chapter I/3.2), can strengthen genetic effects because they create conditions in which inherited genetic differences support the translation of genetic predispositions into observable competencies (*Scarr-Rowe hypothesis*; Rowe et al., 1999; Scarr-Salapatek, 1971). In contrast, children in disadvantaged environments may need to rely more strongly on their genetic disposition when less resources are available, leading to a stronger potential impact of genes in unfavorable settings (*Saunders-hypothesis*; Saunders, 2010). Although much research supports the Scarr-Rowe hypothesis (Attanasio et al., 2025; Baier et al., 2022; Cattan et al., 2024; Nivard et al., 2024; Starr et al., 2024), some evidence favors the Saunders-hypothesis, showing stronger genetic impacts in constrained environments (Baier et al., 2022; M.-J. Lin, 2020). Given the data limitations of this thesis, genetic dispositions cannot be considered.

Accordingly, high-SES families are particularly risk-averse regarding social downward mobility. When their children fail to achieve the same status, the perceived costs of academic failure are significantly higher than for lower-SES peers. Consequently, high-status mothers necessarily prioritize educational success to avoid these costs and maintain their SES.

Moreover, *child abilities* can function as signal of innate abilities that increase maternal expectations about successful finalization of higher education, thus, making choices for education more likely. For example, Neugebauer (2010) demonstrates that high-SES parents choose higher education even when children's competencies are as low as those of lower-SES children. Driven by risk aversion, high-status mothers prioritize status maintenance over realistic achievement probabilities. They are more likely to overestimate success expectations, or choose higher education despite low chance of success, as their superior resources allow them to bear the financial and social risks of potential academic failure.

Although the status attainment model was traditionally developed to explain social inequalities in adolescent transitions in further education or the labor market, its mechanisms are likely already active from birth onwards. Thus, its core assumptions can be readily extended to earlier educational decisions of mothers. Nowadays, decisions on institutional childcare enrolment are seen as first educational decision in children's lives (e.g., Kratzmann & Schneider, 2009; Steinberg & Kleinert, 2022), functioning as *initial secondary effect*. In the context of ECEC, success expectations might seem negligible (e.g., Steinberg & Kleinert, 2022), since childcare lacks formal certification to validate educational success. However, I argue that mothers likely evaluate success expectations based on their ideological views – whether they perceive institutional childcare as beneficial or expect ECEC to “fail” fostering their child. Consequently, those who view ECEC as a valuable learning opportunity are more likely to enroll their children in institutional childcare (Jinseok Kim & Fram, 2009). This group typically comprises higher-educated, risk-averse mothers with less traditional views, who might strategically utilize institutional childcare to promote development, as they have been shown to proactively compensate for potential developmental disadvantages more strongly (Hsin, 2012). These assumptions rely on maternal anticipations of a successful settling-in phase in childcare, which might be shaped by perceptions of child skills and whether the child seems prepared for non-parental care – understood as similar principle to school readiness. Supporting this, Hondralis and Kleinert (2021) demonstrate that higher child abilities correlate with shorter employment interruptions, which inherently necessitates earlier external childcare. Moreover, besides status attainment considerations, the costs and utility of early institutional childcare are socially stratified and closely tied to structural contexts, maternal employment, and preferences (see Chapter I/3.2.4 and II for a deeper discussion).

Other examples of early educational decisions in their widest sense include extracurricular activities for young children, e.g., enrollment in baby swimming, gymnastics, or early musical education courses. Enrollment decisions in such courses are widely recognized as socially stratified and, according to the status attainment model (Breen & Goldthorpe, 1997), driven by mothers' risk aversion to downward

mobility and their expectations concerning the developmental benefits of these activities. Mothers will enroll their children only if they perceive these activities as beneficial. These perceptions can reflect diverging parenting styles in accordance to Lareau's (2011) theory, which emphasizes SES-disparities in both participation and perception of extracurricular activities (see Chapter I/3.2.3 for a deeper discussion of Lareau's parenting styles as part of the home learning environment). Depending on the specific activity, children will ultimately develop different skills (e.g., E. C. Allen et al., 2022; Carolan, 2018; Ding & Leung, 2025; Lucendo-Noriega et al., 2026; Xu et al., 2025). Although these early educational decisions may appear less relevant compared to higher education choices in adolescence, the relevance of these early choices lies in their potential cumulative impact: by fundamentally establishing early primary effects, they create a possible feedback loop that impacts later secondary effects through the socially selective development of child competencies.

This subchapter focused on the emergence of socially selective educational decisions and its drivers. To complement this perspective, the following subchapter conceptualizes child development through the lens of human capital theory from different disciplines for a deeper understanding of the process following educational decisions that contribute to child development.

3.1.3 Child Development as Human Capital Accumulation

When referring to child development, it describes the highly consequential and dynamic process of children's human capital accumulation during infancy and childhood. From a perspective of sociology and related fields, child development subsumes different aspects of child outcomes, e.g., innate abilities, learned skills, both cognitive or non-cognitive, as well as educational attainment.⁶ These outcomes are understood as the child's human capital, which depends on family investments. The following considerations will elaborate on different perspectives on human capital theory from the economic and sociological theories of Becker (1975) and Schultz (1961), Bourdieu (1983), as well as Cunha and Heckman (2010), that emphasize how maternal characteristics in terms of her resource endowment theoretically affects child development through investments.

The more economic perspective of the human capital theory primarily conceptualizes individual efforts to enhance knowledge and skills, via formal schooling or on-the-job training, as calculated investments aimed at maximizing productivity and lifetime earnings (G. S. Becker, 1975; Mincer, 1958; Schultz, 1961). Modern extensions further acknowledge that such investments can also yield significant non-monetary returns, including improved health, civic engagement, or enhanced parenting efficacy

⁶ Perspectives from other disciplines include psychological indicators of child development, such as the development of executive function, attachment, self-regulation, or personality; whereas medical and biological indicators include prenatal fetus development, birthweight, brain maturation and plasticity, or physical and mental health. Many indicators demonstrate the blurred boundaries between different disciplines, as, for example, the investigation of child health is also common in sociology and economics. However, this thesis is limited to the cognitive, non-cognitive, and educational child outcomes due to data limitations that restrict an even more comprehensive evaluation.

(Bastian & Lochner, 2022; Grossman, 2007). During childhood, it is not the individuals themselves who make these investments, but their mothers who more or less strategically invest in their child's development, stressing the linked-lives principle (Elder et al., 2003). This ongoing investment behavior strongly depends on mothers' own previous human capital decisions regarding educational choices and professions practiced, which contribute to current and future investments, thereby affecting the timing of family formation, duration of employment interruptions, uptake of external childcare, or possible future childbirths. Every maternal decision impacts the child's human capital stocks and potentially enlarges the range of available choices (Schultz, 1961). In line with RC theory, mothers only invest in their children's human capital if these investments pay off (Eide & Showalter, 2010), i.e., if the subjectively expected utility of a human capital decision exceeds its costs. However, because the economic perspective focuses predominantly on explaining disparities in lifetime-earnings *through* strategic educational choices, it is criticized to overlook the underlying mechanisms that produce educational inequalities *themselves* (Kristen, 1999), offering a less comprehensive approach.

This is where Bourdieu's (1983, 1987) sociological framework extends the narrow focus on deliberate investments by highlighting the crucial role of families for children's disposition, rather than schools.⁷ Mothers, in particular, transmit economic, social, and, most crucially, cultural capital through socially selective time investments. Families with larger capital endowment are not only better positioned for this transmission but also initiate the process significantly earlier (Bourdieu, 1983). *Early* investments are of particular importance, as they enable children to accumulate as much capital as possible (Bourdieu, 1983; DiMaggio, 1982). Within the process of transmission, families pass on the specific ways of thinking, behaving, preferences, and educational goals, which children internalize throughout their childhood (Bourdieu, 1987; Walper & Grgic, 2019). For example, investment behavior includes mother's sophisticated language use, joint book reading, and high-culture engagement that facilitate the transmission of internalized cultural capital. This provides children early-on with academic predispositions that include the cultural practices necessary to navigate and excel within formal educational systems, which highly value cultural capital (DiMaggio, 1982; Kleinert & Jacob, 2024). Moreover, economic capital can support the acquisition of cultural capital by providing materials and activities that additionally foster cultural capital accumulation (e.g., Ludwig-Mayerhofer et al., 2020; Lugo-Gil & Tamis-LeMonda, 2008), as is also acknowledged by many other theories (Eccles, 1993; Klucznik et al., 2013) and particularly emphasized by the family investment model (see Chapter I/3.2).

Another, yet similar angle on children's human capital accumulation is offered by the dynamic skill formation model of Cunha and Heckman (2010). It extends previous theories by providing additional

⁷ The emphasis of the *family* for early child development does not contradict the notion that institutional learning environments are also relevant. They can be highly important for children's human capital accumulation, particularly when families have less capital to transmit. In this case, the investment opportunities shift from the exclusive family to the institutional environments in childcare, opening new possibilities for beneficial child development (see Chapter III). In addition, schools can also act to some extent as equalizers, although previous research demonstrates that large gaps occur prior to school (Skopek & Passaretta, 2021).

insights into the effectiveness of family investments. Cunha and Heckman describe early childhood as a sensitive period for skill development, in which maternal investments in child's cognitive and social-emotional competencies differ in their productivity across developmental stages. Accordingly, children's skill formation is a dynamic accumulation process within the family that strongly depends on the *timing* of investments – a perspective that aligns with Bourdieu (1983, 1987) and the life-course framework (Elder et al., 2003). This is rooted in human development, as the most substantial brain development, which depends on children's experiences and learning environments, occurs during infancy and early childhood (Shonkoff & Phillips, 2000). Thus, inputs at younger ages are more effective for child development than at older ages (Black et al., 2017; Cattan et al., 2024; Cunha & Heckman, 2010). During these early life stages, child investments are almost exclusively dominated by mothers and the family, and only as children grow older do they themselves and other individuals gain control over investment decisions.

Building on this, Cunha and Heckman (2010) introduce two multiplier effects that explain productivity differences of investments: The first is the principle of (1) *self-productivity of skills*, which states that higher skill levels at one stage foster greater skill development at later stages ("skills beget skills" (Cunha & Heckman, 2010, p. 7)). In this development, cross-productivity emerges, where higher skills in one domain not only benefit further skill improvements in the same domain, but also in other ones, e.g., cognitive skills can foster non-cognitive skills (Cunha & Heckman, 2010). Short-term boosts of child skills can lead to long-term benefits for child development if investments are maintained over the child's life course, otherwise, advantages may fade in the long run. Such mechanisms of cumulative disadvantage and advantage, or *Matthew effects*, where small differences in child skills accumulate over time and result in strong contrasts, are widely recognized in the literature and highlight the long-term implications of early child development (e.g., DiPrete & Eirich, 2006; Pavolini & van Lancker, 2018). The second principle (2) *dynamic complementarity* states that the productivity of future educational investments increases with the level of existing child skills, which provide a stronger foundation for later development (Cunha & Heckman, 2010).⁸ For example, a child's early capacity to concentrate makes later investments in math competencies more effective (Cunha & Heckman, 2010; Duncan et al., 2007).

Together, these different theoretical approaches emphasize the *importance of the family* for child development as human capital accumulation. By framing maternal characteristics and domestic practices as active drivers of a child's early disposition, the theoretical considerations of Bourdieu (1983, 1987) and Cunha and Heckman (2010) provide an additional theoretical bridge to Boudon's (1974) primary effects. It explains how the unequal transmission of maternal capital, or unequal investment behavior, during infancy and early childhood leads to systematic developmental gaps long

⁸ This complementarity only holds if substitutability of investments between children's developmental stages is low. In the case of high substitutability, timing of input plays a minor role (Cunha & Heckman, 2010).

before formal schooling begins. In line with wide RC concepts, it fully drops the notion of aware decisions and stresses the relevance of subtle reinforcement of relevant behavior, language use, and knowledge in the family sphere. Cunha and Heckman (2010) additionally provide a perspective that aligns well with several principles of the life-course framework, highlighting the importance of a trajectory-based perspective on child development.⁹ In conclusion, the central mechanism for beneficial long-term development proposed by the presented theories, is the quality of children's early learning environments as the primary setting, here understood as mothers' resource-dependent investment behavior (see Chapter I/3.2 for a detailed discussion). The following chapter manifests the nature and specific mechanisms of premium learning environments to improve the understanding of how maternal characteristics and resources are transformed into heterogenous child development.

3.2 Children's Learning Environments and Child Development

Learning environments are increasingly recognized as important drivers of inequalities in child development. Traditionally, children's learning environments were restricted to the family, where mothers' SES strongly impacts children's developmental opportunities. However, with the rise of maternal employment and childcare usage, external learning environments, such as ECEC facilities, have gained importance, providing disadvantaged children the possibility to develop independent of family background. The following subchapters discuss two different concepts regarding how families create high-quality home learning environments, how these environments differ by SES and other socio-demographic characteristics, and conclude with elaborations on external learning environments.

3.2.1 The Parent Socialization Model

Eccles' (1993) *parent socialization model* acts as the starting point of the overarching *situated expectancy value theory* (1993; 2024) and emphasizes the role of parents in child development. This theory was originally developed to explain gender-based differences in academic attainment and focuses on intra-child processes on motivation and achievement-related behavior in adolescents, which play a minor role in the current thesis. However, the parent socialization model (Eccles, 1993; Eccles & Wigfield, 2024) makes a relevant contribution to understanding the *processes* behind prevailing home learning environments, which are applicable to early childhood. Thereby, it complements the previous rationales of RC models that treat preferences rather as exogenously given (Chapter I/3.1.1). Accordingly, Eccles and colleagues shed light on the composition and emergence of

⁹ The perspective of the skill formation model Cunha and Heckman (2010) aligns well with principles of the life-course framework, i.e., timing, life-span learning, and the nature of self-referential processes. The skill formation model emphasizes timing in children's lives and creates a path dependency where early disadvantages become increasingly difficult and costly to correct as a child ages, highlighting that past trajectories shape future ones ("self-referential processes"; K. U. Mayer, 2004). Accordingly, the timing of early investments in infancy and childhood will be consequential for children's long-term development, as suggested by the principle of life-long learning (Elder et al., 2003).

subjective preferences, which mirror parents' personal beliefs and their agency within structural constraints (Eccles, 1993, 2008).

The parent socialization model emphasizes the role of family characteristics, parental beliefs as well as activities with the child and provided equipment (see Figure I.3, Panel A). Parents act as socializers during early childhood. Based on sociodemographic characteristics, mothers hold (a) their *own general beliefs*, (b) *efficacy beliefs* about themselves, (c) *other values*, and (d) *expectations and perceptions* of their child's abilities (Eccles, 1993; Eccles & Wigfield, 2024). (a) General beliefs address the relevance of certain domains like sports, math, or music. Through such beliefs, parents shape their children's interests by prioritizing domains they value. They foster development by actively encouraging the child's participation or, if they possess a personal interest in the domain, they serve as role models through observational learning during own engagement. Moreover, (b) mothers' own abilities and feelings of self-efficacy in certain domains shape educational beliefs, as mothers may avoid or devalue domains they feel insecure or inexperienced (Zippert & Rittle-Johnson, 2020). Hence, parents' beliefs actively or subconsciously can hinder children's experiences in certain domains, affecting children's early development. (c) Other values include perceptions of how children learn: when mothers believe that academic intervention is effective, rather than viewing a child's abilities as static, innate, and unaffected by parental investment, they engage more in educational activities (e.g., Vasilyeva, Laski, et al., 2018). Lastly, (d) beliefs about child abilities can be rooted in the previous parental beliefs. Such perceptions are often anchored in objective facts in adolescence, like grades or gender stereotypes (Eccles, 1993), and also play a relevant role in the status attainment model (Breen & Goldthorpe, 1997). During infancy and early childhood, such assessments of child abilities may rather rely on observable developmental milestones, such as motor skills, language acquisition, the child's natural curiosity, and task persistence in specific domains, e.g., outdoor activities or reading a picture book. However, evidence is scarce on how such child-specific beliefs develop during early developmental stages.

The largest additional value of this theory lies in the integration of parental efficacy beliefs about themselves, which is an extension compared to the concept of home learning environments (see Chapter I/3.2.2), that allows for insights in the motivational drivers of learning environments to understand maternal preferences. Research shows domain-specific relations between maternal skills, efficacy beliefs and the home learning environment. Maternal math-related knowledge and self-efficacy benefit math-related activities with the child (e.g., Elliott et al., 2017; Mues et al., 2022), as do language-related skills and activities (e.g., J. Lin et al., 2015; A. Sullivan et al., 2021). Likewise, higher maternal math skills are associated with lower maternal math anxiety (e.g., Retanal et al., 2021), which in turn supports math-related activities and instructions for the child (e.g., Berkowitz et al., 2021; Del Río et al., 2017). These domain-specific maternal skills and beliefs in turn foster children's interest in the respective domains and, thus, benefit their math competence (Cheung et al., 2025). Cosso et al. (2023) demonstrate an even more complex interplay: a high-quality home numeracy environment only benefits child numeracy skills if parental math anxiety is low.

Altogether, these parental beliefs result in *parent-specific behaviors* via different parenting styles and joint child-parent activities that provide children with different experiences and equipment (Eccles, 1993; Eccles & Wigfield, 2024). Although Eccles and colleagues do not label it as such, they describe how parents create a stimulating *home learning environment*. Parental beliefs about the importance of certain skills affect parent-child activities at home (e.g., Simpkins, 2015; Sonnenschein et al., 2025). For example, mothers who highly value academic abilities like reading are more likely to purchase materials like books that help to engage in respective activities. Moreover, mothers' parenting behavior determines the affective climate in the family. Children likely develop different perceptions on a domain, e.g., science, while playing, depending on whether the mother fosters interest by responding with positive encouragement instead of negative reinforcement (Eccles, 1993). The literature highlights the relevance of emotional support, adequate parental involvement and interest, and autonomy-supportive environments to enable children building personal efficacy and a positive achievement orientation (Wigfield et al., 2015). In contrast, maternal disapproval disrupts joint activities and might prevent children from developing play-based skills. These disparities in parent-specific behaviors, based on parental beliefs and motivations, can explain the emergence of differences in child development, which depend on their early home experiences. Further insights into the relationship between parental beliefs and child development are provided in the next subchapter, which offers an additional perspective on home learning environments that also integrates the relevance of parental beliefs, which results in a largely overlapping empirical literature.

3.2.2 The Concept of Beneficial Home Learning Environments

The inclusion of the *home learning environment* framework (Kluczniok et al., 2013) is essential for a holistic analysis. While Eccles' and colleagues (1993; 2024) theory elucidates the underlying motivational drivers of mothers behind prevailing home learning environments, Kluczniok et al. (2013) provide a comprehensive focus on *observable* educational processes, structural conditions, and domain-specificity. This framework originated from the need to apply established quality criteria for institutional childcare to the domestic sphere, recognizing the home as primary site for early learning opportunities, which are profoundly shaped by family background. Accordingly, this concept facilitates comparisons between home and external learning environments (Chapter I/3.2.4), where the parent socialization model applies less (Eccles, 1993). Despite these different focal points, both frameworks highlight similar key mechanisms and converge on the critical importance of sociodemographic characteristics, parental beliefs, and resulting parenting behaviors.

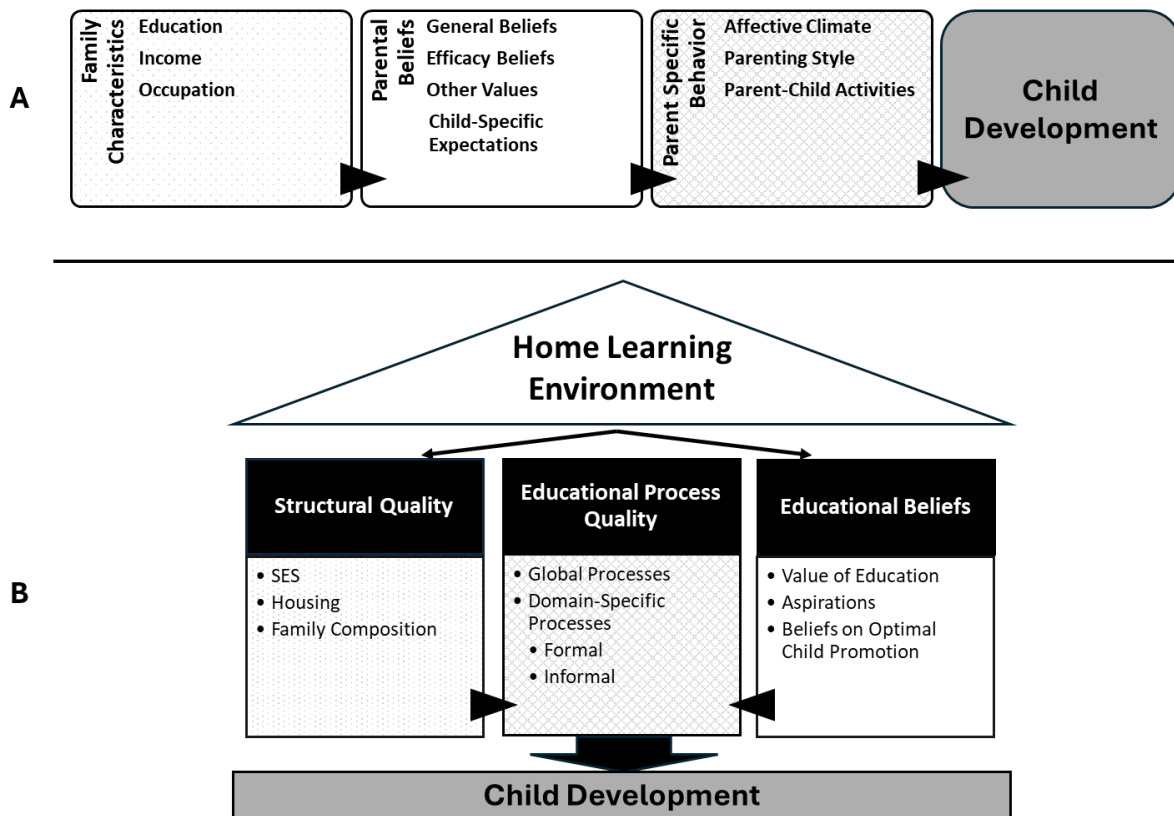


Figure I.3: The Parent Socialization Model (Panel A) and the Concept of Home Learning Environments (Panel B)

Note: Identical background shades highlight parallels of mechanisms in both approaches. Author's own illustration adapted from Eccles and Wigfield (2024) and Kluczniok et al. (2013).

The home learning environment is characterized by three dimensions (see Figure I.3): (1) structural characteristics, (2) educational beliefs and orientations, which both can influence each other, and insert their impact on child development through (3) educational processes (Kluczniok et al., 2013). (1) *Structural characteristics* describe stable, mainly resource-focused family features, such as SES, housing characteristics, or family composition (Kluczniok et al., 2013). The SES determines available resources within the family, which in turn affect home environments and shape children's early experiences: Financial resources influence where and how families live, i.e., the neighborhood, in a house or an apartment, whether it is polluted by traffic and noise, but also how the home is equipped, e.g., whether children have their own rooms and promotional toys are available. Availability of a partner or the second parent can also be seen as an additional resource, potentially adding income to the family resources and support with childcare and housework tasks (e.g., Altintas & Sullivan, 2017; Kan et al., 2022; Morelli et al., 2022). Therefore, structural quality is often interpreted as precursor of process quality (e.g., Slot et al., 2018). Overall, structural characteristics of the child's home learning environment are affected by maternal decisions but mothers have lower discretionary power within the limits of available resources, thus, choices are constrained.

The remaining quality criteria are less resource-constrained. (2) *Educational beliefs* refer to maternal views on the value of education, the relevance and extent of possibilities of child promotion, e.g., whether they believe that child skills are malleable or fixed, and aspirations about educational attainment for the child's future (Kluczniok et al., 2013; Vasilyeva, Laski, et al., 2018). Kluczniok et al. (2013) are less precise in their definition of maternal beliefs compared to Eccles' (1993) approach, although both concepts address similar belief domains. Educational beliefs can be interpreted as preferences that shape decisions on whether and how to invest in children's human capital. When mothers put a strong value on good school grades, succeeding in life in general, and hold higher educational aspirations (Paulson et al., 1998), it will shape their educational interactions accordingly. Strong parental values and aspirations are reflected in more goal-oriented maternal involvement, such as discussing and monitoring schoolwork, which in turn has been shown to benefit academic performance of adolescent children (e.g., Davis-Kean, 2005; Juang & Silbereisen, 2002; Otani, 2019; Skwarchuk et al., 2014; Spera, 2006). But even at younger stages before schooling, maternal beliefs shape learning environments, as positive assumptions about child abilities and high aspirations improve factual child abilities and educational attainment (e.g., Hart et al., 2016; Nicoletti et al., 2022; Otani, 2019; Yang & Wang, 2025; Zippert & Rittle-Johnson, 2020). For example, higher maternal importance of preparation for school predicts different math skills of preschoolers, who perform more math-related activities with their parents compared to mothers who value school preparation less (Vasilyeva, Laski, et al., 2018).

Most importantly, (3) *educational processes* refer to mother-child interactions, covering parenting behavior and activities, as well as children's interaction with spatial-material surroundings. For example, the availability of books can foster reading activities, either together with mothers or for children themselves (Georgiou et al., 2021). Kluczniok et al. (2013) further differentiate between (a) *domain-specific processes* and (b) *global processes*, thereby refining Eccles' (1993) model that, in its core, emphasizes domain-specificity. (a) *Domain-specific processes* foster one specific skill with materials or activities, theoretically differentiating between formal and informal processes (Kluczniok et al., 2013), although in practice differentiations are not always that clear (Elliott et al., 2023). While informal processes refer to rather unstructured, domain-specific activities that naturally occur and promote child abilities without the explicit aim to foster child development, formal activities are targeted to directly and intentionally teach the child and improve skills (Sénéchal & LeFevre, 2002; Skwarchuk et al., 2014). Possibly, mothers with stronger educational beliefs are more aware of the promotional potential of their parenting, thus, incorporating more formal activities, whereas mothers placing lower value on child promotion might prefer unstructured, informal activities. However, empirical evidence on such complex interrelations warrants future research.

Separate domain-specific models to explain skill acquisition emerged from the literature, i.e., the *home literacy model* (Sénéchal & LeFevre, 2002) and the *home numeracy model* (Skwarchuk et al., 2014). The former distinguishes informal literacy-related activities, i.e., free role play that fosters language,

reading books to the child, or joint library visits; and formal activities, i.e., learning the alphabet song or identifying letters (Sénéchal & LeFevre, 2002). For math-related competences, informal activities include quantity comparisons and counting foods while shopping, play with number board games, or shape-sorting toys, whereas formal activities intentionally teach the child numbers, shapes and quantities. Literature reveals promoted child outcomes when mothers provide more domain-specific activities for both language (e.g., Price & Kalil, 2019; Torppa et al., 2022) and math outcomes (e.g., Susperreguy et al., 2020; Waters et al., 2026). Nevertheless, evidence is mixed and only certain domain-specific activities promote child abilities, depending on the exact features considered (Elliott et al., 2023; Missall et al., 2015; Zippert & Rittle-Johnson, 2020). Previous literature also suggests cross-domain effects, such as math activities enhancing language competencies, in line with theoretical arguments of Cunha and Heckman (2010). Given that language serves as the primary medium for instruction and conceptualization, activities targeting math skills can inherently foster linguistic development and enhance child vocabulary (e.g., Lehl et al., 2020; Napoli & Purpura, 2018). Besides child promotion, domain-specific processes can also serve as protective factors: for example, Torppa et al. (2022) show that shared reading before age eight improves reading comprehension in high-risk groups for dyslexia.

In contrast to these domain-specific processes, (b) *global processes* describe the family climate and everyday activities that provide learning opportunities (Klucznik et al., 2013). These opportunities can be unstructured and informal, such as grocery shopping, theater, or family visits. They align with Bourdieu's (1983, 1987) perspectives on the transmission of cultural capital within the family, that is transmitted in everyday situations without explicit emphasis on promoting children's abilities, yet transporting relevant knowledge and behavior. Moreover, mothers may shape supportive environments by integrating the child in informal contexts, e.g., by asking stimulating questions during grocery shopping like "Do you see the green broccoli?" or giving the child responsibility for payment, without necessarily fostering one specific domain. Another example is establishing structures and daily routines, such as for bedtime or mealtime, that supports child development, particularly in risk settings that are more common in low-SES families (see Selman & Dilworth-Bart, 2024 for a recent review on routines; Owens & Jones, 2011; Zajicek-Farber et al., 2014).

Such parenting can reflect *parenting practices*, i.e., specific behavior to socialize the child, that may intend to foster children's human capital stocks and educational development (Kuppens & Ceulemans, 2019). Research has shown that parenting dimensions are associated with higher child abilities when mothers provide instructions or positive reinforcement, show involvement, and are generally supportive (Doepke & Zilibotti, 2024; Otani, 2019; Wigfield et al., 2015), whereas harsh parenting that is intrusive, controlling (psychologically or behaviorally), punishes, and demands obedience is related with lower child development, as they provide less stimulating opportunities for child engagement (Cuartas, 2022; Gershoff & Grogan-Kaylor, 2016; Kuppens & Ceulemans, 2019; Retanal et al., 2021). Systematic patterns and specific combinations of such practices, so called *parenting styles*, are pre-

defined in four groups concerning high or low *demandingness*, i.e., providing clear standards and being assertive without being intrusive, and *responsiveness*, i.e., being supportive (Baumrind, 1991; Kuppens & Ceulemans, 2019).¹⁰ Literature clearly demonstrates the best developmental competencies for those with both high levels demandingness and responsiveness, with lower child development among the other parenting styles (Doepke & Zilibotti, 2024).

3.2.3 Social Disparities in the Home Learning Environment

The previous chapters have illustrated how differences in the home learning environment emerge. The following subchapter now elaborates on the role of maternal characteristics, particularly the SES, for these disparities. Following previous literature (e.g., Doepke & Zilibotti, 2019), the parenting is interpreted as repeated maternal *decision* on how to raise the child, without necessarily implying awareness in this decision. These decisions are socially stratified, primarily by education, occupation, and income – together the SES. While the mothers' SES is itself part of the structural quality criteria (Kluczniok et al., 2013), it crucially affects parental educational beliefs and educational processes with the child (Eccles, 1993). But also other characteristics are associated with resource endowment, such as maternal age at birth.

Disparities by SES-Related Parenting Ideals

Maternal beliefs about ideal parenting and the resulting educational processes differ based on SES. Lareau's (2011) theory emphasizes these disparities, differentiating between (1) *concerted cultivation* and (2) *natural growth*. (1) Concerted cultivation is practiced and perceived as ideal by higher-SES parents: it is characterized by a focus on the child's needs, as well as adult-organized leisure activities like team sport or music lessons to actively promote children's skills and talents. Instead of just giving orders, these parental communication styles include explaining the "why" and encouraging children to think for themselves to help them grow. This parenting ideal aligns with professional views on promotional engagement with the child and establishing daily structures (e.g., Selman & Dilworth-Bart, 2024). In contrast, (2) ideals of natural growth are preferred by lower-SES families, who expect that beneficial child development occurs naturally and spontaneously rather than through active parental intervention, given that basic child needs are satisfied. Children manage their own leisure through unstructured play, yet experience a stricter, more hierarchical form of parental commands rather than negotiation. Generally, natural growth is more family-focused, as children spend more time with their families and have stronger ties with other family members (Hofferth, 2012; Lareau, 2011).

¹⁰ More precisely, these parenting styles include: authoritative parenting (i.e., both high demandingness and responsiveness), permissive parenting (i.e., low demandingness and high responsiveness), authoritarian parenting (i.e., high demandingness and low responsiveness), and neglectful parenting (i.e., both low demandingness and responsiveness) (Baumrind, 1991; Kuppens & Ceulemans, 2019). These parenting styles are ranked in order of effectiveness in promoting child development, starting with the most beneficial style and ending with the least promoting one (Doepke & Zilibotti, 2024).

While both parenting approaches have their advantages, children from high-SES families benefit from active contact with institutional authorities, which has long-term implications for child development (Hofferth, 2012; Lareau, 2011). Due to regular, early-on experiences with instructors from organized activities, they are better prepared to engage with unfamiliar adults or educational institutions. Their parents also behave differently in institutional contexts, given that higher-SES parents are socially “more equal” to professionals like educators regarding their educational background, whereas for lower-SES parents they are “social superiors” (Lareau, 2011, p. 249). This helps higher-SES children to feel more entitled and comfortable in such situations, easing their efforts to achieve their goals in contact with institutions, whereas lower-SES children tend to be more passive (Hofferth, 2012; Lareau, 2011). While several studies reveal the relevance of different parenting styles regarding organized activities or communication (Carolan & Wasserman, 2015; Mikus et al., 2021), these latent differences in entitlement regarding institutions have not yet been evaluated.

Moreover, several studies have reasonably argued that different parenting ideals emerge and influence children already during early childhood, although Lareau’s (2011) theory aimed at school children (e.g., E. C. Allen et al., 2022; Carolan, 2018; Ding & Leung, 2025; Hofferth, 2012; Lucendo-Noriega et al., 2026; Mikus et al., 2021; Ren et al., 2020; Xu et al., 2025). Given that parental care is most highly valued by mothers during children’s earliest and most formative years when children strongly depend on them (Cunha & Heckman, 2010; Mincer & Polachek, 1974), mothers prioritize their personal involvement, directly affecting children’s initial learning environments. Given that children’s brain development relies on early experiences and environments (Shonkoff & Phillips, 2000), it follows that if organized activities positively impact children at school age, the benefits should be even greater at younger ages.

Disparities by Education

Similarly, other educational beliefs are affected by maternal education, which potentially shape socially selective educational processes. Considering the status attainment model (Breen & Goldthorpe, 1997), higher-educated mothers likely value education more strongly and hold higher aspirations (Sosu, 2014), fearing downward social mobility more than lower-educated mothers. Thus, higher-educated mothers are more *risk averse*, which might cause them to emphasize investments in their child’s human capital in their parenting by performing more education-related activities or provide more educational toys for child promotion (e.g., Berkowitz et al., 2021; Cuartas, 2022; Mikus et al., 2021; Mues et al., 2022; Tamis-LeMonda et al., 2019). This stronger risk aversion could also be reflected in time investments per se, as Doepke and Zilibotti (2019) show that higher-educated families across Western countries more strongly increased their time investments in childrearing compared to lower-educated (see also Gao, 2025; Ramey & Ramey, 2010; Schmitz et al., 2026).

Moreover, education can improve parenting cognition, i.e., *knowledge* on parenting and child development. Higher educated mothers often possess more knowledge, because they might more

actively seek out information on child development and parenting (e.g., Fang et al., 2021; Winter et al., 2012). Parenting knowledge is an important prerequisite for effective parenting that has been shown to be higher among higher-educated and higher-skilled occupational groups (Bornstein et al., 2020; McKee et al., 2021; Morawska et al., 2009; Winter et al., 2012). This parenting knowledge includes understanding the different needs of a child (physical, socio-emotional and cognitive) and how to fulfill them, as well as awareness on normative child development, developmental milestones and child health (Bornstein, 2015). While some scholars have questioned the predictive value of such “simplified knowledge” that mothers tend to forget once their children progress to subsequent developmental milestones (Bornstein et al., 2010; Winter et al., 2012), its theoretical and empirical implications are highly relevant.

Parenting knowledge affects home learning environments and child development via two theoretical channels: firstly, parenting knowledge contributes positively to mother’s self-perceptions of their competence, self-efficacy, and investment in parenting (Bornstein et al., 2020). Research shows that parenting self-efficacy can be positively associated with maternal education (e.g., P. K. Coleman & Karraker, 2000). However, findings are mixed, as mothers with lower parenting knowledge, and often lower education, may report high self-efficacy due to overestimating the quality of their parenting (Fang et al., 2021; Seo, 2006). Secondly, mothers apply their knowledge in their parenting, as they decide in everyday situations on *how* to nurture the child: for example, understanding how children process emotions at different developmental stages will affect mothers reaction to the child’s emotional behavior (McKee et al., 2021). Overall, literature demonstrates that higher education fosters parenting knowledge, leading to increased self-efficacy, greater confidence, and healthier parenting practices, reduced dysfunctional behaviors while promoting optimal child development (Bornstein, 2015; Bornstein et al., 2020; September et al., 2016; Winter et al., 2012).

Beyond parenting knowledge, education enhances both domain-specific and global maternal skills. Higher-educated mothers often experience training that improves domain-specific skills relevant to parenting, such as academic training in mathematics, or vocational training in healthcare that informs child health. As outlined above with Eccles (1993), this expertise can boost maternal domain-specific self-efficacy and encourage engagement in respective activities with their children (e.g., Mues et al., 2022; Vasilyeva, Dearing, et al., 2018; Zucker et al., 2021). Some activities might occur more naturally to higher-educated mothers, who possess higher reading skills and more frequently read to their children (Ehmig et al., 2024; Rammstedt et al., 2024). Their advanced skills may make them more responsive to their children’s reading skills and lead them to incorporate reading into home activities if necessary (e.g., Georgiou et al., 2021). Additionally, education can support mothers’ self-regulation (e.g., Iturmendi-Sabater et al., 2026), reducing the likelihood of corporal punishment (Cuartas, 2022; Holden, 2020), and resulting in improved global parenting skills among higher-educated mothers. These mothers also tend to use less harsh and negative parenting in favor of more involvement, structured routines, and warmer interactions (Bornstein et al., 2003; Cuartas, 2022; Davis-Kean, 2005).

However, some studies have not consistently found SES-related disparities in parenting quality (e.g., Gagné et al., 2007), possibly due to inconsistent operationalizations of parenting.

Disparities by Employment

Another component of the SES-related differences in children's home learning environments stems from maternal occupations. Employment can offer mothers vital resources, which can improve structural home quality through purchase of more toys or books (e.g., Jonsson et al., 2009), but it often comes with a trade-off in time and energy (scarcity hypothesis), inducing work-family-conflict that affects the emotional climate at home (Greenhaus & Beutell, 1985; McCredie et al., 2025; Tammelin et al., 2017). According to Greenhaus and Beutell (1985), work-family conflict arises when the role requirements of work and family life become mutually incompatible, mainly with regard to time, strain, and behavior. Time spent at work can decrease available time resources for the family and strenuous work tasks can induce fatigue and stress. Similarly, demands regarding work behavior can be very different to the home sphere, making potentially challenging adjustments between contexts necessary to avoid spillover effects (McCredie et al., 2025). All three factors can result in less beneficial parenting practices, reduced mother-child activities, and lower involvement in children's lives, thereby limiting the promotion of child development.

Although the argument is compelling that maternal employment reduces time available for children, evidence suggests a more nuanced picture. Hsin and Felfe (2014) show that while employment decreases the total time mothers spend with their children, it does not reduce time devoted to beneficial educational activities. More recent studies support these findings (e.g., Bastian & Lochner, 2022; Pilarz & Awkward-Rich, 2024). Working non-standard schedules, which is often assumed to reduce available time, can even be a source of flexibility for the reconciliation of work and family (Carriero et al., 2009; Estes, 2005) and do not always induce stress (Li et al., 2020; Rönkä et al., 2017; Zilanawala & McMunn, 2022). Furthermore, job characteristics such as more flexibility, job security, autonomy, and less working hours can reduce work-family conflict but are often more likely to be available for higher-skilled workers (T. D. Allen et al., 2013; Cho et al., 2024; Luhr et al., 2022; McCredie et al., 2025). Low work-family conflict is in turn associated with higher maternal well-being and lower stress levels (Hwang & Jung, 2020; Sousa & Ferro, 2025), as well as more involvement, parenting warmth, and less irritability – attributes that contribute positively to child promotion (Cooklin et al., 2015; Datta Gupta et al., 2026; Holmes et al., 2018; L. S. Leach et al., 2021; McCredie et al., 2025).

Far less attention received the role of occupations for the intergenerational transmission of skills (Barg & Klein, 2024; García-Sierra, 2025; Jonsson et al., 2009; see Chapter IV for a more detailed theoretical discussion about the transmission of occupational skills) and how occupations and their demands shape maternal skills through performing everyday tasks at work (Pouliakas & Russo, 2015; Russo, 2016). For example, a mother working as a math teacher is more likely to possess higher numeracy-related skills compared to an artist, who in turn might be more advanced in spatial visualization. These

occupational skills act as a catalyst for maternal self-efficacy and mothers may feel more comfortable creating educational experiences that align with their own (occupational) strengths (Zucker et al., 2021), directly influencing the quality and focus of the home learning environment. Research has shown that parents working in STEM occupations translate their skills into a more focused engagement in numeracy-related activities at home (Mues et al., 2021; Zucker et al., 2021). This can also lead to a stronger interest of the child in subjects related to mothers occupations (Guo et al., 2019). As theoretical considerations suggest, these STEM-focused home learning environments mediate the domain-specific relation between occupations and child development in the respective areas, such as science or math (Bowden et al., 2018; Chi et al., 2017; Mues et al., 2021; Plasman et al., 2021; Zucker et al., 2021). But also global relations exist that show that mothers with higher work complexity or skill-level benefit child competencies (Yetis-Bayraktar et al., 2013).

Disparities by Income

Closely related to occupations, economic resources affect children's home learning environments. The *family investment model* emphasizes the role of financial resources, among educational and occupational resources (e.g., Conger & Conger, 2002; Conger et al., 2010; Conger & Donnellan, 2007; Duncan & Magnuson, 2003; S. E. Mayer, 1997), stating that greater economic resources support significant investments in the home learning environment (see Figure I.4; Conger & Donnellan, 2007). While affluent families can strategically invest economic capital into their children's development, low-income families are often forced to prioritize immediate subsistence needs. Accordingly, financial investments take effect through two quality channels: (1) Higher income improves structural quality dimensions, such as better learning materials, housing characteristics and neighborhoods, nutrition, or access to medical care or childcare services. (2) Process-related quality is higher among high-income families, as playing materials can induce mother-child interactions, or out-of-home activities are more affordable, such as theater for children, visiting the zoo or an museum (Conger & Donnellan, 2007). This is also reflected in evidence highlighting that more affluent mothers spend more academically enriching time with their children (Schmitz et al., 2026).

Similarly, the *family stress model* predicts that low income and wealth, work instability, or negative life events like job losses can cause economic hardship and pressure (Conger & Donnellan, 2007; Conger & Elder, 1994; Haveman & Wolfe, 1994; Linver et al., 2002). When families' needs are unmet, e.g., regarding the purchase of basic needs like food and clothing, it can cause emotional distress. Psychological distress is argued to deteriorate family functioning through its main negative impact on parental mental health and parents' relationship quality, or for single mothers, quality with current partners or conflict with ex-partners (Conger & Donnellan, 2007). As a result, the quality of parenting behavior is reduced (e.g., Linver et al., 2002), contributing to lower child development (Figure I.4).

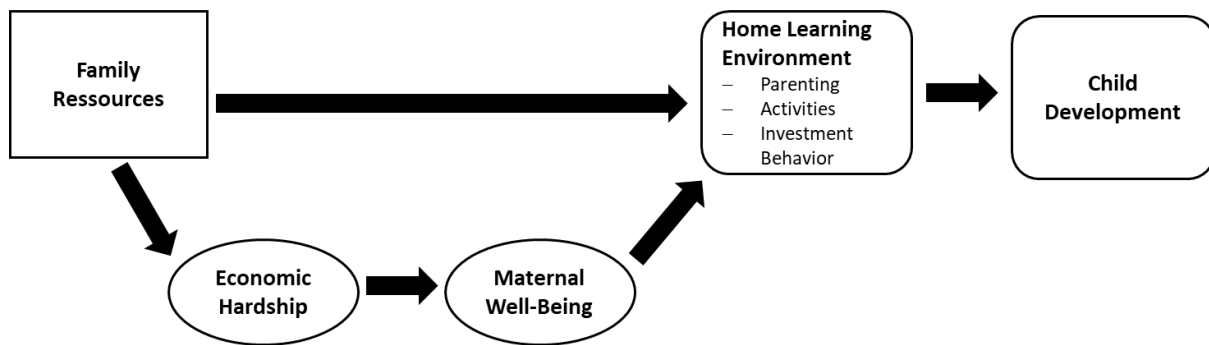


Figure I.4: Joint Perspective of the Family Investment Model (FIM) and the Family Stress Model (FSM)

Note: Author's own illustration adapted from Conger et al. (2010) and Conger and Donnellan (2007). Square: component of FIM; Oval: component of FSM; Rounded Rectangle: FIM & FSM.

The family investment model as well as the family stress model can be integrated into a unified perspective (Figure I.4), linking greater family resources to higher-quality home learning environments, with maternal well-being and economic hardship as key mechanisms. Compared to broader concepts of home learning environments (Kluczniok et al., 2013), this perspective emphasizes on financial resources and adopts a more mother-centered lens to explain how high-quality environments emerge depending on finances. While this strengthens resource-based explanations of child development, its narrow focus on finances risks overlooking other relevant factors: solely focusing on low maternal well-being caused by economic hardship neglects other important drivers of health and life satisfaction, e.g., work-related stress, which likely affect home learning environments in a similar manner. Thus, the integration of such broader perspectives would be an useful addition to the previously introduced concepts.

Recent studies on both models present affirmative evidence (see Masarik and Conger (2017) for a review). Low income and economic hardship are statistically significant predictors of parental psychological distress, including higher levels of depression, anxiety, and hostility (J.-H. Chen et al., 2023; Landers-Potts et al., 2015; Neppl et al., 2016; Newland et al., 2013; Ponnet, 2014; Um & Mincy, 2025). Other indicators of economic hardship, such as housing insecurity, also increase maternal stress levels (Warren & Font, 2015). Economic distress impacts the home learning environment either directly, as suggested by the family investment model (Lugo-Gil & Tamis-LeMonda, 2008; Um & Mincy, 2025; Vasilyeva, Dearing, et al., 2018), or, in accordance with the stress model, indirectly through parent-child conflict (Zhang, 2014) and parental relationship conflict (Landers-Potts et al., 2015; T. K. Lee et al., 2013; Neppl et al., 2016). Both economic distress and conflict diminish parenting quality and quantity, resulting in less time investments, reduced sensitivity, stimulation, and warmth, as well as more intrusive and harsh parenting (Iruka et al., 2012; Landers-Potts et al., 2015; Lugo-Gil & Tamis-LeMonda, 2008; Nærde et al., 2026; Neppl et al., 2016; Newland et al., 2013; Schmitz et al., 2026; Um & Mincy, 2025). In extreme cases, economic hardship can increase the risk of child abuse and neglect (Warren & Font, 2015). However, not all studies identify a direct relation between economic stress and

parenting quality (J.-H. Chen et al., 2023). Finally, the evidence demonstrates the impact of economic distress on child development (J.-H. Chen et al., 2023; Iruka et al., 2012; Landers-Potts et al., 2015; Nærde et al., 2026; Neppl et al., 2016; Ponnet, 2014; Um & Mincy, 2025; Vasilyeva, Dearing, et al., 2018; Zhang, 2014).

Disparities by Age

Mothers' fertility decisions are socially stratified and closely linked to the quality of the home learning environment through the timing of childbirth in mothers' life courses, i.e., maternal age at birth (see Chapter V for a detailed discussion). Women who delay family formation often do so to invest in education and career advancement in response to higher anticipated opportunity costs, thereby increasing the mothers' socioeconomic resources (Doepke et al., 2022; Guzzo & Hayford, 2020). Older maternal age is also linked to greater life experience (e.g., Duncan et al., 2018), emotional readiness for motherhood (Ahmad et al., 2024; Bornstein & Putnick, 2007) and higher maturity, which is reflected, e.g., in higher self-acceptance or warmer responsiveness (Allport, 1961; Baumrind, 1989; Josefsson et al., 2013). Thus, such higher psychosocial functioning can enhance home educational processes by improving mothers' ability to respond adequately to their children's needs. Moreover, older mothers also tend to take parenting information more seriously and may have gained experience through peers and family, where exposure to childrearing is more common than in teenage motherhood (Bornstein & Putnick, 2007; Bornstein et al., 2020).

Previous studies demonstrated that older, more mature mothers show better psychosocial functioning and, thus, provide higher-quality learning environments (Ahmad et al., 2024; Lysons & Jadv, 2023). Individuals with higher maturity show more beneficial parenting in terms of sensitivity, hardiness and mind-minded communication (Camberis et al., 2016), as do older mothers, who additionally possess higher aspirations and use less sanctions and harsh parenting (Barnes et al., 2014; Farley et al., 2021; Holden, 2020; Sosu, 2014; Trillingsgaard & Sommer, 2018). With older age, self-esteem has been shown to increase (Orth et al., 2018), which in turn benefits parenting abilities of mothers (Ahmad et al., 2024; Leerkes & Crockenberg, 2002). Moreover, older mothers tend to provide a more protective environment, resulting in fewer physical and health-related risks for their children (Sutcliffe et al., 2012).

3.2.4 Learning Environments in External Childcare and Child Development

The theoretical considerations in previous chapters illustrated the key role of mothers in shaping home learning environments. Aside from their importance for children's development, mothers can expand these learning environments by offering additional contexts through usage of alternative caregivers, most commonly in institutional childcare, but also in schools in later childhood and adolescence (see Chapter III for a detailed theoretical discussion of the *bioecological theory* of Bronfenbrenner and Morris (2006) and other considerations on the relevance of institutional learning environments for

child development). As elaborated in Chapter I/3.1.2, mothers' decisions on childcare usage are interpreted as first educational choices, which presumes that mothers strive to find high-quality childcare to optimize their child's development. According to the status attainment model (Breen & Goldthorpe, 1997), this is especially true for higher-SES mothers. However, these decisions are constrained and made under uncertainty, in line with the RC considerations (see Chapter I/3.1.1). A primary source of this uncertainty is asymmetric information: while mothers seek optimal learning environments that foster their child, they can only restrictedly assess a caregiver's true quality. Conversely, caregivers have superior knowledge of their standards but may signal inflated quality to protect their reputation.

The quality of learning environments in institutional childcare is characterized by three features that are similar to the home learning environment: (1) *structural quality* refers to rather objective criteria, i.e., group size, learning materials, educational qualification of educators, or spatial conditions (Helburn & Howes, 1996; Kluczniok & Roßbach, 2014). (2) *Educators' beliefs* regarding developmental processes, i.e., pedagogic orientation, teaching self-concept and goals, or whether children learn best through self-initiated play or through pre-set curricula (Cassidy et al., 1995; Kluczniok & Roßbach, 2014). Lastly, (3) *process quality* describes either (a) global aspects, such as the quality and warmth of child interactions with caregivers, other children, and the material and spatial environment; as well as (b) domain-specific stimulation targeting specific skill domains, such as early numeracy or vocabulary (Kluczniok & Roßbach, 2014; Ulferts et al., 2019). Process quality has been shown to be the most important quality dimension for child development, which can be affected by structural quality (Kluczniok & Roßbach, 2014; Slot et al., 2018; Suchodoletz et al., 2023; see Howard et al., 2024 for a recent review).

While these criteria are highly relevant from a scientific and professional perspective, characteristics important to mothers that affect their decisions may differ and vary across SES groups. Literature has shown that maternal quality perceptions deviate from professionals (Camehl et al., 2018; Mocan, 2007; Stahl & Schober, 2020). Often, aspects of feasibility and practicability, such as operating hours, siblings enrolled in the same institution, and proximity to home, are more decisive for maternal choices than pedagogical concepts (B. Becker & Schober, 2017). Particularly home proximity can be relevant for institutional quality in light of residential sorting, as compositional effects likely occur in disadvantaged regions where lower-SES families reside and lower-quality childcare facilities are more prevalent (B. Becker & Schober, 2017; Friedrichs & Triemer, 2009). Nevertheless, mothers' willingness to use institutional childcare increases when they perceive its quality as premium (Philipp et al., 2025; Stahl & Schober, 2020), and particularly high-status mothers tend to emphasize quality in their childcare choices (Grogan, 2012). This supports the status attainment model (Breen & Goldthorpe, 1997), demonstrating that higher-status families prioritize their children's optimal development. Moreover, other features influencing childcare choices include norms, preferences, and costs, including direct, indirect, opportunity, and psychological costs (see Chapter II for a detailed discussion).

Constraint-driven choices also occur, as lower-SES mothers have fewer chances of securing the childcare they need, especially when supply is scarce (Jessen et al., 2020), as institutions often favor better-off mothers when allocating available slots (Steinberg et al., 2024).

Research on formal childcare quality is mixed. Internationally, formal childcare quality varies significantly. In for-profit regimes, high quality is often tied to higher costs (e.g., Cleveland & Krashinsky, 2009); however, in Germany, subsidies and strict regulations limit the ability to increase financial investments to secure premium childcare (B. Becker & Schober, 2017). Since the 1990s, German childcare has generally maintained intermediate quality levels with minimal fluctuations quality levels (Spieß et al., 2008; Tietze, 1998, 2008; Tietze et al., 2013). Slight structural improvements recently emerged for children aged 3 and older (Autor:innengruppe Bildungsberichterstattung, 2022). Similarly, the 2019 *Childcare Quality Act* has triggered gradual structural improvements for childcare under three regarding staff training on health and language promotion, nutritional standards, and staff-child ratios (Fackler et al., 2024), whereas process quality gains are under-evaluated despite their importance (Slot et al., 2018). Nonetheless, evidence confirms that adequate staff-child ratios are a critical predictor of high-quality pedagogical process quality, as it shapes opportunities for educator-child interaction (Hausladen et al., 2026).

Given that formal childcare must adhere to strict legal quality-standards, it is often expected to have superior quality over unregulated informal care, which might depend more strongly on family SES (e.g., Ghirardi & Gioachin, 2025; Steinberg, 2025). Accordingly, the scarce empirical evidence on informal childcare remains nuanced. For example, P. Leach et al. (2008) found for the UK that group-based nursery care for infants under one year often scored lower in quality than home-based care by nannies, grandparents, or childminders. Within informal settings, nannies and childminders typically provided more stimulation and less punitive behavior than grandparents (P. Leach et al., 2008). Similarly, Otero and Melhuish (2015) noted high interaction quality among childminders, despite significant disparities in activity quality. However, small sample sizes in these UK studies limit the reliability of the results. In the US, Forry et al. (2013) identified that licensed childminders provide more sensitive, higher-quality care when supported by financial stability, lower stress, high motivation, and progressive educational beliefs. To the best of the author's knowledge, no study in Germany compares the quality differences in informal childcare, demonstrating a need for future research on informal childcare quality.

As elaborated before, maternal decisions on the type of childcare and its quality are socially selective, with lower and later uptake among low-SES mothers (Huebener et al., 2023; Steinberg, 2025; see also Chapter II), with lasting consequences for child development (Cunha & Heckman, 2010). Evidence on the beneficial short-term and long-term effects of formal childcare is large and mixed, depending on countries' childcare regimes, targeted age groups, intensity, and child outcomes (e.g., L. M. Berger et al., 2021; Cornelissen et al., 2018; Felfe & Lalive, 2018; Ghirardi & Gioachin, 2025; Gray-Lobe et al., 2023; Hustedt et al., 2021; Kühnle & Oberfichtner, 2020; Watts et al., 2023; Zachrisson et al., 2024).

However, there is consent, that ECEC is at least beneficial for children from disadvantaged family backgrounds (e.g., Blau, 2021; Ghirardi et al., 2023; Kulic et al., 2019; Schmutz, 2024; van Huizen & Plantenga, 2018; see Chapter III for a detailed discussion on the benefits of childcare for child development). In contrast, little is known about the promotional potential of informal childcare, which is mainly rooted in restricted information on the quality of informal learning environments. A limited literature demonstrates the minor promotional effects by grandparental care, with larger gains for children enrolled in ECEC (Barschkett et al., 2022; Del Boca et al., 2017), contributing to an inconsistent evidence.

3.3 Summary of Theoretical Considerations

In summary, the theoretical considerations of this thesis emphasize the central role of mothers' decisions in shaping learning environments, thereby affecting child development. Their early rational choices, without necessarily implying consciousness, are governed by subjectivity, bounded rationality, and altruism, rather than strict egoistic optimization, and directly shape children's human capital accumulation (Fishburn, 1981; Opp, 1999; Simon, 1990). While traditional human capital frameworks emphasize need of large maternal capital stocks at time of childbirth and afterwards for possible child investments (G. S. Becker, 1975; Bourdieu, 1983, 1987; Schultz, 1961), the skill production model by Cunha and Heckman (2010) additionally highlights the critical nature of early timing of investments in the child. As a general rule, all theories emphasize that greater available capital, coupled with earlier and greater investments, accumulate over time and optimize child promotion. These investment disparities result in varying ability levels (primary effects), which can further intensify socially selective decision-making regarding a child's educational pathway (secondary effects; Boudon, 1974).

Further considerations illustrated how children's early learning environments vary significantly in their quality, primarily shaped by mothers. Two key frameworks categorize the quality of learning environments: Eccles' (1993) parent socialization model emphasizes the process of how mother-specific characteristics shape child development through the mediation of SES, beliefs, and parenting behavior. Similarly, the concept of the home learning environments (Kluczniok et al., 2013) differentiates between structural quality, educational beliefs, and process quality, contributing with its critical distinction between domain-global and domain-specific processes that result in distinct developmental promotion. Moreover, disparities in the home learning environment are driven by education, occupation, income, and maternal age at birth. These factors correlate positively with parenting quality due to mothers' better parenting knowledge, higher skill levels, lower stress, and better well-being. Greater financial resources help prevent economic hardship and stress, ease the purchase of educational materials, and contribute to a warm emotional climate at home (Conger & Donnellan, 2007), all of which foster higher-quality environments and mother-child interactions. Additionally, high-SES mothers are more likely to provide additional learning environments of high quality in formal childcare, which is often considered to be of superior to informal childcare.

Collectively, these maternal characteristics significantly influence child development across various skill domains and improve long-term educational attainment.

4. Contribution of Present Studies

This dissertation comprises of four individual articles that contribute to answering the question on how maternal characteristics and learning environments contribute to early heterogeneities in child development. In the following, I elaborate on the overarching contribution to the body of research of the novel evidence from these four empirical studies by (1) expanding the scope of observed child outcomes, (2) investigating educational heterogeneities, (3) implementing a mechanism-based approach, and (4) exploring the German context with its unique features. Table I.1 offers a descriptive outline of the empirical articles.

(1) This dissertation contributes by expanding previous research by taking into account developmental child outcomes that have not all been studied yet sufficiently. Child development is a complex process, as developmental competencies evolve as a child grows and ages, making them a highly dynamic outcome that requires age-appropriate consideration. This complexity can complicate measures of child development, as they must be both comparable over time but yet age-adequate. Thus, child development cannot be captured by single indicators, but require a comprehensive assessment that includes multiple measures and dimensions. Existing research remains fragmented and outcome selection is often driven by specific study interests. For example, the social science literature about advanced maternal age and child development predominantly investigates academic child outcomes, such as years of schooling or educational attainment (e.g., Augustine et al., 2015; Duncan et al., 2017; Fishman & Min, 2018; Fredriksson et al., 2022; Grätz & Wiborg, 2024; Yu & Yan, 2022), while fewer consider cognitive competencies (Duncan et al., 2018; Goisis et al., 2017; Grätz, 2018; Yu & Yan, 2022) and even less address non-cognitive outcomes (Alvik, 2014; Duncan et al., 2018; Trillingsgaard & Sommer, 2018). In contrast, evidence about ECEC and its consequences focuses on short-term relations with cognitive and non-cognitive child skills (Ansari et al., 2020; L. M. Berger et al., 2026; Drange & Havnes, 2019; Fort et al., 2020; Ghirardi et al., 2023; Ghirardi & Gioachin, 2025; Gørtz et al., 2024; Szabó-Morvai et al., 2023) with comparatively little attention to long-term educational achievement (Bustamante et al., 2022; García et al., 2021; Schweinhart et al., 2005; Silliman & Mäkinen, 2026), particularly for Germany (Kühnle & Oberfichtner, 2020; Schlotter, 2011).

Both approaches have their merits: Direct measures of competencies provide detailed, multidimensional assessments but are sensitive to short-term fluctuations and only capture points-in-time. Such tests can encourage satisficing, as low-stakes assessments are irrelevant to children and may not reflect their actual competences (Wise & DeMars, 2005). Formal qualifications, by contrast, reflect accumulated performance over longer periods and carry greater relevance for children's future,

Table I.1: Overview of Individual Articles and their Publication Status

Chapter	Title	Journal	Contribution	Co-Author(s) and Contribution
II	The Early Interplay of Childcare Histories and Maternal Work Trajectories: A Multichannel Sequence Analysis	Journal of Marriage and the Family – <i>Under Review</i>	60% Conceptualization (equal), Methodology (equal), Data Curation (lead), <i>Formal Analysis (supporting)</i> , Writing - Original Draft (equal), Writing - Review & Editing (equal), <i>Visualization (supporting)</i>	Hannah Steinberg (40%) Conceptualization (equal), Methodology (equal), Data Curation (supporting), Formal Analysis (lead), Writing - Original Draft (equal), Writing - Review & Editing (equal), Visualization (lead)
III	The Long-Term Effects of an ECEC Reform on Educational Attainment	Child Development – <i>Published</i>	100% Conceptualization, Data Curation, Formal Analysis, Methodology, Visualization, Writing – Original Draft, Writing – Review & Editing	/
IV	Maternal Occupation-Specific Skills and Cognitive and Non-Cognitive Child Development in Germany	Research in Social Stratification and Mobility – <i>Under Review</i>	60% Conceptualization (equal), Methodology (equal), Data Curation (lead), Formal Analysis (lead), Writing - Original Draft (lead), Writing - Review & Editing (lead), Visualization (lead)	Gundula Zoch (30%) Conceptualization (equal), Methodology (equal), Writing - Original Draft (lead), Writing - Review & Editing (lead) Ann-Christin Bächmann (10%) Conceptualization (equal), Methodology (equal), Data Curation (supporting), Writing - Original Draft (supporting), Writing - Review & Editing (supporting)
V	Advanced Maternal Age and Child Development: New Evidence From Germany	Demographic Research – <i>Under Review</i>	70% Conceptualization (equal), Methodology (equal), Data Curation (lead), Formal Analysis (lead), Writing - Original Draft (lead), Writing - Review & Editing (lead), Visualization (lead)	Mathias Huebener (10%) Conceptualization (equal), Methodology (equal), Writing - Review & Editing (supporting) Malin Mahlbacher (10%) Conceptualization (equal), Methodology (equal), Data Curation (supporting), Writing - Review & Editing (supporting) Gundula Zoch (10%) Conceptualization (equal), Methodology (equal), Writing - Review & Editing (lead)

creating stronger incentives for effort. Nevertheless, educational attainment is also shaped by social filters, as highlighted by secondary and tertiary effects that operate independently of actual abilities (Boudon, 1974; Esser, 2016; Chapter I/3.2.1). Therefore, a comprehensive evaluation of child

development in all its facets requires a consideration of both types of measures to profoundly assess the emergence of heterogeneities in child outcomes. *This dissertation addresses these gaps by contributing novel evidence considering early cognitive and non-cognitive child development in the context of advanced maternal age (Chapter V) and occupational skills (Chapter IV), while also examining children’s educational achievement in the context of ECEC long-term effects (Chapter III).*

(2) Furthermore, this dissertation systematically examines how the relationship between maternal characteristics and child development varies across educational subgroups. Instead of treating maternal attributes as universal, this approach acknowledges their heterogeneous implications. Education acts as key differentiator (see Chapter I/3), shaping mothers’ occupational paths and finances (e.g., Conger et al., 2010; Möhring & Weiland, 2022), fertility timing (e.g., Doepke et al., 2022), childcare choices (e.g., Huebener et al., 2023; Steinberg, 2025), and parenting practices (e.g., Bornstein et al., 2020; Schmitz et al., 2026). Consequently, similar maternal characteristics, such as age, preferences, and occupations, can lead to vastly different learning environments based on mothers’ education. *Thus, this dissertation contributes in all four studies by explicitly modeling educational heterogeneity to go beyond global effects and to explore the role of maternal education for children’s early learning environments in greater detail, to enhance the understanding of how early developmental inequalities emerge.*

(3) Moreover, this dissertation contributes by adopting a mechanism-based approach that advances a deeper understanding beyond overall associations. Much of the literature on early child development focuses on global relationships, which neglects the underlying processes. The investigation of mechanisms can “open the black box” of links between maternal characteristics and child outcomes, as the analysis of mediating mechanisms exposes the key elements of potentially causal pathways and enables a more granular, theory-informed interpretation (Elster, 1989; Hedström & Ylikoski, 2010). Simultaneously, the inclusion of mechanisms requires a clear theoretical guidance prior to investigation on which processes are likely to matter – pointing towards the reciprocal relationship between theory and mechanism and the need for a deeper theoretical discussion, which is often limited. For example, many studies on advanced maternal age consider possible mechanisms only to a limited extent, often without sufficient theoretical foundation (e.g., Duncan et al., 2018; Fredriksson et al., 2022; Yu & Yan, 2022), or analyses are constrained by data limitations, both of which prevent the integration of crucial theory-based mechanisms into empirical analyses (e.g., Grätz & Wiborg, 2024). Similarly, the small evidence on occupational skills and child development provides limited insights into underlying mechanisms (Barg & Klein, 2024). In both contexts, theory emphasizes maternal resources as well as the home learning environment as key pathways in shaping child development, demonstrating the merit of a closer mechanism-based investigation that identifies the drivers of the relationship of interest. *Thus, this dissertation contributes to the literature by expanding previous studies by incorporating theory-based mechanisms, i.e., rich information on children’s early*

learning environments and the role of maternal characteristics in the contexts of occupational skills (Chapter IV) and advanced maternal age (Chapter V).

(4) Lastly, this dissertation contributes across all four studies to the global scholarship by extending the limited evidence for Germany and situating its findings in an international context. Much of the existing research on early child development is based on US contexts, where institutional settings differ substantially, limiting the transferability of findings. Germany provides an informative case to study, given the distinct combination of labor market structures, social policies, and educational institutions. The German labor market is characterized by a higher educational system that is complemented by a strong *vocational education and training* (VET) dual system, that integrates vocational schooling and in-company apprenticeships. Thus, there is an emphasis on occupation-specific skill formation that facilitates labor market entry and improves workers' attachment to it (e.g., E. A. Hanushek et al., 2017; Schulz et al., 2023; Shavit & Müller, 2000). This is reflected in relatively stable employment trajectories in Germany, showing limited occupational mobility (Manzoni et al., 2014). This institutional setting offers a unique context for studying maternal skill endowment and employment histories and their relevance for children's early environments. Additional labor market regulations like the strict employment protection can increase perceived job security, which has been shown to benefit maternal stress (e.g., McCredie et al., 2025). Further policies like continued payment of wages during sickness, maternity protection, paid parental leave, and child sick days might support mothers' well-being through reduced pressure of presenteeism and lower time pressure (e.g., Callen et al., 2013), leading to a potentially better capacity to invest in early childrearing. *Hence, this dissertation contributes by investigating how the distinct German labor market shapes maternal employment trajectories (Chapter II) and by employing a recently emerging occupational skill frameworks for mothers (Chapter IV), which altogether shape early learning environments and child development.*

Moreover, the educational system further reinforces Germany's relevance as a case study. Although legally not part of the schooling system (Roßbach, 2008), childcare is nowadays acknowledged as the first stage of the education system. Universal childcare occurred comparatively early in Germany, leading to a high usage already during the early 2000s (Eurostat, 2023), with further expansions from 2013 onwards. This inclusive start in the elementary sector contrasts with the rigid system of comparatively early ability tracking in lower secondary schooling. This selective system perpetuates social stratification by limiting the developmental opportunities of children in lower tracks, thereby reinforcing and effectively institutionalizing the link between family SES and academic achievement, despite largely free access to education (Dodin et al., 2024; Herrmann & Bach, 2025). *Thus, this dissertation contributes to the literature by analyzing the emergence of childcare histories in Germany's early-developed universal ECEC system (Chapter II), and by evaluating the potential of external learning environments to mitigate social disparities in long-term child development (Chapter III).*

Finally, Germany exhibits a particularly pronounced trend toward delayed childbearing, particularly among higher educated mothers, making it a relevant context for studying advanced maternal age implications, also for other Western context underlying this trend. In combination with a comprehensive welfare state that provides access to healthcare, income support, employment protection after birth, and parental leave, this setting may buffer potential health-related risks associated with later motherhood while amplifying resource-related advantages, altogether benefitting child promotion. *Thus, this dissertation contributes by investigating the strong trend of advanced maternal age in the unique social policy setting of Germany (Chapter V).* Altogether, the dissertation contributes by internationalizing German evidence on early child development. By analyzing ongoing trends in maternal employment, childcare usage, and advanced maternal age, this thesis provides insights into how country-specific institutional structures shape family dynamics, early learning environments, and developmental inequalities.

In summary, the four articles enhance the literature on early heterogeneities in child development by expanding analyzed child outcomes, and thoroughly investigating their mechanisms and heterogeneities by education, while also contributing with exceptional data to the German case. The following subchapters will briefly summarize the individual research aims of the four articles, their empirical approaches, main findings, and implications. Chapters II to IV present the four studies in full, before the final Chapter VI jointly discusses their results, limitations, and implications for future research.

4.1 Study 1: The Early Interplay of Childcare Histories and Maternal Work Trajectories: A Multichannel Sequence Analysis

The first study investigates how maternal employment trajectories are interrelated with the usage of different childcare types, and how resulting childcare-work-patterns vary by SES. It is joint work with Hannah Sinja Steinberg and currently under review at the Journal of Marriage and the Family (JMF). While prior research mainly examines how institutional childcare supports maternal employment, the joint development of employment and diverse childcare arrangements over time remains insufficiently understood, despite the crucial relevance for mothers' workforce. Drawing on the life-course perspective (Elder et al., 2003) and the linked-lives paradigm, we conceptualize maternal employment and childcare as interdependent processes across mother's and child's life domains. Based on rational cost-benefit considerations (Breen & Goldthorpe, 1997; Opp, 1999), we argue that advantaged mothers face higher opportunity costs of providing childcare themselves and, thus, outsource childcare and re-enter employment earlier, while less advantaged mothers delay both. This study extends previous research by providing novel evidence on the joint interplay between childcare histories and maternal employment trajectories from a trajectory-based perspective that accounts for the role of

childcare and offers greater analytical depth by capturing the full range of childcare and employment statuses, including phases of non-employment.

Using linked NEPS-ADIAB data from administrative employment records of mothers from the Institute of Employment Trajectories (IAB) and the NEPS Newborn Starting Cohort 1 survey data (NEPS Network et al., 2023; 2012-2017; N=1,521), we analyze monthly information on childcare arrangements (parents, family, institutions, childminders, and their combinations) and maternal employment (full-time, part-time or marginal employment, unemployed, inactivity, parental leave) from birth until age five. We apply multichannel sequence and cluster analysis to identify childcare-work patterns and multinomial regression models to examine their stratification by socio-economic background, maternal preferences, and regional constraints.

We categorize the six clusters into two overarching patterns: *family-focused* patterns, marked by extended periods of parental or family care and low labor market participation; contrasting the *work-centered* patterns, characterized by early external childcare use and high maternal employment, which dominate the sample. Cluster affiliation is stratified by socioeconomic resources: Work-centered patterns show more advantageous family characteristics, particularly maternal education. While preferences and other life-course dynamics also matter, regional factors play a minor role.

The results reveal considerable complexity in the childcare-work arrangements, extending well beyond the conventional patterns. Our results align with previous studies regarding the general distinction between early and late labor market re-entry, while also highlighting differences caused by country-specific institutional settings. Timing and intensity of maternal employment is a key differentiator in employment patterns, where studies from outside of Europe often identify continuous full-time employment without interruptions after childbirth (Cabello-Hutt, 2020; Killewald & Zhuo, 2019), which is virtually absent in the German data and other European countries (Reichert et al., 2024), where part-time work dominates. We can further support the finding, that non-parental childcare trajectories are more common among intense employment levels (Shattuck, 2022), where the higher degree of detail in data reveals that formal childcare is more often combined with intensive maternal employment. Overall, we contribute with the detailed consideration of different childcare arrangements and employment states, thereby revealing patterns of childcare-work reconciliation that remained concealed in conventional cross-sectional analyses that focused on shorter periods.

4.2 Study 2: The Long-Term Effects of an ECEC Reform on Long-Term Educational Attainment

My single-authored study is the first to investigate the causal long-term relation between universal childcare for three- to under six-year-olds and the attainment of school-leaving certificates in adolescence in Germany, using an instrumental variable (IV) approach. The 1996 reform, which

introduced a legal entitlement to childcare for three-year-olds, generated an exogenous expansion in supply and serves as the instrument for causal identification. I draw on interdisciplinary theories from sociology, economics, and developmental psychology on disparities in proximal processes, parenting, and educational decisions (Boudon, 1974; Bronfenbrenner & Morris, 2006; Lareau, 2011), as well as mechanisms of cumulative advantage (Cunha & Heckman, 2010) to explain the developmental benefits of institutional childcare. Accordingly, this study hypothesizes positive global effects of longer childcare duration on educational attainment, with stronger benefits for children from lower-educated or immigrant families. This study extends existing research by focusing on long-term outcomes for a policy-relevant population, i.e., families interested in utilizing institutional childcare, across whole West Germany.

This study uses the two starting cohorts SC3 and SC4 of the NEPS (NEPS Network, 2022; NEPS Network, 2021; 2010-2021; N=7,886) and local data on childcare usage that varied between regions and time (Federal and State Statistical Offices Germany, 2021, 2022). The first stage of the IV approach suggests a modest impact of the reform on children's childcare attendance: a 10 percentage points increase in supply resulted in up to 1.7 months longer duration in ECEC. However, second stage results demonstrate that this longer duration in childcare caused no attainment of higher school-leaving certificates, robust to many specifications. Subgroup analyses revealed the same null finding between educational and immigrant groups.

While these findings support the limited evidence on global short- and medium-term impacts of German ECEC (e.g., Kühnle & Oberfichtner, 2020), it contrasts with international studies detecting benefits for socio-economically disadvantaged children (e.g., Cornelissen et al., 2018; Ghirardi et al., 2023; Silliman & Mäkinen, 2026). The results indicate that a purely quantitative expansion of universal childcare has limited effects on long-term educational attainment. This may reflect neglected quality during expansion, a lack of targeting of disadvantaged families that have the greatest potential to benefit, contextual differences, or fade-out effects, underscoring the need for research on more recent reforms with a stronger focus on quality.

4.3 Study 3: Maternal Occupation-Specific Skills and Cognitive and Non-Cognitive Child Development in Germany

The third study examines the link between maternal occupation-specific skills and child development following mothers' return to work – co-authored by Gundula Zoch and Ann-Christin Bächmann. While the literature acknowledges that the intergenerational transmission of human capital is a key driver of social inequality across the life course, the role of occupational skills as part of mother's human capital endowment is under-researched. Given that the ongoing technological change and job specialization have expanded the diversity of occupational tasks and skills, understanding the implications of maternal occupational skills for child development has gained urgency. The article extends previous

literature by integrating the theory-driven *task based approach* (Autor et al., 2003) to examine the role of maternal occupational skills for child development (Jonsson et al., 2009). Differentiating between cognitive and non-cognitive tasks as well as routine and non-routine dimensions, we expect that occupations characterized by cognitive and non-routine tasks are associated with more stimulating home learning environments, in which mothers transmit their skills to the child, compared to manual and routine tasks. We contribute to the literature with this more specific measurement of maternal occupational skills, a broader range of early child cognitive and non-cognitive outcomes, as well as rich dataset that allows for a deeper analysis of the mechanisms of this relation.

Again, this study draws on the NEPS-SC1-ADIAB linkage with administrative records on mothers' employment biographies from IAB and NEPS survey data (NEPS Network et al., 2023; 2012-2021; N=2,109) and measure occupational skills using expert-coded occupational task data. Results from OLS-models show small but statistically significant associations between mothers' cognitive, analytical non-routine job tasks and children's vocabulary, while links with math, science, and socio-emotional competencies were modest. Other types of job tasks showed only small associations with other child outcomes. Moreover, the mechanism analysis further reveals robust results with limited relevance of family resources and the home learning environment. Robustness checks using fixed-effects models did not alter any of these conclusions.

Overall, our findings highlight the modest but meaningful role of maternal job characteristics in shaping early inequalities in child development that go beyond maternal education or employment status. We support earlier findings regarding the strongest benefits of maternal cognitive tasks for children's language competencies while contrasting the evidence by revealing mainly domain-general associations (Barg & Klein, 2024; García-Sierra, 2025).

4.4 Study 4: Advanced Maternal Age and Child Development: New Evidence From Germany

This last study investigates whether and how higher maternal age at childbirth benefits child development over different developmental stages in Germany. The study is currently under review at *Demographic Research* and is co-authored with Mathias Huebener, Malin Mahlbacher, and Gundula Zoch. Internationally, advanced maternal age plays a well-documented role for augmented child cognitive and non-cognitive skills as well as educational attainment, particularly in the US and with limited evidence for Europe. Drawing on theories of child development and human capital accumulation, on the one hand, we expect that advanced maternal age is associated with higher human capital accumulation due to finalized education and established careers, which likely drives child promotion rather than age itself. On the other hand, we expect that older maternal age and maturity enhance parenting skills and maternal well-being, which benefits the child. We contribute to the literature by providing novel insights for European contexts, i.e. Germany, while investigating the

theory-derived mechanisms linking maternal age to child development, instead of focusing on overall relationships.

We use multiple waves based on the NEPS Newborn Cohort 1 to analyze the relation of advanced maternal age with both standardized cognitive child outcomes, i.e. math and vocabulary, as well as non-cognitive, social-emotional development (NEPS Network, 2023; 2012-2021; N=2,387). We further shed light on the mechanisms of the age-child-relationship, investigating maternal parenting skills, well-being and family resources. Results from OLS regression show inversely U-shaped associations between maternal age at birth and both cognitive and social-emotional development, with largest gains of older age before and during mothers' twenties. However, our mechanisms only partially explained this relationship, with parenting quality and family resources emerging as main drivers, whereas maternal well-being only played a minor role. A closer look on heterogeneities in the relationship by maternal education demonstrates, that for tertiary-educated mothers, age at birth only plays a minor role, whereas for non-tertiary-educated mothers, we observe stronger increases in cognitive child abilities until mothers' age 30.

In sum, our results support previous evidence from Europe and the US (Goisis et al., 2017; Grätz & Wiborg, 2024; Kalmijn & Kraaykamp, 2005; Trillingsgaard & Sommer, 2018), and point out similarly that particularly positive associations of postponement are only relevant until mother's thirties (Addo et al., 2016; Augustine et al., 2015; Duncan et al., 2017; Fishman & Min, 2018). Contributing by uncovering the key drivers of maternal age impacts, we further support no-findings from family FE studies (Barclay & Myrskylä, 2016; Duncan et al., 2018; Fredriksson et al., 2022), as the mechanisms account for large parts of the association. Overall, maternal age seems to be influential even in the European setting with more supportive institutional settings compared to the US. We contribute to a deeper understanding of aging societies by investigating the mechanisms that underlie maternal age at birth and child development.

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Chapter II – The Early Interplay of Childcare Histories and Maternal Work Trajectories: A Multichannel Sequence Analysis

Abstract

Objective: This study examines the joint development of childcare and maternal employment trajectories and their social structure.

Background: Early childhood represents a critical period when families organize care and employment under institutional constraints and normative expectations. Decisions about maternal employment and childcare are interconnected and shape both gender inequalities in the labour market and children's early life conditions. Capturing how these arrangements evolve requires a trajectory-based perspective, considering their interrelated dynamic development across early family life courses.

Method: We use linked survey and administrative data (NEPS-ADIAB) on n=1521 mother-child dyads in Germany from register-based sampling, providing full panel details on care and employment. Multichannel sequence analysis models monthly trajectories across both domains until age five. Multinomial regressions assess how socio-demographic, attitudinal, and contextual factors are associated with cluster affiliation.

Results: Six childcare-work clusters emerged, categorized into two overarching patterns: family-focused patterns show low workforce and family-dominant care, whereas work-centred patterns reveal intense employment and early institutional care. Education and preferences emerge as key differentiator, with minor relevance of contextual factors.

Conclusion: Findings highlight that reconciling childcare and employment is shaped by multiple, socially stratified pathways into diverse arrangements, rather than a unified strategy, as similar childcare strategies do not translate into similar employment patterns, and vice versa. Analysing work and childcare as interdependent trajectories reveals inequalities in childcare-work-patterns that remain obscured in previous transitional approaches.

Keywords: Maternal Employment, Formal and Informal Childcare, Childcare Arrangements, Mothers' Reconciliation of Work and Care

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1. Introduction

In recent decades, European countries have increased funding for early childhood education and care (ECEC) to support maternal employment. In Germany, public expenses rose up to 36 percentage points between 2014 and 2022 (European Commission, EACEA, & Eurydice, 2025). Despite these efforts, there is still a mismatch between families' childcare needs and the ECEC supply regarding slots and hours (BMFSFJ, 2023). This limited provision increases reliance on alternative caregivers to enable maternal employment. As employment rates for mothers of one-year-olds grew to 46% and further rise with child age, the need for external non-parental childcare becomes increasingly evident (Statistisches Bundesamt, 2023). Given that maternal employment rates still exceed the usage rates of ECEC for young children (BMFSFJ, 2023), the question arises of how mothers reconcile work and childcare.

Existing research primarily examines formal childcare supply as a prerequisite for maternal employment but highlights inequalities in childcare usage and mothers' return. Literature has shown that ECEC uptake is socially selective: more advantaged families enrol their children earlier and more often in formal childcare (Pavolini & van Lancker, 2018; Steinberg & Kleinert, 2022). This aligns with evidence that childcare supply enables maternal employment, but unequally (Bauernschuster & Schlotter, 2015; Huber & Rolvering, 2023; Müller & Wrohlich, 2020). Mothers who are partnered (Boll & Lagemann, 2019), have younger children (Bousselin, 2022), are born in West Germany or have higher education (Zoch, 2020) benefit most from childcare expansions regarding employment or working hours. The small evidence on informal childcare, particularly on grandparental care, is mixed, showing stronger usage among families with lower socio-economic status (SES) (e.g., Jappens & van Bavel, 2012; Steinberg, 2025) and indicating higher maternal employment due to informal childcare uptake (e.g., Bünning, 2017; Thil, Lawson, & Lefebvre, 2023). However, the interaction between formal and informal childcare arrangements is rarely examined explicitly and most studies focus on single transitions, neglecting a trajectory-based perspective that accounts for the simultaneous development of childcare and employment over time.

Some literature acknowledged diversity in trajectories for childcare use and maternal employment, but a joint perspective remains underexamined. One study on childcare histories in the German context showed that families combine various formal and informal arrangements, with selection significantly influenced by social and regional factors (Steinberg, 2025). However, the existing analysis is limited on the period up to age three.

For employment trajectories, Fauser, Struffolino, & Levanon (2025) demonstrated that ECEC expansions contributed to a convergence of maternal work patterns between East and West Germany. Nevertheless, differences persist after childbirth, as West German mothers take longer maternity leave or remain inactive, compared to East German mothers, who follow trajectories of early full-time employment (Fauser et al., 2025; Simonson, Gordo, & Titova, 2011). Main differences in US mother's work histories after childbirth emerge in terms of continuous employment and working hours, the

timing of return, and non-employment (Hynes & Clarkberg, 2005; Killewald & Zhuo, 2019; Lu, Wang, & Han, 2017). Similar to European contexts, employment reductions occur after childbirth (Reichert, Emery, & Bartova, 2024). Most trajectories are socially selective, with more stable careers for higher-educated mothers, whereas the lower educated tend to follow homemaker trajectories (Cabello-Hutt, 2020).

The only study investigating both life domains of childcare and employment jointly highlighted the diversity of patterns between SES groups. Lower-SES, US mothers are more likely inactive and provide care themselves or use relative care (Shattuck, 2022). Shattuck (2022) revealed greater labour market attachment, more stable partnership trajectories, and stronger non-parental childcare among higher-educated mothers, and also identified dropouts of stay-at-home moms. However, the binary childcare classification fails to account for the diversity of childcare arrangements, and the analyses only include employed mothers, thus, neglecting trajectories characterised by inactivity. Moreover, US-findings lack applicability to Europe due to differing social systems, such as the absence of universal childcare or parental leave (Bordone, Arpino, & Aassve, 2017). To the best of our knowledge, no other study examines this complex interplay of childcare and employment in the European context.

Focusing on Germany, we investigate (1) how maternal employment trajectories are interrelated with the usage of different childcare types; and (2) how the families behind the different childcare-work trajectories vary by socio-economic background. Based on the German *National Educational Panel Study (NEPS)*, we use a survey of newborns and their mothers (NEPS-Network [LIfBi] et al., 2023; NEPS-SC1-ADIAB7521; doi: 10.5164/IAB.NEPS-SC1-ADIAB7521.de.en.v1; 2012-2017, N=1,521), containing detailed information on childcare type from birth until age five, linked with administrative records on maternal employment. Firstly, we use multichannel sequence analysis (MCSA) and cluster analysis (CA) to capture holistic life-course trajectories and identify dyadic childcare-work patterns considering both life domains jointly. Secondly, we identify how socio-economic, life-course, attitudinal, and contextual characteristics that predict mother's cluster affiliation, using multinomial regression analysis. Although we recognize fathers as important for shaping childcare and employment decisions (e.g., Fanelli & Profeta, 2021), we focus on mothers, who remain to carry the main burden of reconciling paid and unpaid work (e.g., Felfe, 2012; Hobler et al., 2017; OECD, 2016) and have more complex employment trajectories affected by parenthood (McMunn et al., 2015; Struffolino, Studer, & Fasang, 2016).

Our study contributes in several ways: (1) We provide novel evidence on the joint interplay between childcare histories and maternal employment trajectories, which have previously been investigated separately (e.g., Fauser et al., 2025; Steinberg, 2025) or in combination with other life domains, neglecting the key relevance of childcare (e.g., Firat, Visser, & Kraaykamp, 2023). This offers new insights on gender inequalities regarding mothers' reconciliation of work and family during a life stage when career development and family formation compete with each other. (2) Using panel data, we adopt a dynamic trajectory-based perspective that links durations in and transitions between work and

childcare, rather than focusing on isolated events. Given mothers' unstable careers (e.g., Struffolino et al., 2016), our approach uncovers long-term patterns of stability, change, and diversity in work and childcare trajectories, surpassing conventional transition analyses. (3) Unlike previous studies, our data allows us to elaborate on the full range of childcare and employment statuses. We differentiate formal and informal childcare and their combinations, overcoming limitations of binary indicators (Aassve, Billari, & Piccarreta, 2007; Marco, Crouter, & Vernon-Feagans, 2009; Shattuck, 2022) and short-term perspectives (Steinberg, 2025). Our data also provides more details on employment (Cabello-Hutt, 2020; Killewald & Zhuo, 2019; Shattuck, 2022), distinguishing employment intensity and inactivity, which have different implications for family dynamics. These details provide greater analytical depth and the possibility to investigate trajectories with lower labour market participation, which have often been neglected (e.g., Shattuck, 2022). Thus, we provide a detailed overview of dyadic childcare-work patterns, offering a richer representation of social realities in the European context.

2. Theoretical Considerations

2.1 Conceptual Framing of Life-Courses

We apply the life course approach (LCA) as a conceptual frame to explain the pre-structured nature of trajectories and to emphasize the value of a joint trajectory-based perspective (Elder, Johnson, & Crosnoe, 2003; Mayer, 2004). Mothers actively shape their own and their child's life courses through *human agency* in different life domains (Elder et al., 2003). In the context of childcare and employment, these domains are mutually interdependent and compete with each other (*multidimensionality*; Mayer, 2004), as mothers can either provide childcare or participate in the labour market. Thus, maternal employment decisions cannot be disentangled from childcare decisions (*linked lives*; Elder et al., 2003).

Life courses are *multilevel processes* (Mayer, 2004) affected by historical, social, and institutional contexts on the macro level, dependent on *time and place* (Elder et al., 2003), and shaping family biographies on the micro level. The German welfare state provides attractive family support: Following 14 weeks of paid maternity leave around childbirth, parents can take up to 36 months of job-protected parental leave, including 14 months of paid leave benefits at 67% of income shared between parents. Moreover, children in our data are legally entitled to formal childcare at age three (Kindergarten), reflecting today's high usage of 92% (BMFSFJ, 2023). Nurseries (Krippe) for children aged one to three are utilized at a lower rate of 36% in 2022.

Childcare demand exceeds supply, particularly for younger children, creating a competitive market that restricts parental choice (BMFSFJ, 2023). Insufficient supply possibly reinforces socially selective childcare-work patterns, as institutions prioritise employed or better-off parents when allocating placements, also to avoid legal action (Steinberg, Schüller, Öztürk, Klein, & Schober, 2024). In light of

this scarcity, mothers still need to opt for alternative caregivers. For example, half of families in Germany consistently rely on grandparental care (e.g., Zanasi, Arpino, Bordone, & Hank, 2023).

Within macro contexts, social norms and cultural settings affect preferences on the *micro level* and shape childcare and employment decisions. According to *Preference Theory* (Hakim, 1998), women are (1) *work-centred* (having no children), (2) *home-centred* (focusing on family), or (3) *adaptive* (choosing a lifestyle in between the two poles of family and career). This study focuses on the latter two groups. Home-centred women are likely more traditional with stronger normative ideals of intensive mothering (Hays, 1996). This ideal positions children as the primary priority, leading mothers to forgo early employment and external childcare (e.g., Diabaté & Beringer, 2018), although grandparental care is often more readily accepted (Jappens & van Bavel, 2012). Prevailing traditional norms likely pose challenges for more egalitarian, adaptive women. Despite their stronger work-oriented preferences, strengthening norms of maternal employment might intensify the pressure to work and care for the family (Shattuck, 2022). Due to Germany's historical division, these preferences also vary by region: Whereas the socialist legacy of the former GDR promoted full-time maternal employment and provided extensive childcare supply, making mothers more egalitarian and work-oriented (Bauernschuster & Rainer, 2012), in the West, mothers typically followed traditional, home-centred norms. These historical macro-differences still exist, despite convergence between both regions (Fauser et al., 2025; Simonson et al., 2011; Zoch, 2021).

The principle of *timing* (Elder et al., 2003) emphasizes that identical life-course transitions are evaluated differently depending on when they occur in children's lives. Ideals on timing of ECEC can be influenced by availability, enhancing perceived appropriateness and acceptance of external childcare and maternal employment (Neimanns, 2021; Zoch & Schober, 2018). Moreover, timing is also key when mothers prefer informal grandparental care: healthy, retired grandparents are more likely locally available for childcare when mothers start families at younger ages (e.g., Seilbeck & Langmeyer). This is more common among lower-SES families (e.g., Doepke, Hannusch, Kindermann, & Tertilt, 2022), who also exhibit less geographical mobility (e.g., Brandén, 2013). The closer grandparents live, the more care they provide (Barschkett, Spiess, & Ziege, 2022), potentially explaining why high-educated parents rely less on family care (Seilbeck & Langmeyer). Additionally, high-educated mothers may depend less on informal care, as they are less likely to work non-standard hours, whereas informal childcare offers greater flexibility to accommodate needs for non-standard hours of lower-SES families (e.g., Hepburn, 2018; Marco et al., 2009; Morrissey, 2008).

2.2 Childcare and Employment Decisions as Rational Choices

From a rational choice perspective, individuals aim to maximize net utility by weighting the costs and benefits of decisions (Becker, 1975; Opp, 1999). We regard decisions on mothers' employment and childcare enrolment as human capital investments, reflecting past human capital and shaping future

investments (Becker, 1975; Breen & Goldthorpe, 1997). This perspective aligns with the principle of *self-referential processes* of the life-course framework (Mayer, 2004). Those mothers who invested already more in their human capital and expect higher returns from employment are more likely to continue working to advance their future careers (Mincer & Polachek, 1974). The underlying factors of decision-making processes can vary systematically based on SES, resulting in a disparate selection of mothers into specific childcare-work patterns, depending on their resources and needs regarding employment and childcare (Breen & Goldthorpe, 1997; Kim & Fram, 2009; Steinberg, 2025).

2.2.1 Costs and Constraints

Childcare and employment decisions entail direct and indirect costs. External caregivers cause direct monetary costs. In Europe, formal childcare is more expensive than informal childcare, which often is free of charge, such as grandparental care, whereas other informal options, such as nannies, play a negligible role. In Germany, costs vary by region and age group, with higher costs for younger children (Schmitz, Spieß, & Stahl, 2017). Despite increasingly rising costs for ECEC, they remain comparatively low from an international perspective due to expanded income-dependent subsidies benefiting disadvantaged families. However, these fees still place a greater financial strain on low-income households. As a result, lower SES families may rely on cheaper informal care and more complex combinations (e.g., Scott, London, & Hurst, 2005).

Indirect opportunity costs occur for mothers as primary caregivers, as they forfeit income and miss potential career opportunities (Becker, 1975; Mincer & Polachek, 1974). Longer employment interruptions increase motherhood penalties due to depreciation of human capital and loss of qualifications, lowering future career opportunities (Adda, Dustmann, & Stevens, 2017; Aisenbrey, Evertsson, & Grunow, 2009). Absence from the labour market is less costly for low-educated women, whereas higher-educated mothers face greater opportunity costs (Doepke et al., 2022; Firat et al., 2023), making early external childcare more attractive. Especially formal childcare can reduce opportunity costs due to its high reliability, enabling mothers to work more (e.g., Bryson, Brewé, Sibieta, & Butt, 2012; Morrissey, 2008). Conversely, if family resources are scarce, mothers may need to return to work earlier to increase household income. However, the financial benefits of working are significantly reduced when childcare costs exceed potential income, making formal childcare less attractive (Connelly, 1992).

Moreover, childcare and employment decisions incur indirect psychological costs shaped by societal gender norms and networks. According to *doing gender* theory, mothers benefit from engaging in gender-appropriate female behaviours, such as being a homemaker, and may compensate for supposedly deviating behaviour to mitigate these costs (Brines, 1994; West & Zimmerman, 1987). Conflicting maternal beliefs or constraints with network expectations can result in increased costs (Grunow & Lietzmann, 2021; Hakim, 2002; Jappens & van Bavel, 2012; Khoudja & Fleischmann, 2018). Societal expectations and the perceived intensity of these norms vary across social groups, thereby

shaping socially selective decisions: higher-status individuals tend to have less traditional views and greater acceptance of maternal employment (e.g., Deole & Zeydanli, 2021; Neimanns, 2021). Given that mothers value non-parental care more when children are young (Lippert, Hüsken, & Kuger, 2022; Mincer & Polachek, 1974; Schenck, 2019), the costs of external childcare decrease over time.

2.2.2 Utility

Take-up of external, high-quality childcare can be viewed as early educational decision. High-quality childcare extends exclusive family investments by providing distinct learning opportunities that shape early experiences and can have long-lasting consequences for child development (e.g., Bronfenbrenner & Morris, 2006; Cunha & Heckman, 2010). Although the evidence is mixed (e.g., Ghirardi, Baier, Kleinert, & Triventi, 2023; Schmid, 2026), there is consensus about the beneficial impacts of ECEC for children with lower socioeconomic status (e.g., Ghirardi et al., 2023; Schmutz, 2024). Less is known about the implications of informal childcare, which may offer fewer developmental investments, especially in low-SES families or if grandparents are working or face health issues (e.g., Barschkett et al., 2022; Del Boca, Piazzalunga, & Pronzato, 2018; Ghirardi & Gioachin, 2025). Nevertheless, families may favour informal care due to perceived negative impacts of formal childcare (Lippert et al., 2022).

Mothers may anticipate the benefits of high-quality childcare, frequently discussed in the literature, even if these considerations are not based on scientific knowledge. Following the status attainment model (Breen & Goldthorpe, 1997), higher-SES mothers aim to secure their children's educational success and choose institutional childcare as a strategic investment. SES-based parenting behaviour is also indicative of this investment perspective, as higher-SES families tend to participate more in beneficial activities (e.g., Kluczniok & Mudiappa, 2019; Mikus, Tieben, & Schober, 2021). Furthermore, higher-SES parents tend to be more quality-conscious in their childcare choices, as higher quality perceptions increase childcare take-up (Grogan, 2012; Philipp, Büchau, Schober, Werner, & Spiess, 2025; Stahl & Schober, 2020).

Given the explorative approach of this study, we refrain from formulating formal hypotheses regarding the nature and prevalence of childcare-work trajectories. Instead, we offer analytical guidance based on expectations of socially selective decision-making, in line with our theoretical arguments. Regarding the first research question about the interplay of childcare-work trajectories, we anticipate that a key differentiator between patterns are labour market intensity and the timing of employment returns and formal childcare enrolment, characterised by stability in both domains. According to our second research question regarding socioeconomic disparities in childcare-work patterns, we expect that trajectories of disadvantaged mothers likely involve instability or inactivity, paired with longer periods of maternal care. Notably, maternal non-employment is ambiguous, as it may represent a privilege for the most advantaged and a constraint for the least advantaged.

3. Data and Method

3.1 Data and Sample

We examine the interplay between childcare and maternal work trajectories using MCSA and CA. Our analysis is based on longitudinal data from the NEPS *Newborn Starting Cohort* (NEPS-SC1; see Blossfeld & Roßbach, 2019; NEPS Network, 2023), which surveyed mothers and their infants born between February and July 2012, using a register-based, two-stage disproportional stratified sampling technique. Interviews with the mother were conducted annually, providing rich details about monthly childcare usage and family characteristics.

The Institute for Employment Research (IAB) merged the NEPS with mothers' administrative employment biographies if consent was given (NEPS-Network (LifBi) et al., 2023; NEPS-SC1-ADIAB7521, 2012-2017). Social security records stem from obligatory employer reports to health, pension, and unemployment insurance, ensuring high accuracy of daily information. This data limited to employees subject to social security contributions, excluding self-employed, freelancers, civil servants, and soldiers. Nevertheless, this uniquely linked panel data is well-suited for examining the interplay between childcare and maternal work trajectories, due to its high level of detail.

The gross NEPS sample included 3,481 individuals. We identified biological and adoptive mothers from the first wave (n=3,473) who consented to linkage with administrative records in the fourth wave, resulting in successful matching for n=2,014 individuals. We further excluded individuals with exclusively empty spells as well as men, who both are not part of our population of interest (n=1,803). Following technical recommendations (Dlouhy & Biemann, 2015), we dropped dyads with over 30% missing information on employment spells or childcare arrangements between childbirth and age five (n=285). Ultimately, the study includes n=1,521 mother-child dyads with monthly data for the first 60 months of the children's lives (more details on sample restrictions are available in Table A-II.1).

We analysed first and higher-parity births of mothers to capture the full heterogeneity of family life courses, including complex family structures. This approach allowed us to use a less selective sample, increase statistical power, and identify undetected patterns. In line with the LCA, we also captured path dependencies reflecting the cumulative nature of maternal decisions, as childcare-work trajectories are influenced by prior births, revealing additional trajectories that would otherwise be omitted.

3.2 Analysis Strategy

Our analysis followed a three steps procedure. Firstly, we applied sequence analysis (SA), more specifically MCSA (Gauthier et al., 2010; Pollock, 2007), a holistic approach that captures the longitudinal and interdependent nature of entire trajectories over time rather than modelling

probabilities between states (Aisenbrey & Fasang, 2010). This way, we identify the most prevalent patterns in individuals' childcare and employment biographies jointly.

Sequence similarity is assessed through sequence alignment, which transforms sequences via insertions, deletions, and substitutions to minimize transformation costs (Studer & Ritschard, 2016). In the multichannel setting, substitution costs are specified separately for childcare and employment but sequence alignment is performed jointly, resulting in a joint cost matrix that captures all possible state combinations across both domains (Aisenbrey & Fasang, 2017). As no single alignment algorithm is universally optimal (Studer & Ritschard, 2016), we tested several specifications, including optimal matching, (dynamic) hamming distance, and time warp edit distance, using both constant and transition-based substitution costs. As results were highly consistent across specifications, we relied on the standard *optimal matching algorithm* (OMA) with constant substitution costs and indel cost of 2. Only transitions between parental leave states and between birth-related non-employment and inactivity had substitution costs set to zero, reflecting their conceptual similarity. The resulting distance matrix captures pairwise dissimilarities in joint childcare-work trajectories.

Secondly, we applied CA to group similar trajectories into distinct and interpretable childcare-work clusters. Thus, we applied partitioning-around-medoids (PAM) clustering, initialised with Ward's hierarchical linkage method (Kaufman & Rousseeuw, 1990; Studer, 2013). This approach combines the advantages of hierarchical clustering in structuring the data with PAM's ability to optimize cluster assignment, ensuring high internal homogeneity and clear differentiation between clusters. Determining the optimal number of clusters in SA involves both statistical and substantive considerations (Aisenbrey & Fasang, 2010). We adopted a combined strategy drawing on established cluster quality criteria (Studer, Ritschard, Gabadinho, & Müller, 2011) and on the substantive interpretability of cluster solutions (Aisenbrey & Fasang, 2010; Brzinsky-Fay, 2007). Whereas statistical indicators, including point biserial correlation (PCB) and the average silhouette width (ASW), suggested a six- or seven-cluster solution (Appendix Figure A-II.1), we selected the six-cluster solution because PCB and ASW were almost identical and the six-cluster solution provided the clearest and theoretically most meaningful differentiation between childcare-work trajectories. Moreover, individual silhouette values per cluster indicate high internal homogeneity and external heterogeneity (Appendix Figure A-II.2).

Thirdly, we examined the probability of affiliation with the six derived childcare-work patterns with the families' socioeconomic background using multinomial regression. To reduce potential bias from item nonresponse, we employed multiple imputation ($M=50$) by chained equations (Little & Rubin, 2002; see Appendix Table A-II.3).

3.3 Operationalization

Information on childcare status stems from mother-reported spell data from NEPS, which included monthly reports of start and end dates of childcare usage. We created eight categories: exclusive “parental care”, paid formal childcare in “institution”, or by a “childminder” (including nannies and au-pairs); unpaid informal childcare by “kinship” (grandparents, other relatives, friends, neighbours), and their various combinations.

We obtained information on nine states of monthly maternal employment status mainly from administrative records of employee history, indicating working status and scope of employment, i.e., “full-time”, “part-time”, and “marginal”. Information on “unemployment” stems from unemployment benefit recipient and jobseeker histories. Details on “parental leave” for the focal child and “parental leave for siblings” were taken from NEPS spell and yearly survey information. Similarly, NEPS data is included for phases of “inactivity” for mothers without employment due to education, illness, or being a homemaker. To visualize additional births for inactive mothers without parental leave entitlement, we labelled one-year periods following childbirth as “not working childbirth”.

In the multinomial regressions, covariates were either time-constant or measured at the start of the trajectories to avoid endogeneity and conceptual issues related to anticipatory analyses (Hoem & Kreyenfeld, 2006; Studer, Struffolino, & Fasang, 2018). We conditioned on SES, including maternal education (low, intermediate, high) and net household income around time of birth. Family life-course dynamics were operationalized by maternal age at birth and the number of older siblings. We captured normative orientations through attitudes towards the importance of maternal employment, the perceived usefulness of childcare for employment, and the idealistic age for ECEC enrolment. In a similar vein, we consider maternal socialization by including mother’s region of birth (East, West, abroad). Lastly, regional unemployment rates and childcare provision at the district level in 2011, prior to childbirth, capture the structural embeddedness. Further information on all variables is available in the appendix Table A-II.2.

4. Results

4.1 Identifying Childcare-Work Patterns

The first research question investigates how childcare trajectories relate to mothers’ employment histories. Therefore, Figure II.1 presents the relative frequency (RF) plots (Fasang & Liao, 2014) of our six clusters, each representing a distinct childcare-work pattern over the first 60 months following childbirth. Complementary state distribution plots are shown in Figure II.2. In both figures, cluster size corresponds to the cluster’s relative share in the sample.

Drawing on differences in the timing and type of childcare arrangements, as well as patterns of labour market re-entry and the intensity of maternal employment, we further categorized clusters. The first

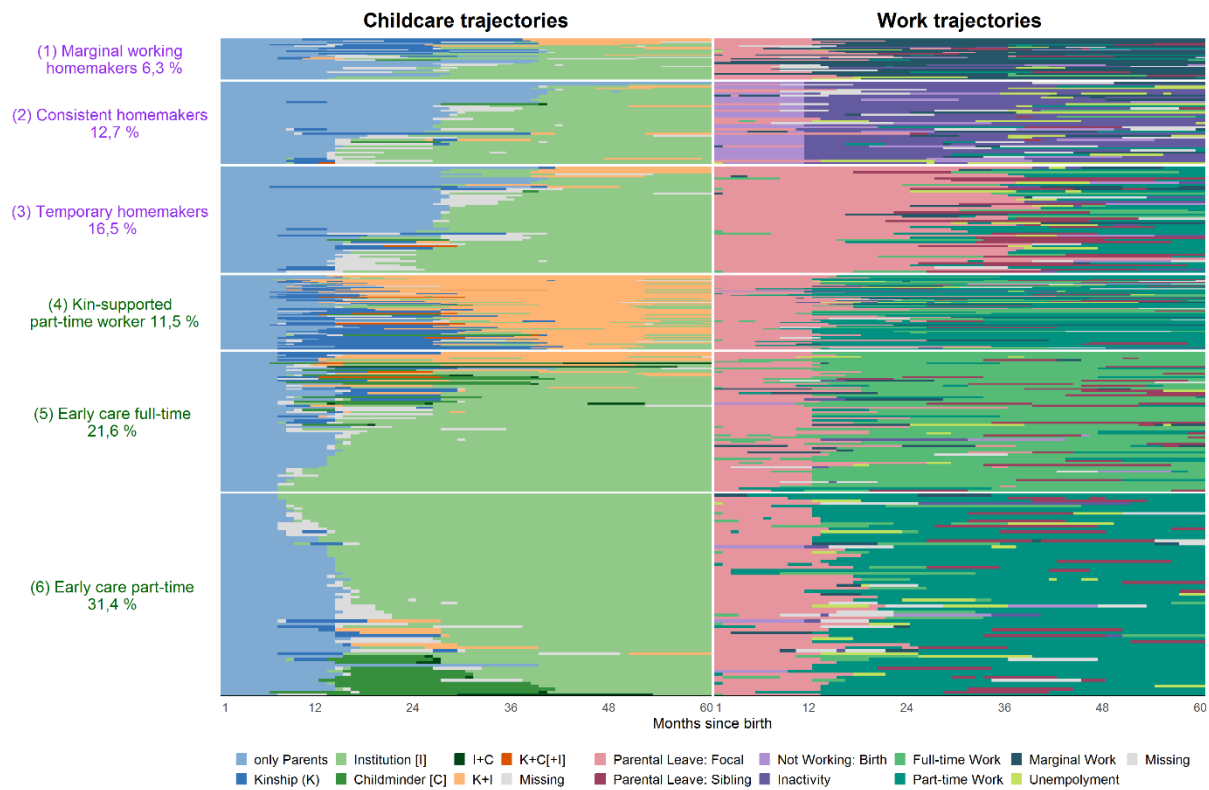


Figure II.1: Relative Frequency Plots of Childcare-Work Patterns by Cluster

Note: In RF plots, sequences are ordered by their silhouette width, with the higher-ranked, most representative cases in reflecting the typical structure of the cluster displayed at the top, whereas lower-ranked sequences indicate greater internal variation. Information on sequence representativeness is provided in Figure A-II.4. Each line displays between 3 and 7 representative individual sequences. Childcare sequences on the left correspond to the work sequences on the right.

Source: NEPS-SC1-ADIAB7521, 2012-2017, own illustration.

comprises *family-focused* patterns (cluster 1 to 3), with extended periods of parental or family care and low labour market participation. The second encompasses *work-centred* patterns (clusters 4 to 6), characterised by early external childcare and high maternal employment, with 64.5% of the sample falling in this category. Although clusters in these categories share similarities in timing and duration of childcare and employment, they also exhibit systematic within-variation. Table II.1 summarizes the clusters' key characteristics. Further details on status durations and transitions are reported in Table A-II.4 and Figure A-II.3 in the appendix.

4.1.1 Family-Focused Patterns (Clusters 1–3)

Clusters in family-focused patterns predominantly comprise mothers with low or intermediate education. Whereas high-educated mothers make up to 26.7% in Cluster 3, this share amounts to 13.5% and 17.5% in Clusters 1 and 2, respectively (overall: 35.7%). Conversely, the proportion of low-educated mothers ranges from 13.9% to 33% (overall: 10.5%).

Table II.1: Descriptive Statistics for Six Childcare-Work Clusters

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Total
N	96	194	251	175	328	477	1,521
Cluster Size %	6.3	12.7	16.5	11.5	21.6	31.4	100
Education Mother (%)							
Low	24.0	33.0	13.9	8.6	2.4	3.1	10.5
Intermediate	62.5	49.5	59.4	55.4	52.1	51.4	53.8
High	13.5	17.5	26.7	36.0	45.4	45.5	35.7
Birthplace Mother (%)							
West Germany	60.4	55.7	71.7	70.9	48.8	57.9	59.6
East Germany	7.3	18.6	11.6	13.1	37.8	31.4	24.3
Abroad	32.3	25.8	16.7	16.0	13.4	10.7	16.2
Maternal Age at Birth	31.6	30.9	32.0	32.3	32.6	32.4	32.1
	(4.9)	(5.9)	(4.5)	(4.9)	(4.1)	(4.4)	(4.7)
Number of Older Siblings	0.9	1.4	0.6	0.6	0.5	0.7	0.7
	(1.0)	(1.4)	(0.8)	(0.8)	(0.8)	(0.9)	(1.0)
Household Income (log.)	3258.4	2786.3	3345.7	3361.9	3612.8	3605.7	3410.5
	(2546.2)	(1446.5)	(1612.5)	(1551.7)	(1510.3)	(2053.0)	(1803.9)
Importance Work (%)							
Low/Medium	43.8	57.7	49.0	29.1	13.7	19.6	30.7
High	56.2	42.3	51.0	70.9	86.3	80.4	69.3
Childcare Utility (%)							
Low/Medium	28.4	46.9	21.5	13.8	7.1	10.6	17.8
High	71.6	53.1	78.5	86.2	92.9	89.4	82.2
Idealistic Age Childcare (years)	2.4	2.6	2.5	2.2	1.6	1.8	2.0
	(0.8)	(1.0)	(0.8)	(0.8)	(0.8)	(0.8)	(0.9)
Unemployment Rate	7.4	8.7	7.9	7.6	8.4	8.4	8.2
	(2.6)	(2.6)	(2.6)	(2.7)	(2.7)	(2.6)	(2.7)
Childcare Rate for Under Threes	20.1	25.0	23.8	23.9	28.2	28.4	26.2
	(6.9)	(12.9)	(10.5)	(11.2)	(12.1)	(12.0)	(11.8)

Note: Cluster 1, Marginal Working Homemakers; 2, Consistent Homemakers; 3, Temporary Homemakers; 4, Kin-Supported Part-Time Workers; 5, Early Care Full-Time; 6, Early Care Part-Time.

Source: NEPS-SC1-ADIAB7521, 2012-2017, INKAR 2025; own calculations.

Mothers born in West Germany were represented at above-average rates (up to 71.7% in Cluster 3 and 32.3% in Cluster 1; overall 59.6%), whereas those born in East Germany were considerably less (maximum of 18.6% in Cluster 2; overall 24.3%). In attitudinal terms, these mothers place below-average importance on employment, show a lower perceived usefulness of ECEC for employment, and a higher ideal age for childcare enrolment compared to the sample average.

Childcare trajectories in these clusters are relatively homogeneous and characterised by extended periods of exclusive parental care, often lasting until the child is approximately two and a half to three years old. The average duration of exclusive parental care ranges from 18.7 to 23.4 months, substantially above the overall mean of 14.5 months (for cluster details see Table A-II.4 and Figure A-II.3). Around the child's first birthday, some families implement family care. In Cluster 1 (n=96), up to 42.7% of children receive relative care at least once between six months and three years of age, peaking at age two. Mothers in the family-focused patterns rarely utilized institutional childcare before

age two but it gains importance around age three, coinciding with typical Kindergarten entry in Germany, but the usage remained below-average.

The main difference within family-focused clusters concerns employment trajectories. Cluster 1 is characterised by early marginal employment: on average, mothers spent 60% in marginal employment – well above the overall average of 7% (Figure A-II.3). Although many of these mothers take about 12 months of parental leave, about 37.5% are already marginally employed during the first year after birth. By the child's third birthday, 84.4% are marginally employed, and only 1% leave this status that time. However, marginal employment declines by up to 59.4% by age five, whereas the part-time working share increases up to 19.8%. The increased use of external childcare, correlates with mothers' employment status, allowing them to increase their work intensity. Given the stronger home-centred and family involvement in childcare and the predominance of marginal work, we label this cluster *Marginal Working Homemakers*.

In contrast, employment trajectories in Cluster 2 (n=194) and Cluster 3 (n=251) are characterised by long periods of inactivity. Mothers in Cluster 2 spend an average of 50 months outside the labour market, which is more than twice as long as the overall average. By the child's third birthday, only 9.3% are employed (overall: 63.4%). We therefore refer to this cluster as *Consistent Homemakers*. In Cluster 3, labour market withdrawal is more closely tied to the family formation phase, as many mothers are on parental leave with the focal child or subsequent siblings, which extended the already longer employment interruptions. From around 30 months after childbirth, part-time employment increases slightly to 13.9% by month 60, whereas full-time employment remains rare at 3.6%. Unlike in Cluster 1, the use of external childcare precedes the mother's return to work. As labour market disengagement appears concentrated around childbearing, we label this cluster *Temporary Homemakers*.

4.1.2 Work-Centred Patterns (Clusters 4–6)

In clusters of work-centred patterns, the proportion of highly educated mothers is above average, ranging from 36% to 45.5% (overall: 35.7%), with small shares of low-educated mothers (maximum of 8.6% in Cluster 4). Except for Cluster 4, mothers born in East Germany are overrepresented in Cluster 5 by 13.4 and in Cluster 6 by 7.1 percentage points. Mothers following work-centred patterns place above-average importance to paid work and they view institutional childcare as particularly supportive of employment. Accordingly, the ideal age for external childcare enrolment is below-average.

Childcare trajectories in these three clusters show early use of external care. The average duration of exclusive parental care ranges from 9.6 months to 11.3 months, below the overall mean of 14.5 months. Some families introduce external care before parental leave ends – either within the family or institutionally. In Clusters 5 (n=328) and 6 (n=477), institutional childcare becomes dominant from age one onward, reaching up to 85% by age three. On average, children in cluster 6 spent 64% in institutional care, exceeding the overall duration by 14 percentage points. In Cluster 6, larger shares

of mothers rely on childminders for children aged one to three, before they transition to institutional care (Figure II.1).

All three clusters were further characterised by at least 12 months of parental leave, reflecting Germany's institutional context. Following this period, 85.1% and 81.1% of mothers, respectively, returned to work, either in full-time (Cluster 5) or part-time (Cluster 4 and 6). After approximately 24 months, the share of mothers taking another period of parental leave increases across all three clusters. As the predominant use of institutional childcare correlates with intense maternal employment in Cluster 5 and 6, we label them *Early Care Full-Time* and *Early Care Part-Time*.

Cluster 4 (n=175) exhibited similar employment trajectories to the *Early Care Part-Time* Cluster but differed substantially in childcare histories. The extended family network played a prominent role, particularly during the first 18 months after childbirth. Children spent an average of 11.3 months in care by relatives (overall: 3.4 months). As children aged, institutional childcare complemented family care rather than replacing it, unlike in Clusters 5 and 6 (Figure II.1). The proportion of exclusive institutional care remained the lowest among all clusters. Based on these features, we label Cluster 4 *Kin-Supported Part-Time Workers*.

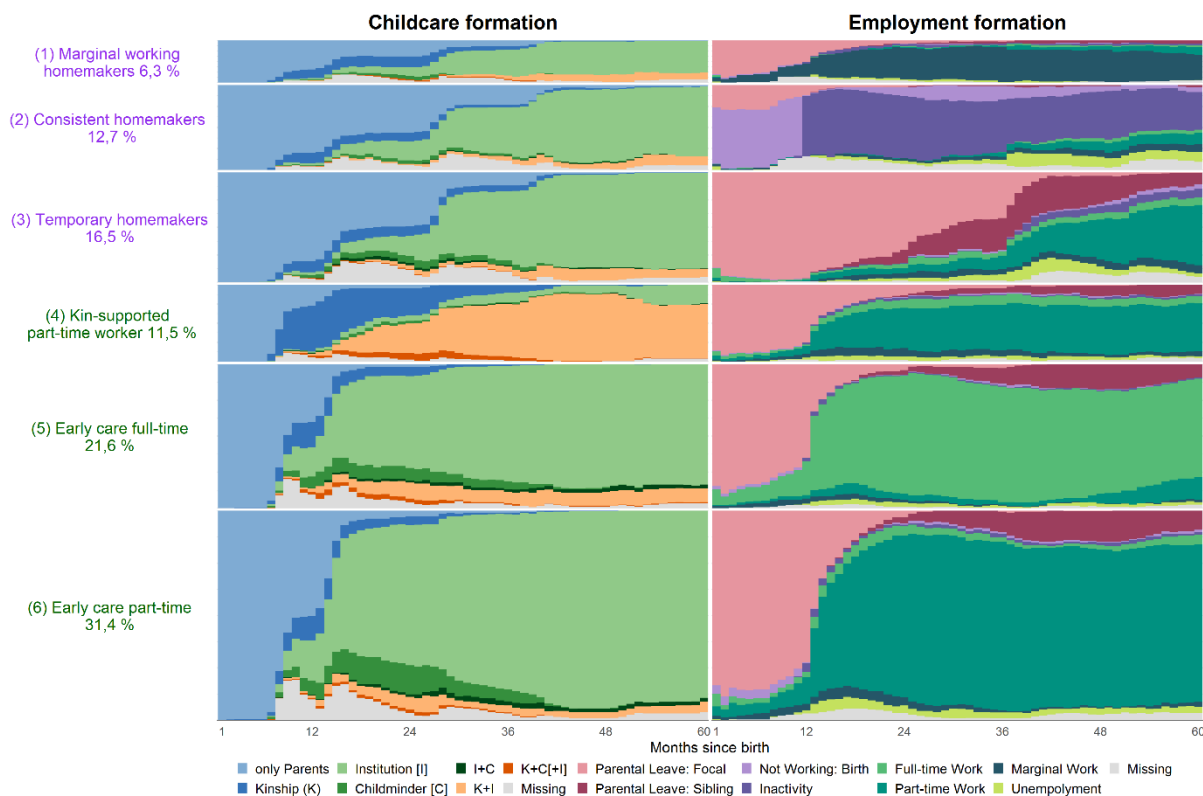


Figure II.2: State Distribution Plot of Childcare-Work Patterns by Cluster

Note: Each month displays the proportion of individuals in a given state.

Source: NEPS-SC1-ADIAB7521, 2012-2017, own illustration.

4.2 Describing the Families Behind the Patterns

In answering our second research question – how the families behind the different childcare-work trajectories vary by SES – we conducted multinomial regression analyses to predict cluster affiliation. Figure II.3 displays the association of our controls on the probability of belonging to each cluster as average marginal effects (AMEs; see Table A-II.5). We structured the results along four analytical dimensions: (1) SES, (2) family life-course dynamics, (3) normative orientations, and (4) regional and structural embeddedness. This approach profiles the clusters as socially structured configurations, instead of merely variable by variable.

4.2.1 Socio-Economic Status: Education and Income

The most pronounced differences between the clusters emerge with education. Compared to low-educated mothers, those with intermediate and high education are about 5 to 12 percentage points less likely in family-focused patterns (Table A-II.5). Conversely, higher education increases the probability of belonging to work-centred patterns, particularly for the Early Care Part-Time Cluster with up to 19 percentage points larger likelihood to belong. With the exception of the Kin-Supported Part-Time Workers Cluster, these associations are statistically significant and noteworthy in coefficient size, demonstrating a clear educational divide between family-focused and work-centred patterns.

However, household income displayed less selective patterns. Higher income significantly reduced the probability of belonging to the Consistent Homemakers Cluster about 5 percentage points, whereas a weak negative link for the Kin-Supported Part-Time Workers Cluster failed to reach statistical significance. Surprisingly, no significant income relations were observed for the other clusters and coefficients were close to zero. This pattern suggests that limited financial resources coincide with either absence from the labour market (Cluster 2) or supplemented childcare by family networks (Cluster 4), which are often easier to afford.

4.2.2 Life-Course Dynamics: Maternal Age and Older Siblings

Beyond SES, the clusters differ in life-course dynamics. Higher maternal age at birth is statistically significantly associated with a 5 percentage points lower probability of belonging to the Consistent Homemakers Cluster. However, no systematic age patterns emerged for the other clusters.

We found more differentiated associations for the presence of older siblings. More older siblings increased probability of belonging to the Consistent Homemakers and Early Care Part-Time Clusters. In contrast, having more older siblings was associated with about a 4 percentage points lower likelihood of belonging to the Early Care Full-Time and Temporary Homemakers Clusters. This suggests that higher employment intensity coincides with fewer cohabiting children, indicating the potential need for part-time or non-employment for mothers of larger families.

4.2.3 Normative Orientations: Work Centrality and Childcare Preferences

A high importance of paid work, a strong perceived benefit of institutional childcare for maternal employment and a younger idealistic age for enrolment into ECEC were linked to an increased probability of belonging to work-centred patterns by up to 10 percentage points, and a decreased likelihood of affiliation with family-focused patterns by up to 13 percentage points (Table A-II.5). These associations were statistically significant, with the exception of the two smallest clusters that regularly fail to reach statistical significance, i.e., the Kin-Supported Part-Time Workers and the Marginal Working Homemakers. For the Kin-Supported Part-Time Workers the results align with the cluster's logic: early involvement of extended family networks combined with the complementary use of institutional childcare indicate that formal childcare served as an addition to informal arrangements, not a substitute. Overall, attitudes mirrored the analytical distinction between family-focused and work-centred patterns. Whereas SES characteristics selectively profiled individual clusters, attitudinal dimensions aligned with the overarching cluster grouping.

Beyond attitudes, clear differences emerged by maternal origin, reflecting differences in normative socialization regarding maternal employment and childcare. Within the work-centred patterns, being born in East Germany rather than the West increased the probability of belonging to the Early Care Full-Time Cluster by approximately 13 percentage points. Conversely, East German origin had a medium-sized negative association with the likelihood of belonging to the Kin-Supported Part-Time Workers Cluster, similar to the family-focused Temporary Homemakers Cluster. For mothers born abroad, we observe no statistically significant patterns, probably due to small sample size.

4.2.4 Regional and Structural Embeddedness

Structural indicators of childcare coverage and unemployment rates displayed only marginal and statistically non-significant associations with cluster affiliation in the fully controlled models, pointing in inconsistent directions. However, given the small sample size of the two clusters showing a negative association, i.e., the Marginal Working Homemakers and Kin-Supported Part-Time Workers Clusters, we refrain from overinterpreting results and consider regional constraints to be inferior.

Finally, sensitivity analyses accounted for additional family-level factors that may shape both employment and childcare decisions, i.e., the presence of a partner in the household, whether the partner took parental leave, and the egalitarian co-parenting style of the parents. In sum, additional analyses showed robust findings, not altering our conclusions (Table A-II.6).



Figure II.3: Coefplot of Cluster Affiliation

Note: Average Marginal Effects and 95%-CI. Results from multinomial regression models, see also corresponding Table A-II.5. N=1,521.

Source: NEPS-SC1-ADIAB7521, 2012-2017, INKAR 2025; imputed data (M=50), own calculations.

5. Discussion

This study examines the interplay between childcare histories and maternal employment trajectories from birth to age five in Germany, and explores the social stratification of these patterns, which are closely linked to gender inequalities in the labour market and children's early life conditions. Previous research investigates ECEC supply and mothers' return to employment behaviour primarily as isolated point-in-time events (e.g., Bousselin, 2022; Huber & Rolvering, 2023; Müller & Wrohlich, 2020; Zoch, 2020), neglecting their joint development over time. Our study uniquely addresses this gap using state-of-the-art MCSA to analyse an exclusive survey and administrative data linkage. We capture a broader range of childcare and work status across an extensive period of early childhood, thereby revealing patterns of childcare-work reconciliation that previously remained concealed (Aassve et al., 2007; Marco et al., 2009; Shattuck, 2022; Steinberg, 2025).

5.1 The Interrelation of Childcare Histories and Maternal Employment Trajectories

We identify six childcare-work clusters of mother-child dyads, grouped into two overarching patterns that reflect considerations of the Preference Theory (Hakim, 1998): family-focused patterns for home-

centred mothers, and work-centred patterns for adaptive mothers. Family-focused patterns vary in the duration of maternal employment interruptions and the timing of low-intensity workforce and informal childcare, mainly provided by the extended family. Conversely, the majority of mothers follows work-centred patterns with high-intensity workforce in part- or full-time. Here, childcare histories are marked by early non-parental care, with varying degrees of ECEC, occasionally complemented by the family. These findings highlight that early maternal employment does not correspond to a single childcare strategy but is embedded in diverse arrangements. Correspondingly, similar childcare strategies do not result in the same employment trajectories. This indicates that the reconciliation of childcare and employment is neither a binary decision on whether to work and use childcare, nor is it determined by a single pathway. From a theoretical perspective, these findings extend human capital approaches that conceptualize maternal employment primarily as discrete return-to-work decisions (e.g., Bousselin, 2022; Huber & Rolvering, 2023), by showing that employment decisions are embedded in ongoing and interdependent decisions on childcare arrangements. These results highlight the value of our joint analysis of childcare and employment trajectories, revealing patterns that remain invisible in solely transitional approaches. More broadly, our findings underscore the importance of a life course perspective that considers the timing, sequencing, and interdependence of life domains in early family life courses, rather than treating employment and childcare as separate processes.

Our results support previous research but demonstrate institutional differences. Unlike studies from the US and Chile, which have identified continuous employment after birth (Cabello-Hutt, 2020; Hynes & Clarkberg, 2005; Killewald & Zhuo, 2019; Lu et al., 2017), such patterns are rare in Germany and Europe due to parental leave regulations (Reichert et al., 2024). Our results therefore differentiate between early and late labour market re-entry as well as intensity of employment, supporting international findings. However, most US-mothers work full-time (e.g., Killewald & Zhuo, 2019), whereas German mothers, particularly those born in the West, predominantly work part-time, as supported by our results and previous studies (e.g., Fauser et al., 2025). Shattuck's (2022) findings on family-care-work trajectories vaguely demonstrate patterns of higher childcare usage with higher employment. We support this result, additionally revealing disparities in timing, as even non-employed mothers utilize ECEC after age three.

Previous findings on childcare histories from Steinberg (2025) identified similar patterns using German data but with a limited observation period until age three. Hence, we provide a more comprehensive examination of care-work arrangements, demonstrating relevant shifts after age three primarily for family-focused mothers. Patterns of informal childcare are more common among part-time working mothers, indicating either easier compatibility with lower work intensity (Hegewisch & Gornick, 2011) or structural barriers in accessing formal childcare, potentially contributing to differences in children's early care experiences.

5.2 Socio-Economic Stratification of Childcare-Work Arrangements

Our results further show that the organization of childcare and maternal employment in early childhood is closely linked to families' SES and normative orientations, which has implications for the reproduction of gender inequalities in employment as well as unequal early life conditions for children. As expected, maternal education is a key differentiator between clusters: Higher-educated mothers are substantially more likely to belong to work-centred clusters, particularly those with early ECEC uptake and vice versa for family-focused clusters. This pattern of higher education and greater workforce is supported by previous literature (Cabello-Hutt, 2020; Firat et al., 2023; Killewald & Zhuo, 2019; Reichert et al., 2024; Shattuck, 2022) and aligns with human capital considerations that higher-educated mothers face greater opportunity costs for work interruptions (Becker, 1975; Breen & Goldthorpe, 1997; Stahl & Schober, 2018). Our results indicate that opportunity costs are not evaluated in isolation but in relation to available childcare arrangements, suggesting that employment decisions are embedded in broader work-care configurations rather than driven solely by wage-related considerations. At the same time, these patterns indicate that educational differences are linked not only to maternal labour market attachment but also to stratified access to and use of early childcare environments.

Moreover, higher education correlates with egalitarian views (Deole & Zeydanli, 2021; Neimanns, 2021) and a greater likelihood of viewing ECEC as a strategic promotion of child development (Steinberg & Kleinert, 2022), resulting in socially selective timing in childcare uptake (Huebener, Schmitz, Spieß, & Binger, 2023). This is mirrored in our study by greater attitudinal support of maternal employment and childcare for higher-educated mothers, such as a younger idealistic ECEC enrolment age, resulting in selective childcare-work patterns. Furthermore, higher education might improve informational resources and social networks that facilitate navigating childcare systems and secure childcare (Seibel & Yerkes, 2025). Possibly, higher-educated mothers are more likely to work in occupations with standard hours (e.g., Gracia, Han, & Li, 2021), increasing ECEC usage due to compatible operating hours (e.g., Bryson et al., 2012; Hepburn, 2018; Shattuck, 2022).

In contrast, household income is less relevant to childcare-work patterns. Only the Consistent Homemakers Cluster shows a statistically significant link between lower economic resources and a higher likelihood of belonging to this cluster. This finding supports the considerations of Killewald & Zhuo (2019) that extended absence from the labour market reflects economic constraints and restricted employment opportunities, opposed to preference-based family arrangements. This interpretation highlights that similar trajectories can arise from different underlying mechanisms, including both normative orientations for potentially advantaged families, and structural constraints for rather disadvantaged families.

Additionally, differences occur between West and East German mothers despite convergence (e.g., Fauser et al., 2025), with the latter being more likely to follow patterns characterised by earlier

employment and uptake of ECEC. Our results are further consistent with East-West differences in employment norms, childcare usage, and maternal age at birth, potentially affecting the availability of grandparental care (BiB, 2026; Zoch, 2020; Zoch, 2021). Nevertheless, regional characteristics play a minor role in childcare-work cluster affiliation.

5.3 Limitations

Our analysis has several limitations. Our MSCA is restricted to outcomes of decisions, as we lack information on actual reasoning and cannot clarify whether observed trajectories follow preferences or are forced by social or structural constraints. We also had to balance the incorporation of more employment characteristics, e.g., fixed-term contracts and occupational levels, with the feasibility of including even larger numbers of statuses using MCSA. Moreover, our explorative approach does not permit causal conclusions. The strength of our study lies in describing social realities that deepen our understanding, not in assessing causal directions.

Furthermore, several data-driven limitations occur. Regarding the administrative data, it only includes mothers subject to social security contributions, limiting transferability of results. In cases where no employment is recorded, mothers may still work in jobs not captured by the data. Moreover, NEPS information on inactivity, e.g., being a homemaker or on parental leave, primarily stems from annual self-reports, with lower accuracy than daily administrative records, introducing higher uncertainty and lower precision in classification. Like most panel data, the NEPS suffers from positive selection and attrition. To address this, we control for potential drivers of sample selection in our multivariate analyses and used multiple imputation to reduce bias from non-response, but possible bias cannot be fully ruled out. Nevertheless, we use the best available data to analyse the interplay of childcare-work trajectories.

Lastly, our analyses lack information on fathers. Given that the organization of childcare and employment within families is inherently relational, a more comprehensive understanding of childcare-work trajectories would benefit from incorporating paternal employment trajectories and their joint development over time. Recognizing paternal perspectives in decision-making processes could provide new insights into the dynamics of household-level work-care arrangements and the broader patterns of gender specialization within family trajectories. We highlight the need for future research to extend the analytical perspective beyond mothers' trajectories and consider the driving factors in childcare and employment decisions. Despite these limitations, our study offers a novel and powerful framework for analysing the complex interplay of childcare and employment trajectories across life-courses.

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Chapter III – The Long-Term Effects of an ECEC Reform on Educational Attainment

Abstract

This study is the first to investigate the causal relation between universal childcare for three- to under six-year-olds and long-term educational attainment in Germany using an instrumental variable approach. A reform, which legally entitled three-year-olds to childcare in 1996, caused an exogenous expansion of childcare supply, which serves as instrument. Using the German National Educational Panel Study (NEPS, 2010-2021, N=7,886, 48% female; 22% immigrant origin; Mean_{AgeGraduation}=17.3), the results suggest that the reform extended children's childcare attendance up to 1.7 months for each 10 percentage points increase in supply, but a longer duration in childcare caused no attainment of higher school-leaving certificates. Findings illustrate the limited effectiveness of a mere quantitative expansion of universal childcare for enhanced educational attainment.

Keywords: instrumental variable approach, universal childcare reform, long-term educational achievement

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Chapter IV – Maternal Occupation-Specific Skills and Cognitive and Non-Cognitive Child Development in Germany

Abstract:

This study examines the link between maternal occupation-specific skills and child development following mothers' return to work. We draw on the Newborn Starting Cohort of the German National Education Panel Study, linked with administrative records on mothers' employment biographies (NEPS-SC1-ADIAB, 2012-2021) and measure occupational skills using expert-coded occupational task data. Extending previous research with mixed findings on mathematical and verbal competencies after age 5, we examine cognitive and non-cognitive child development between ages three and nine. Results from OLS-models show small but statistically significant associations between mothers' specialised analytical job tasks and children's vocabulary, while links with math, science, and socio-emotional competencies were modest. Other types of job tasks showed only small associations with other child outcomes. Overall, findings suggest that maternal occupational tasks – as aggregated proxies for occupational skill application – play a limited role in shaping children's early developmental outcomes and, thus, in the intergenerational reproduction of educational inequalities.

Keywords: administrative data linkage; educational inequalities; intergenerational mobility; job tasks; maternal employment; occupations; parenting; work-family conflict

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This article is co-authored by Gundula Zoch and Ann-Christin Bächmann.

1. Introduction

Maternal education and employment are widely recognised as key influences on children's cognitive and socio-emotional development. Numerous studies have documented that higher parental education is associated with better developmental outcomes, while maternal employment has been shown to affect children in more complex ways, depending on factors such as job quality, working hours, and family resources (Bornstein & Bradley, 2003; Kopp et al., 2024; Letourneau et al., 2013). As maternal labour supply has increased substantially in many Western countries, understanding how dimensions of mothers' work – beyond employment status alone – shape child development has become an increasingly important area of research.

Previous research highlights that job skills, often measured as occupation-specific tasks, are linked to labour market outcomes such as wages and mobility (Black & Spitz-Oener, 2010; Gathmann & Schönberg, 2010). However, their role in shaping children's developmental outcomes remains underexplored. So far, only two studies have addressed the relevance of mothers' occupational skills for child development, revealing mixed evidence. While Barg and Klein (2024) indicate weak and few statistically significant associations between maternal job-related verbal skills and corresponding child competencies for the UK, longitudinal analyses for the US highlight small effects of changes in maternal job skills on children's math competencies after age five (García-Sierra, 2025). Both studies build on the micro-class approach (Jonsson et al., 2009), which theorises that occupation-specific skills and values can shape parenting and, thus, contribute to the intergenerational transmission of skills. However, the two empirical studies focus on the influence of a very specific set of mothers' occupational skills on a smaller number of children's cognitive competencies, leaving the broader implications of other maternal skills for both cognitive and non-cognitive child development as well as the relevant mechanisms underexplored.

Although only few studies have examined maternal job skills in a narrow sense, a substantial body of research draws on similar theoretical arguments regarding the importance of qualitative aspects of maternal employment for child development. This literature stresses negative implications of atypical employment characteristics – such as nonstandard working hours – for child development via increased job-related stress and work-family conflict (for an overview see Li et al., 2020; Rönkä et al., 2017; Tammelin et al., 2017; Yetis-Bayraktar et al., 2013). Shifting the focus to more positive workplace characteristics, Yetis-Bayraktar and colleagues (2013) identify smaller associations between mothers' occupational skills – operationalised by occupational complexity based on workplace task complexity, autonomy, and authority – and children's early reading and math competencies.

Our study contributes to the growing research on the role of maternal job skills in the intergenerational transmission of educational inequalities by addressing two research questions: (1) How are mothers' occupation-specific skills linked to children's cognitive and non-cognitive development between ages three and nine? (2) What explains these associations? Using Germany as a case study, we estimate

ordinary least square regressions without and with individual fixed-effects (FE) based on rich longitudinal data from the Newborn Cohort from the National Educational Panel Study linked to both administrative data on mothers' employment from the Integrated Employment Biographies (NEPS-SC1-ADIAB, 2012-2021, doi: 10.5164/IAB.NEPS-SC1-ADIAB7521.de.en.v1; NEPS-Network et al., 2023) and expert-based occupational task data (Dengler et al., 2014).¹¹ By combining a comprehensive, theoretically based set of occupation-specific tasks as measure of mothers' occupational skills with rich information on cognitive and non-cognitive child development in Germany, we contribute to the small but growing literature, by offering new insights through the use of in-depth task-based measures, the inclusion of socio-emotional competencies, investigation of mechanisms, detailed longitudinal linkage data, and the underexplored German context:

Firstly, our paper contributes to existing literature by providing a theoretically justified selection of maternal job skill dimensions for analysis. As previous studies have found only weak correlations between their measures of maternal occupational skills and child development, it is relevant to analyse comprehensive, theoretically grounded occupational skill sets to see if clearer correlations emerge. Similar to García-Sierra (2025), but in the context of Germany, we operationalise occupation-specific skills using expert-coded information on occupational-level tasks. While skills refer to a worker's underlying knowledge and abilities, tasks capture how those skills are applied in the specific contents and demands of their job. Focusing on actual skills that employees apply in their everyday work-routine (Handel, 2017; Spitz-Oener, 2006) – although we do not capture task performance on individual level – this approach is particularly well suited to examine its role for child development. Building on prior studies (Barg & Klein, 2024; García-Sierra, 2025), we examine a broad range of mothers' occupational-level tasks that are anchored in the *task-based approach* (Autor, Levy and Murnane, 2003) – an approach that has recently been widely adopted in labor market research and has been demonstrated to be a fruitful concept for analyzing various stratification dimensions, such as gender wage disparities (Black & Spitz-Oener, 2010). Thus, we draw on detailed measures of routine and non-routine analytical, interactive, cognitive, and manual tasks, aggregated on the occupational level, offering a more precise assessment of occupational task composition and its potential impact on child development.

Secondly, while previous studies have largely been restricted to cognitive child outcomes, we not only analyse vocabulary and math competencies but also consider test scores of children's science competencies as well as parental reports on socio-emotional competencies. This way, we can reveal new insights into additional competency domains that are crucial for enhancing educational

¹¹ Ideally, we would have estimated individual fixed-effects models as main specification to not only account for observed but also *unobserved* time-constant heterogeneity, e.g., mother's ability or unobserved family characteristics, yielding a more causal assessment of how changes in maternal occupations and tasks relate to child development. However, despite the longitudinal design, we observed limited variation in occupational tasks, as only 7% of mothers changed occupational groups, which is why we included this analysis only as a robustness check. See Brüderl & Ludwig (2014) for more technical details on fixed-effects panel analysis.

trajectories and career success (e.g., Heckman et al., 2006).¹² Whereas prior studies were limited by cross-sectional designs (Barg & Klein, 2024) or cognitive assessments from age five onwards (García-Sierra, 2025), we adopt a dynamic perspective on children's development by examining competencies from slightly younger ages between three and nine. From a theoretical perspective, investigating these earliest years is crucial, as very young children are most strongly affected by their mothers and the created learning environments (e.g., Cunha & Heckman, 2007). Especially in the light of the severe shortage of institutional childcare supply in Germany, findings for children under school age may differ significantly from those observed at age five or older.

Thirdly, using rich data on mothers' and children's individual and household characteristics, we explore potential mechanisms of the relationship between mothers' occupational skills and child development. This way, we aim to deepen the understanding of whether and to what extent the observed associations are linked to differences in the home learning environment and family resources.

Finally, we draw on a rich longitudinal dataset that combines annual survey data with both daily administrative records on mother's employment histories and expert-based occupational task information, allowing us to capture stability and variation in maternal occupational tasks over time. Unlike previous studies that had to rely on cross-sectional data (Barg & Klein, 2024) or were constrained by the biannually timing of interviews (García-Sierra, 2025), our detailed employment information allows for a more nuanced analysis of mothers' occupational skills. This may be particularly relevant in the early years after childbirth, a period often shaped by job transitions with potential consequences for family life and child outcomes, but overlooked due to data limitations in studies focused on later childhood (García-Sierra, 2025). Moreover, by examining mothers who were mainly born between 1973 and 1986, we capture labour market conditions and occupational structures that might be more reflective of current dynamics than previous studies (e.g., García-Sierra, 2025, based on American women born 1957-1965), further enhancing the relevance of our findings.

Understanding how mothers' occupational skills influence child development has become increasingly important due to rising maternal labour supply and tremendous transformations in modern labour markets. While maternal education is a well-established predictor of child outcomes (Bornstein & Bradley, 2003; Letourneau et al., 2013), less is known about the role of job skills. This question has gained urgency as technological change and job specialisation have expanded the diversity of occupational tasks and skills (Dengler et al., 2014), i.e., skill-biased technological change (Katz &

¹² Socio-emotional competencies facilitate the development of critical thinking and problem-solving ability alongside resilience and adaptability, traits that are vital for navigating academic hurdles, career progression, and the evolving demands of the workplace. Moreover, individuals with strong socio-emotional competencies are better positioned to engage in lifelong learning, a key component of sustained employability and personal fulfilment in an ever-changing global economy.

Murphy, 1992), the task-based approach (Acemoglu et al., 2004), and an increased specialisation (Liu & Grusky, 2013). As job tasks and associated skills become more diverse, ranging from manual routine tasks to highly specialised, well-paid non-routine analytical tasks, the simple distinction between skilled and unskilled workers applied in previous research may no longer be sufficient to explain how work conditions shape family life and child development.

Focusing on mothers and their job tasks is relevant, as they – despite increased employment – continue to bear the primary responsibility for childcare in many Western societies (Zoch & Heyne, 2023). Consequently, the demands and skills associated with their jobs are more closely intertwined with daily family life and may have a stronger influence on children’s developmental environments than fathers’ occupational roles. Given that occupation-specific tasks are linked to broader inequalities, such as wage differentials or occupational mobility (Black & Spitz-Oener, 2010; Gathmann & Schönberg, 2010), examining mothers’ occupational tasks offers a promising avenue to understand the mechanisms behind the intergenerational transmission of inequality.

Against the background of increased maternal employment but persistent gendered divisions in family work, Germany offers a valuable context for studying the link between mothers’ occupational skills and child development, complementing research from the UK and US. Historically, maternal employment – especially in West Germany – was low (Aisenbrey et al., 2009), but major childcare and parental leave reforms have promoted a dual-earner/dual-carer model (Leitner et al., 2008) and increased maternal labour supply, especially among higher-educated women. However, limited provision of full-day childcare and schooling, along with joint income taxation that incentivises second-earner roles, contributes to the continued prevalence of maternal part-time work (Simonson et al., 2011). Unlike in countries with more extensive childcare systems, maternal employment and caregiving in Germany remain closely intertwined, with mothers continuing to be the primary caregiver (Zoch & Heyne, 2023). Their occupational experiences might, therefore, be particularly relevant for child development through both direct interaction and time-use patterns at home.

Lastly, Germany’s distinct labour market and education system offer a strong case for examining the link between maternal occupational skills and child development. Unlike countries with predominantly general education systems, Germany’s labour market is characterised by highly specialised skill training, strong institutional ties between education and employment, and relatively stable employment, wage, and skill-use trajectories (Gangl, 2004; Schulz et al., 2023), contributing to steadier home environments. Its well-established vocational education and training (VET) system structures labour market entry and occupational skill-use distinctly (Müller et al., 1998; Shavit & Müller, 2000). Although the VET-system combines specific and general competencies – such as technical, literacy, numeracy, or communication skills – Germany’s manufacturing-oriented economy and emphasis on high-quality craftsmanship likely foster distinct skill profiles among working mothers compared to more service-oriented economies like the US or UK. These institutional features generate systematic

variation in occupational skills, offering important leverage to investigate how different maternal skills relate to children's cognitive and socio-emotional development.

2. Theoretical Background

The intergenerational transmission of human capital is a key driver of social inequality across the life course, as specific knowledge, competencies, and skills are valued in the educational system and labour market (Hanushek & Woessmann, 2008; Heckman & Vytlačil, 2001). Research shows that parental education and competencies, such as math and language, shape child development (Breinholt & Holm, 2020; Hanushek et al., 2022; Lundborg et al., 2014). However, associations vary by country – being weaker in Nordic welfare states and stronger in Germany (e.g., Björklund et al., 2009; Black et al., 2009) – and age, demonstrating cumulative disadvantage in child development over time (Anger, 2012; Cunha & Heckman, 2007).

In labour market research, occupation-specific tasks extend traditional measures of formal education or innate abilities, reflecting the practical application of occupational skills required to perform job-related duties effectively. A growing literature highlights a dynamic, reciprocal relationship between tasks and skills: skills are developed through job tasks and, in turn, influence future task performance (Russo, 2016). Within the *task-based approach* (Autor et al., 2003), job content is defined by bundles of tasks shaped by broader economic and technological trends. In line with previous studies (Barg & Klein, 2024; García-Sierra, 2025), we operationalize occupation-specific skills through tasks, given their strong interdependence.

The tasks literature distinguishes two key dimensions of job tasks and related skill demands: (1) *cognitive vs. non-cognitive tasks* and (2) *routine vs. non-routine tasks* (Autor et al., 2003). Cognitive tasks include *analytical* and *interactive tasks*, while non-cognitive tasks refer primarily to *manual labour*. Routine tasks, such as machine operation or accounting, follow explicit procedures, typically require less formal education, are more easily automated, and are generally associated with lower wages and higher displacement risk. In contrast, non-routine tasks, such as negotiating and coordinating, involve problem-solving, decision-making, creativity, and complex social interaction. These tasks are associated with higher wages, greater job security, and better working conditions, including flexible schedules. Certain manual tasks, such as truck driving, also fall into this category if they are not (yet) automatable.

To examine the role of maternal job skills for child development, we employ a conceptual approach that combines the two dimensions of cognitive vs. non-cognitive and routine vs. non-routine tasks, distinguishing five occupational task types: cognitive non-routine tasks – i.e., (1) analytical non-routine tasks, (2) interactive non-routine tasks – (3) cognitive routine tasks, (4) manual non-routine tasks, and (5) manual routine tasks (see Table IV.1 for more details on task dimensions). For example, non-routine analytical tasks require strong problem-solving and critical thinking, such as in reading, writing, or

mathematics. In contrast, manual routine tasks are typically low in autonomy, repetitive, and physically demanding due to factors like lifting or standing continuously – factors associated with stress and reduced cognitive stimulation. Our task-based framework is based on detailed occupational data, captures a wider composition and variation of occupational tasks unlike previous literature, although individual tasks execution is not considered.

Table IV.1: Examples of Occupational Tasks

	Tasks	Examples
Cognitive	(1) Analytical non-routine	management, analysis, programming, planning and supervision; e.g., operating resource planning
	(2) Interactive non-routine	commerce, counselling, training, service; e.g., telephone information service
	(3) Cognitive routine	Electronics, operating systems, inspection, administration; e.g., personnel management
Non-Cognitive	(4) Manual non-routine	refurbishing, manual therapy, handicraft businesses; e.g., patisserie
	(5) Manual routine	farming, construction, production, operating machines; e.g., manufacture cement

Notes: Information is based on Dengler et al., (2014).

The complexity and nature of occupational tasks profiles – especially higher levels of cognitive non-routine tasks – are positively associated with workers’ cognitive stimulation (Pouliakas & Russo, 2015), with important implications for the resources and environments mothers may bring into family life and, ultimately, for child development. We build on the well-established insight that educational investments are particularly effective during the early, dynamic phase of children’s competency development (Cunha & Heckman, 2007). Following Barg and Klein (2024), also drawing on the micro-class approach by Jonsson et al. (2009), we argue that mothers’ occupational skills shape child development – across verbal, math, science and socio-emotional domains – through multiple pathways: (1) directly via the home learning environment, including resources and parent-child activities, (2) indirectly through less intentional forms of parental behaviour, and (3) via the broader emotional climate within the family.

We conceptualize mothers’ occupational skills as a continuum directly influencing the home learning environment by shaping – subconsciously or strategically – the quality and frequency of cognitively stimulating and instructive interactions. At one end of the continuum, mothers in cognitively demanding non-routine jobs – often requiring analytical skills such as mathematics, research, or problem-solving – may enrich the home learning environment through educational materials (e.g.,

number of books) or by integrating critical thinking into conversations and play (Mues et al., 2021). Similarly, non-routine interactive tasks involving communication skills, literacy, and social understanding are expected to foster children's language development through both structured (e.g., reading books) and informal interactions (e.g., rich conversations) (Carroll et al., 2019; Martini & Sénéchal, 2012). These maternal interactive skills can also support emotional regulation, social and problem-solving abilities, as well as other domain-specific competencies (Zeytinoglu et al., 2019). At the other end of the continuum, however, cognitive routine, manual non-routine and manual routine tasks – lower in autonomy and stimulation – likely foster fewer cognitively enriching interactions.

In addition to deliberate forms of parental engagement, mothers' occupational skills may shape child development indirectly by affecting parental stress and time availability through less intentional behaviour (Barg & Klein, 2024; Jonsson et al., 2009). Jobs dominated by manual routine tasks often involve physical strain or rigid schedules, limiting both the quantity and quality of parent-child interactions. Thus, mothers may engage less in structured and cognitively demanding activities such as reading or homework support. Similarly, cognitively demanding jobs with high analytical or interactive task loads may lead to mental fatigue, reducing energy for structured learning or focused conversations. However, mothers with higher levels of non-routine cognitive tasks (analytical or interactive) may be better equipped to manage stress, time pressure, and multitasking than those with more routine and manual tasks. These non-routine skills may help sustain responsive, low-threshold engagement – such as shared meals or informal conversations – even under strain, supporting regular albeit less structured, positive interactions that benefit child development.

Finally, occupational tasks are likely linked to occupational characteristics influencing mothers' well-being (e.g., Carlson et al., 2011) and, consequently, the emotional family climate (Barg & Klein, 2024; Jonsson et al., 2009). Jobs involving non-routine analytical or interactive tasks typically offer greater autonomy, meaningful engagement, and social interactions – factors linked to higher job satisfaction and lower stress (e.g., Clausen et al., 2022). These favourable conditions may enhance emotional availability, communication, and parenting consistency, supporting a warm and stable environment for children's cognitive and socio-emotional development. In contrast, routine manual or cognitive tasks are often repetitive and low in autonomy, possibly contributing to physical and emotional exhaustion (e.g., Van Ruysseveldt et al., 2011). Over time, such strain may reduce parental warmth and patience, increasing the risk of conflict, harsher interactions, and a less nurturing atmosphere (e.g., Cooklin et al., 2015). Moreover, the economic insecurity often linked to routine low-skilled jobs – especially those at higher risk of automation – may further amplify stress and undermine the emotional climate, limiting opportunities for positive developmental support.

Altogether, we presume that mothers' occupational tasks are linked to children's cognitive and non-cognitive development (for an overview see Table IV.2). Specifically, non-routine cognitive tasks – i.e.,

analytical and interactive tasks – are expected to positively shape child development (H1), with stronger associations with cognitive than non-cognitive competencies. Through domain-specific skill transmission, we expect mothers to model, scaffold, and reinforce children’s cognitive competencies in everyday routines. Conversely, non-cognitive competencies such as prosocial or problem behaviour may be less directly shaped by task-related skills and more indirectly influenced by mothers’ well-being and the emotional family climate. We anticipate that mothers’ analytical tasks are more strongly associated with children’s math and science competencies (H1a), while interactive non-routine tasks are more closely linked to verbal and socio-emotional competencies (H1b). However, we refrain from formulating hypotheses for each domain and examine these associations empirically. We expect that manual routine tasks are negatively linked to children’s cognitive and non-cognitive development (H2). For manual non-routine tasks, we do not formulate specific expectations, as associations may vary with job quality, working conditions, and stress. Finally, we presume that the relationships between mothers’ occupational skills and child development are partly explained by differences in the home learning environment and family resources (H3) and test these mechanisms empirically.

Table IV.2: Mothers’ Occupational Tasks and Child Development: Theoretical Expectations

		Math	Science	Verbal	Socio-emotional
Cognitive	Analytical non-routine	++	++	+	+
	Interactive non-routine	+	+	++	++
	Cognitive routine	±	±	±	±
Non-Cognitive	Manual non-routine	±	±	±	±
	Manual routine	-	-	-	-

Notes: + positive / - negative expected association; ± mixed or uncertain association

3. Data and Method

We examine the role of mothers’ occupational skills for children’s cognitive and socio-emotional development using linear regression and panel data from the German National Education Panel Study (NEPS). Specifically, we utilize a novel linkage between the NEPS Newborn Starting Cohort 1 and administrative employment records (NEPS-SC1-ADIAB, 2012-2021, doi:10.5164/IAB.NEPS-SC1-ADIAB7521.de.en.v1; NEPS-Network et al., 2023). This data provides annual survey data, mainly from mothers, on family context and the socio-emotional competencies of their 2012-born child. From age three, children have participated biannually in standardised math, science, and vocabulary tests. Additionally, the Integrated Employment Biographies of the Institute for Employment Research provide daily records of mothers’ employment biographies, including detailed occupational

information, allowing us to link our employment biographies with expert-rated occupational task data for corresponding occupational groups based on the German occupation classification 2010 (KldB 2010 3-digit level¹³).¹⁴

Our gross sample included 3,481 parents and their child. We excluded few fathers, non-biological mothers, as well as mothers who were unidentifiable in social security records, or gave no consent to linkage (n=3,044). We applied listwise deletion of missing values on occupational information, child outcomes and any control variable. The final sample comprised about N=9,808 observations from n=2,109 mothers-child dyads. For details on sample restrictions and characteristics see the online appendix (Tables A-IV.1 and A-IV.2).

We examined cognitive child development via *mathematical* and *scientific literacy*, *receptive vocabulary*, and non-cognitive *socio-emotional competencies* (more information on all variables in supplementary Table A-IV.3). Math (age 4, 6, 8) and science tests (age 5, 7, 9) contained daily life challenges that require the understanding of mathematics, natural sciences and technology. We used weighted likelihood estimators (WLE) provided by NEPS, which present positive values denoting above-average competencies and vice versa.¹⁵ Our *vocabulary* score stems from the Peabody Picture Vocabulary Test (age 3, 5, 7, 9). Lastly, we built a compound score¹⁶ on the *socio-emotional competencies* provided by mothers (age 5, 6-7, 8-9), which contains four indices on strengths and difficulties of the child with five items each: prosocial (e.g., helps voluntarily) and problem behaviour (e.g., tells lies), hyperactivity (e.g., easily distracted), and peer problems (e.g., gets teased). Sum scores of both vocabulary and socio-emotional competencies were mean-standardised with higher values denoting more positive, above-average competencies.

Our key independent variable *maternal job skills* measured occupational tasks for 144 different occupational groups for Germany (Dengler et al., 2014).¹⁷ Based on the task-based approach by Autor et al. (2003) and its interpretation of Spitz-Oener (2006), this task measure assigned approximately 8,000 different job requirements to distinguish five task dimensions: (1) analytical non-routine, (2) interactive non-routine, (3) cognitive routine, (4) manual non-routine, and (5) manual routine tasks.

¹³ Using the German occupational classification KldB 2010 enables us to accurately map the German occupational landscape. At the same time, the KldB 2010 is highly compatible with the ISCO 08 (Christoph et al., 2020).

¹⁴ Administrative data are based on obligatory employer notifications to the social security system, providing employment information on all persons in Germany who are employed subject to social security or marginally employed but registered as unemployed or job seekers.

¹⁵ For math and science, the level of difficulty varies between test items and changes between waves. To consider this, the WLE gives the weighted scores according to their difficulty instead of using a sum score.

¹⁶ Cronbach's alpha ranged from $\alpha=0.74$ to $\alpha=0.77$, depending on the wave, and indicated good reliability for the compound index.

¹⁷ The task measures are based on an expert database for Germany: BERUFENET. This online information portal, created by the German Federal Employment Agency mainly for career guidance, comprises expert knowledge on the required tasks and qualifications as well as working conditions and equipment used of approximately 3,900 single occupations in Germany.

For every occupational group the numerical composition of the five task dimensions was available. Figure IV.1 exemplifies the stark differences in task compositions between occupational groups, demonstrating that occupations can mainly consist of cognitive tasks (teacher and researcher), of all possible tasks with larger variation dominated by cognitive skills (office clerks) or manual tasks (production and textiles). The distribution of task measures (see supplementary Figure A-IV.1) highlighted high shares of cognitive tasks in our sample, while manual tasks were less common among mothers.

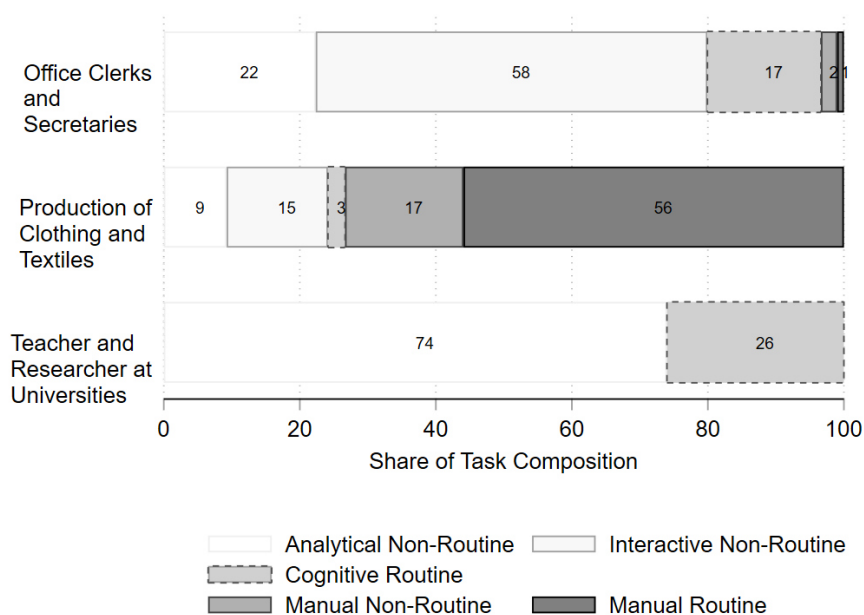


Figure IV.1: Examples for occupational groups (KldB 2010, 3-digits) with distinct task compositions

Source: own illustration based on Dengler et al., 2014

We estimated pooled ordinary least square (POLS) regression models to examine the role of mothers' occupational skills for each cognitive and non-cognitive development measure. To account for possible domain-specific implications, we included four out of five separate, compositional indicators on the share of each task in our main models, using the fifth, omitted cognitive routine task as sort of a reference category to avoid perfect multicollinearity.¹⁸ Thus, the remaining coefficients can therefore be interpreted as "substitution effects" relative to the omitted category. We implemented a stepwise strategy, estimating raw associations first, followed by fully controlled models to address unobserved heterogeneity as good as feasible. The resulting equation for the main model of child i in year t is:

$$ChildDevelopment_{it} = \beta_0 + \beta_1 MaternalJobSkills_{it} + \beta_2' Covariates_{it} + \beta_3' Covariates_i + \epsilon_{it}$$

¹⁸ Job tasks tend to be bundled together within occupations rather than appearing randomly distributed. As their share sums up to 100%, including all five task compositions in the regression model would lead to perfect multicollinearity, also referred to as *unit-sum constraint*.

where we accounted for various characteristics of the child, mother and family (see Table A-IV.3 for coding details): child gender and age at measurement, firstborn status, main German or foreign language use at home; and mother's age at birth, cohabiting status with current partner, education (compulsory, intermediate, maturity, tertiary) and major occupational group in each wave of employment (1-digit KldB 2010) to account on observables for selection into occupations. While this approach is the best we can implement with the available data, we acknowledge that it cannot account for unobserved characteristics that likely influence selection into specific occupations.

In an additional step, we explored key time-variant mechanisms in family life, that potentially explain the observed relationship between mother's occupational skills and child development. We accounted for age-appropriate parent-child activities as part of the home learning environment, and family resources, measured as logarithmised, monthly net household income:

$$ChildDevelopment_{it} = \beta_0 + \beta_1 MaternalJobSkills_{it} + \beta_2' Covariates_{it} + \beta_3' Covariates_i + \beta_4 HomeLearningEnvironment_{it} + \beta_5 Resources_{it} + \epsilon_{it}$$

In all models, we clustered standard errors at the individual level to account for the nested structure of multiple observed mother-child dyads. To test the stability of our findings, we examined effect heterogeneity by mothers' education, child's gender and age, as well as alternative specifications, including models with individual fixed-effects, exploiting mothers' job changes.

4. Results

Figure IV.2 presents results from POLS regression between maternal occupational task compositions and children's cognitive and socio-emotional competencies (full models in supplementary Tables A-IV.4 and A-IV.5). Raw models (dot) indicate that a one-unit increase (i.e., 100 percentage point) in analytic non-routine tasks at the expense of the omitted category cognitive routine tasks – under control of manual (non-/routine) and interactive non-routine tasks – was positively associated with all cognitive and non-cognitive child competencies. For example, children of mothers with 100% analytic tasks (compared to 0% cognitive tasks) attained, on average, vocabulary scores that were $\beta_{Vocab_ANR1}=0.8SD$ higher than those of children of mothers with a task composition of 0% analytical tasks (compared to 100% cognitive tasks). For interactive non-routine tasks, solely vocabulary showed a positive statistically significant relationship relative to the omitted task variable ($\beta_{Vocab_INR1}=0.3SD$). In contrast, for the lower continuum of job tasks, results revealed negative associations for manual non-routine and manual routine tasks compared to cognitive routine tasks across all child outcomes. However, given larger uncertainty due to few women working in jobs with high shares of manual routine tasks, coefficients were only statistically significant relative to the omitted variable for socio-emotional competencies ($\beta_{SE_MR1}=-0.3SD$).

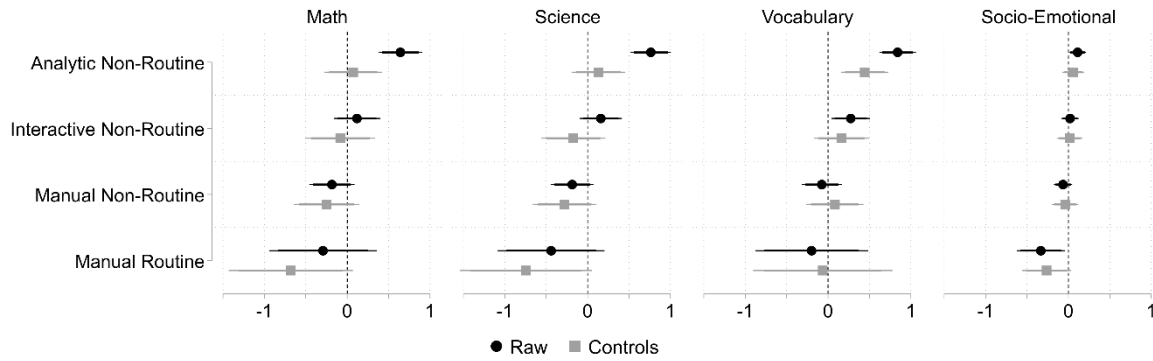


Figure IV.2: Main Specification: Maternal Task Composition and Child Development

Note: Results from joint (pooled) OLS models with 95% CIs (thin line) and 90% CIs (thick line). *Controls:* Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, child gender, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, N~9,808 person-years, n~2,109 mother-child dyads; full models in Tables A4, A5.

Model 2 (square) included individual and household controls, which partly explained the initial correlations between maternal tasks and child outcomes. While associations for analytical non-routine tasks became non-significant for most child outcomes, the link with vocabulary remained statistically significant compared to the omitted cognitive tasks ($\beta_{\text{Vocab_ANR2}}=0.4\text{SD}$). At the other end of the task continuum, coefficients for manual routine tasks relative to cognitive routine tasks increased for math and science ($\beta_{\text{Math_MR2}}=0.7\text{SD}$; $\beta_{\text{Science_MR2}}=0.7\text{SD}$), though remained statistical non-significant. For socio-emotional competencies, a marginally significant link was found at the 10%-level ($\beta_{\text{SE_MR2}}=0.3\text{SD}$).

Overall, these findings partly support Hypothesis 1, assuming positive links between cognitive non-routine tasks, i.e., analytical and interactive tasks, compared to cognitive routine tasks and child development, showing stronger associations for cognitive than non-cognitive child competencies. Contrary to our expectations of stronger domain-specific links for math and science in Hypothesis 1a, associations between mothers' analytical non-routine tasks, relative to the omitted category, and children's vocabulary scores were more pronounced. However, mothers' interactive non-routine tasks compared to cognitive routine tasks related positively to verbal child outcomes but not to socio-emotional competencies, providing partial support for Hypothesis 1b. Similarly, negative associations between manual routine tasks compared to omitted tasks and socio-emotional competencies offered some support for Hypothesis 2, assuming a negative link between manual tasks and child development. Although few associations reached conventional levels of statistical significance, the observed patterns and effect directions were consistent with theoretical expectations, particularly for tasks located at both ends of the routine–non-routine and cognitive–non-cognitive spectrum.

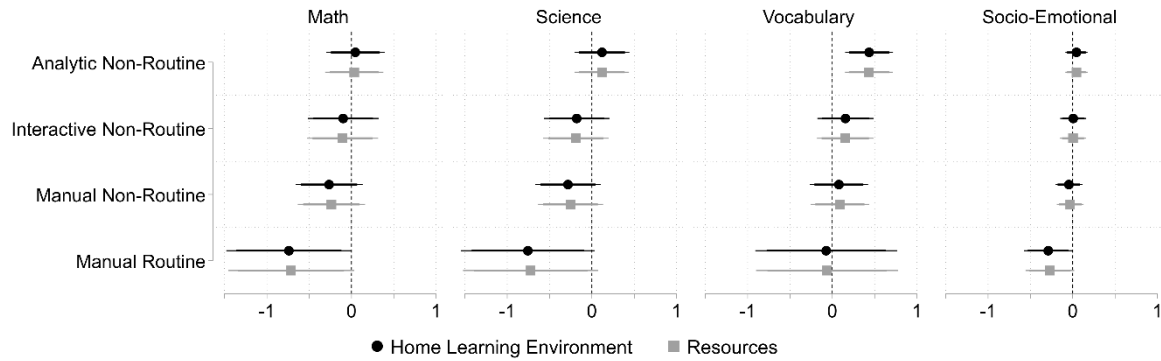


Figure IV.3: Mechanism Model: Maternal Task Composition and Child Development

Note: Results from joint (pooled) OLS models with 95% CIs (thin line) and 90% CIs (thick line). *Controls:* Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, child gender, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, N~9,808 person-years, n~2,109 mother-child dyads; full models in Tables A-IV.4, A-IV.5.

In a third step, we added potential mechanisms in Figure IV.3 to explain associations between occupation-specific tasks and child development: the home learning environment (model 1, dot) and family resources (model 2, square). Coefficients remained virtually identical, indicating little explanatory power of these variables. Accordingly, we found no support for Hypothesis 3, which posited that the association between tasks and child development would be explained by home learning environments and household resources.

4.1 Exploring Effect Heterogeneity

We further explored heterogeneity by maternal education, child gender, and age. Tertiary-educated mothers, who are more likely to work in jobs involving cognitive skills (e.g., Schulz et al., 2023), may be better positioned to translate these skills into developmental support. We therefore expected stronger positive associations between analytical or interactive tasks and child development among tertiary-educated mothers, and more negative associations of manual tasks among non-tertiary-educated mothers. Consistent with our main findings, mothers' higher shares of analytic non-routine tasks, compared to the omitted task, were positively linked to children's math and vocabulary competencies in both educational groups (see supplementary Figure A-IV.2 for raw models), even after adjusting for key controls (Figure IV.4). However, the association remained significant only for child vocabulary and higher-educated mothers, and was only marginally significant for lower-educated mothers (10% level). The largest educational disparities emerged for manual routine tasks, relative to cognitive routine tasks, and cognitive child outcomes: non-significant, slightly positive associations for tertiary-educated mothers contrasted with negative associations for lower-educated mothers. Although only coefficients

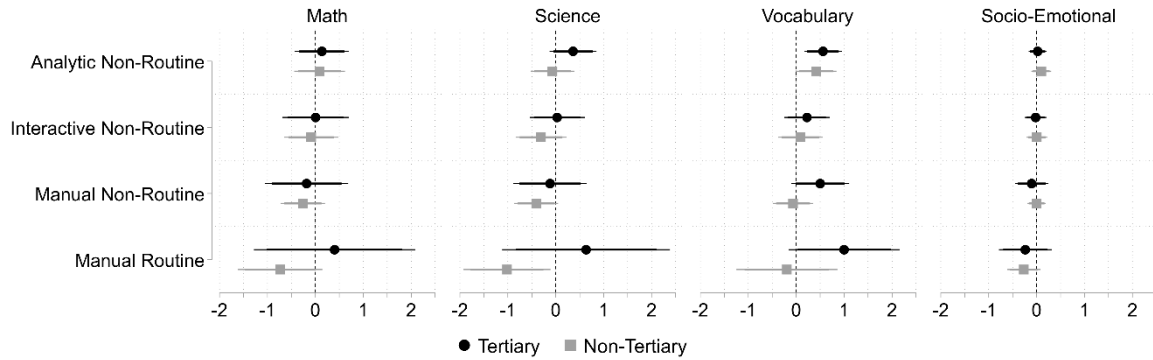


Figure IV.4: Effect Heterogeneity in Task Composition and Child Development by Maternal Education

Note: Results from joint (pooled) OLS models of tertiary education sample split with 95% CIs (thin line) and 90% CIs (thick line). *Controls:* Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, KldB2010 1-digit. Raw models are available in Figure A2.

Source: NEPS-SC1-ADIAB 2012-2021, $N \sim 9,808$ person-years, $n_{\text{tertiary}} \sim 972$ and $n_{\text{non-tertiary}} \sim 1,172$ mother-child dyads.

for lower-educated mothers and science were statistically significant, findings consistently suggested the expected direction, with more favourable associations for tertiary-educated mothers and more adverse links for lower-educated mothers, particularly with manual tasks. Nevertheless, educational group differences were not statistically significant, although we observed some differences in size and direction of coefficients.

Given gendered patterns in children's competency domains found in prior research (e.g., Duncan et al., 2009), including more pronounced positive associations with daughter's math competencies (García-Sierra, 2025), we also examined effect heterogeneity by child gender (Figure IV-5). Surprisingly, for analytic non-routine tasks relative to cognitive routine tasks, our findings showed stronger associations for boys across all cognitive competencies that remained statistically significant for boys' and girls' vocabulary after including covariates (see Figure A-IV.3 for raw models). In contrast, for higher shares of manual routine tasks, compared to the omitted cognitive tasks, boys showed lower competencies than girls across all domains, although gender differences were throughout statistically non-significant.

Lastly, we assessed whether the associations between maternal occupational tasks and child development varied across the dynamic competency formation process between age three to nine (Cunha & Heckman, 2007). Results from age-specific models showed small variations and suggested slightly stronger links for cognitive child development at younger ages at both ends of the task continuum, though without clear age-specific patterns as well as non-significant age-group differences (see supplementary Figure A-IV.4). Thus, findings indirectly supported our simplified, pooled strategy that accounted for child age.

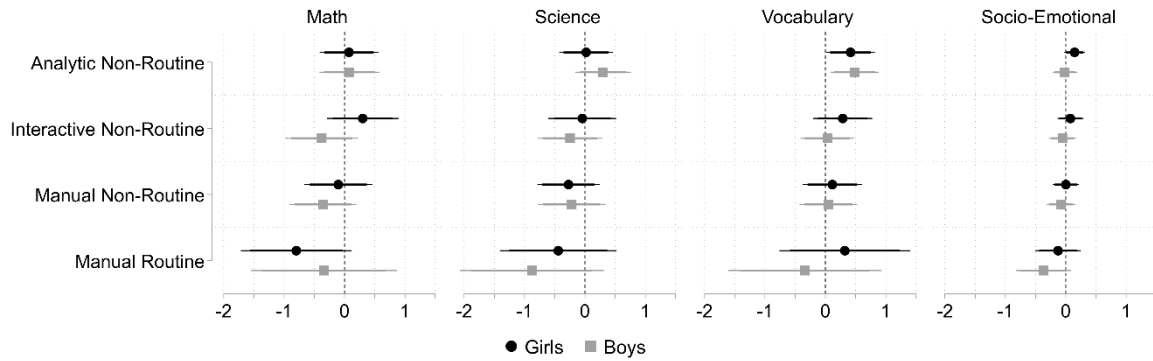


Figure IV.5: Effect Heterogeneity in Task Composition and Child Development by Child Gender

Note: Results from joint (pooled) OLS models of gender sample split with 95% CIs (thin line) and 90% CIs (thick line). *Controls:* Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, child gender, KldB2010 1-digit. Raw models are available in Figure A3.

Source: NEPS-SC1-ADIAAB 2012-2021, $N \sim 9,808$ person-years, $n_{\text{male}} \sim 1,068$ and $n_{\text{female}} \sim 1,041$ mother-child dyads.

4.2 Robustness Checks

In several robustness checks, we examined the relevance of mothers' working hours, duration in occupation, childcare attendance, and various child health indicators, which altogether did not alter previous conclusions (see Figures A-IV.5 – A-IV.8).

To examine the independent, univariate relation of each individual task with child development more flexibly than our fully controlled main specification, we estimated separate models for each task component. Results showed stronger, statistically significant links for most tasks and child outcomes (see supplementary Figure A-IV.9). This suggests that failing to account for the full occupational task composition risks overstating associations between specific tasks and child outcomes, likely reflecting selection or unobserved confounding. However, weakened associations after including controls and mechanisms underscore the robustness of our main findings and highlight the importance of adjusting for the broader occupational context when examining the role of maternal job tasks.

Finally, we exploited mothers' occupational mobility accompanied by shifts in task composition by estimating linear regressions with individual FE, accounting for both observed and unobserved time-constant heterogeneity. However, given limited variation in occupational tasks (7% changed occupational groups), we found no evidence that these few shifts in mothers' occupational task composition were linked to within-child changes in competencies – in either baseline or fully controlled models (see supplementary Figure A-IV.10). The only exception was a shift from omitted cognitive routine to manual routine tasks, which was linked to statistically significantly lower science competencies. However, given the small share of mothers with jobs dominated by manual routine tasks, the generally low levels of occupational mobility, and limited task variation overall, these findings should be interpreted with caution and demonstrate the need for further research.

5. Discussion and Conclusion

This study is the first to examine how mothers' occupational skills relate to children's cognitive and socio-emotional development between ages three and nine in Germany. Using a unique linkage of German panel survey and competency-test data, administrative social security records, and expert-coded occupational task information, we conceptualise maternal occupational skills, operationalized as occupational tasks, as a key dimension of mothers' human capital. These skills are assumed to shape the intergenerational transmission of educational inequalities through various pathways – both directly and indirectly via the home learning environment and access to relevant resources.

Results from stepwise linear regressions reveal that analytical non-routine tasks, compared to cognitive routine tasks, are most strongly and positively associated with child outcomes, especially in cognitive domains. Coefficient sizes decrease progressively across the task spectrum, with manual routine tasks showing negative associations with child development relative to cognitive routine tasks. In models accounting for child and family characteristics, only analytical non-routine tasks remain statistically significantly linked to children's vocabulary competencies in comparison to cognitive routine tasks. This phenomenon may be attributed to the foundational role of language as a cross-domain means for learning. Even in activities targeting non-linguistic competencies, language serves as the primary medium for instruction and conceptualization, and, thus, has been shown to benefit child vocabulary and other linguistic competencies (Lehrl et al., 2020; Napoli & Purpura, 2018). Surprisingly, these results remain robust even after accounting for potential explanatory mechanisms, including parent-child activities and financial resources. Across specifications, coefficients remain modest: up to a 0.8SD shift for a hypothetical 100 percentage point change in task composition relative to cognitive routine tasks – contrasting with the actual variation of 10 to 30 percentage point observed within our sample's interquartile range (25th-75th percentile). This equals an average shift of 0.08SD to 0.24SD in child outcomes. Moreover, these patterns are largely consistent, with only minor differences in associations between mothers' tasks and child outcomes by maternal education, child gender, and age. Our main findings highlight that maternal occupational skills play a relevant role in the intergenerational transmission of advantage, supporting early theoretical perspectives on the role of occupations in shaping parenting environments and social reproduction (Jonsson et al., 2009). Consistent with earlier findings for the UK (Barg & Klein, 2024), we observe the strongest associations between maternal cognitive tasks and children's language competencies, and negative but non-significant associations for manual tasks. Previous literature revealed both domain-general relationships as well as domain-specific links in language competencies (Barg & Klein, 2024) and math (García-Sierra, 2025). We contrast these results, as we mainly identify domain-general associations: Occupational analytical tasks involving higher cognitive stimulation support vocabulary development but not math or science. Manual tasks could limit cognitive flexibility for engaging in stimulating interactions – though without statistically significant effects for cognitive and non-cognitive child development. Our mechanism analysis further supports our main conclusions, revealing robust results

and only limited roles of resources and the home learning environment – similar to García Sierra's (2025) findings for the US.

Additional analyses and robustness checks demonstrate small gender differences with somewhat stronger links for boys only among cognitive domains, contrasting previous findings for stronger associations for girls' math and verbal competencies in the US (García-Sierra, 2025). Results for socio-emotional development showed negligible gender differences. Drawing on a longer time span by assessing ages three to nine, our age-specific analyses suggest a tendency of stronger associations between maternal occupational tasks and child development at younger ages. These results indicate that the null findings in earlier studies, focusing on child outcomes from age five onward (Barg & Klein, 2024; García-Sierra, 2025), may reflect fade-out effects at older ages. Lastly, we find only significant effects of mothers' occupational changes on child science competencies, again, contrasting stronger longitudinal relationships from the US (García-Sierra, 2025). However, given limited occupational mobility in our data, further research is needed to fully assess this relationship.

From a broader perspective, our findings underscore that maternal occupational skills contribute to children's early development, though their influence is modest compared to the overall impact of maternal education. This aligns with theoretical expectations, as occupational skills are a component of overall human capital and, therefore, partly shaped by educational attainment. Hence, once formal education is controlled for, only limited effects of job-specific tasks remain. Despite the improved measurement of job skills through complex and rich task composition that is theoretically grounded in the task-based approach (Autor et al., 2003), our results align with Barg and Klein (2024), highlighting a modest direct impact of maternal occupational skills on child competencies. Still, the robustness of our results across model specifications and after accounting for key explanatory mechanisms supports the conclusion that maternal occupational tasks are linked to children's early cognitive and socio-emotional development.

Although our results provide first evidence on the link between maternal job skills and child development for Germany, several important limitations should be noted. First, despite controlling for a rich set of observed background characteristics, our cross-sectional OLS-estimates remain vulnerable to unobserved heterogeneity and omitted variable bias. These may include unmeasured factors, such as mothers' cognitive ability or career preferences, which likely influence both occupational sorting and return-to-work-behaviour after childbirth. Due to data limitations, more advanced techniques (e.g., inverse probability weighting) were not feasible, and fixed-effects estimation as well as lagged specifications were constrained by limited within-person variation in occupational tasks. As such, our results should not be interpreted causally. Potential bias could overestimate positive associations for more stimulating job tasks, while negative associations – particularly for disadvantaged mothers pursuing more manual tasks – may be underestimated if these women are underrepresented due to delayed return to work, labour market exit, or selective attrition from the panel. Conversely, positive associations might be underestimated, if confounded by adverse psychosocial working conditions and

job strain, such as low job autonomy, noise pollution, or nonstandard work schedules, which are likely more prevalent in manual occupations, whereas negative associations could also be overestimated when correlated disadvantages, such as individual health or stress, are not fully controlled.

Second, several additional data-related limitations occur. Specifically, measures of socio-emotional competencies rely on parental reports and may be affected by systematic reporting bias, potentially linked to maternal stress or expectations. Additionally, task measures are aggregated at the occupational level and, therefore, cannot capture actual individual tasks execution or within-occupation variation between employees. While this limits precision of findings, our approach offers a more differentiated perspective than previous studies (e.g., Barg and Klein, 2024), by covering task compositions across 140 occupations and mapping broader combinations along the routine–non-routine and cognitive–non-cognitive dimensions. In doing so, our findings contribute to a more comprehensive understanding of how occupational demands relate to child development. Moreover, it is important to note that our task measures may capture not only occupational activities in a narrow sense but also work-related strains, particularly with regard to manual tasks. Future research should therefore clearly distinguish between the nature of job tasks and associated strains, as both may influence child development through different direct and indirect pathways. Data limitations may also affect our mechanism analysis, suggesting surprisingly limited explanatory power despite the theoretical relevance of home learning environments and resources. For the former, the available data may not consistently capture age-appropriate parent-child activities over time due to the complexity of underlying processes, potentially leading to measurement error and limited comparability. Consequently, our measure may not fully capture all relevant aspects of home learning environments, which could partly explain the absence of stronger associations. This limitation may also reflect the possibility of omitted variables influencing both occupational tasks and parenting behaviour.

Additionally, our sample size was considerably smaller compared to previous literature, which obtained three to six times more individuals in their data (Barg & Klein, 2024; García-Sierra, 2025), potentially affecting statistical significance. This might be partly reflected in the limited variation in manual non-routine (2-33 percentage point) and routine tasks (0.4-5 percentage point) in the interquartile range, which also leads to less precise estimates and large confidence intervals. Consequently, these results should be interpreted with caution and warrant further research with data that better covers these occupational tasks.

Lastly, due to data restrictions, our analysis focuses exclusively on mothers, leaving the role of paternal occupational skills unexplored. With various family policy reforms in Germany increasingly encouraging paternal involvement in caregiving, the occupational characteristics of fathers likely play a growing role in shaping child development in contemporary cohorts. Future research should therefore consider both parents' occupational profiles to better understand how family dynamics and labour market experiences jointly influence early child outcomes.

Despite these limitations and various avenues for future research, our findings highlight the modest but meaningful role of maternal job characteristics – beyond maternal education or employment status – in shaping early inequalities in child development. As digitalisation and task specialisation continue to transform labour markets (Maier, 2022), understanding how evolving occupational demands influence family life and child outcomes becomes increasingly important. Future research should aim to identify causal effects, draw on individual-level task data, preferably for both parents, and explore how job skills interact with both household and institutional settings to inform policies that promote equal opportunities from early childhood onwards.

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Chapter V – Advanced Maternal Age and Child Development: New Evidence From Germany

Abstract

Background: Rising maternal education and labor market participation have contributed to an increase in maternal age at first birth, linked to improved child abilities in the US. However, for Europe, where demographic dynamics and institutional settings differ, evidence remains limited. Theories of child development, human capital and concepts of maturity can explain this link through improved home learning environments.

Objective: We examine whether higher maternal age benefits cognitive and non-cognitive child development, and test theory-derived mechanisms underlying this relationship.

Method: This study uses a sample of newborns of the German National Educational Panel Study (NEPS-SC1; 2012-2021; N=2,387) to examine the relationship between maternal age at birth and cognitive (math, vocabulary) and social-emotional child development up to age nine. Linear regression analyses investigate the main relationship and explore potential mediators (parenting quality, maternal well-being, family resources).

Results: Results show inversely U-shaped associations between maternal age at birth and both cognitive and social-emotional development. Enhanced cognitive abilities are largely attributable to family resources and parenting quality. However, differences by maternal age are primarily driven by young mothers up to age 30 and lower educated mothers.

Contribution: Our results contribute to a deeper understanding of aging societies by investigating the relationship between maternal age at birth and child development, which remains relevant among socioeconomic groups, despite accounting for theory-derived family mechanisms.

Keywords: Delayed Motherhood, Cognitive and Non-Cognitive Child Abilities, Educational Inequalities, Demographic Transition, Aging Societies

This article is co-authored by Mathias Huebener, Malin Mahlbacher, and Gundula Zoch and currently under review at the journal *Demographic Research*.

1. Introduction

In recent decades, family dynamics in Western societies have changed, as mothers increasingly delay first childbirth. Key drivers of this demographic shift are innovations in medical technology enabling planned parenthood, increased normative acceptance of childless women, as well as prolonged education and greater female labor market participation (Guzzo & Hayford, 2020; Mills et al., 2011; van de Kaa, 1987). For many women, these developments have improved resource endowment prior to family formation, which positively impacts family life. Nonetheless, as more mothers aim to reconcile work and family life, children's early learning environments are changing. Working mothers often face greater time pressure, which can negatively affect maternal well-being and parenting styles (e.g., Hess & Pollmann-Schult, 2020; Tammelin et al., 2017). Simultaneously, older mothers tend to possess higher financial and educational resources (Fulco et al., 2020) and exhibit more effective parenting – all of which support child development (Lugo-Gil & Tamis-LeMonda, 2008).

However, knowledge of the impact of advanced maternal age at birth on the cognitive and non-cognitive development of children is mostly US-focused, with mixed evidence and an incomplete understanding of relevant mechanisms. While medical research shows higher health risks of advanced maternal age at birth for both mother and child (Lemoine & Ravitsky, 2015; Ratiu et al., 2023), sociological and economic studies often highlight beneficial associations between older age and child development (Addo et al., 2016; Duncan et al., 2017; Myrskylä & Fenelon, 2012; Yu & Yan, 2022). Nevertheless, some studies contradict the notion of maternal age as an influential factor, as family characteristics largely explain the age-child-relationship, i.e., the relationship of advanced maternal age at birth and cognitive or non-cognitive child development (e.g., Augustine et al., 2015; Torres, 2015). When accounting for time-constant family characteristics, studies with advanced causal designs find only small age effects (Duncan et al., 2018), with benefits mainly observed when mothers delay childbirth beyond teenage years (Fishman & Min, 2018). However, by focusing predominantly on teenage or early-life-course births, most US studies lack sufficient observations of advanced maternal age, leaving its impact on child development underexplored.

Although the trend of advanced maternal age at birth is quite pronounced in Europe, (Eurostat, 2024), only a few studies investigate the impact of maternal age on child ability. Some studies confirm a positive relationship between maternal age and cognitive and non-cognitive child abilities. However, these associations appear to be limited to younger children up to age 11 for social-emotional development (Trillingsgaard & Sommer, 2018 for Denmark), or to more recent birth cohorts from the 2000s for verbal ability (Goisis et al., 2017 for the UK). Other studies reveal a negative relationship between advanced maternal age at birth and child development (Alvik, 2014; Goisis et al., 2017; Myrskylä et al., 2013), whereas for Germany, a sibling fixed-effects (FE) study – predominantly focusing on the within-family impact of sibling characteristics – finds no effect of maternal age on cognitive development at age 16 (Grätz, 2018).

Additionally, some studies explore the role of maternal age and education in intergenerational mobility, i.e., children's educational attainment. While Kalmijn and Kraaykamp (2005) emphasize positive age effects on children's educational attainment for the Netherlands using sibling FE, two studies from Northern Europe find no long-term effects using the identical method (Barclay & Myrskylä, 2016; Fredriksson et al., 2022). Similarly, a cross-country comparison of Norway, Germany, and the US, highlights the strongest correlations between maternal age and intergenerational educational inequalities for the US (Grätz & Wiborg, 2024). For Germany, associations are somewhat weaker, confirming earlier findings by showing more pronounced links between maternal age and educational attainment among lower-educated parents compared to minor benefits for children from highly educated families. In contrast, another study for Germany reveals negative effects of higher maternal age in higher-educated families on educational attainment (Grätz, 2018).

Together, these studies provide initial insights into the relationship between maternal age and child development but leave key gaps in understanding *whether* and *how* maternal age shapes child development. It is relevant to investigate age implications for children's actual abilities, which is not accurately captured by previous studies using educational attainment like years of schooling. Such outcomes can reflect social selection mechanisms due to family background that are difficult to disentangle from individual ability. Moreover, generalizability of existing evidence to Europe is limited. While US studies have primarily focused on the high prevalence of teenage births, like other international literature (e.g., Marteleto & Dondero, 2013), teenage motherhood has remained low across most European countries (Eurostat, 2015; Guzzo & Hayford, 2020; National Vital Statistics Reports, 2023). These considerations underscore the need to examine child abilities in contemporary European contexts, where rising maternal age follows different social and institutional patterns, requiring further research about the implications of the ongoing trend of advanced maternal age.

Focusing on Germany, this study investigates (1) *whether higher maternal age is positively associated with beneficial child development across various developmental stages*; (2) *whether the theory-derived mechanisms parenting quality, maternal well-being and family resources explain this link*; and (3) *whether these associations vary according to mothers' educational background*. Building on theories of child development, human capital and maturity, we provide a deep theoretical perspective and argue that higher human capital accumulation is more important for child development than maternal age itself. Maternal personal growth across the life course fosters maturity, enhancing parenting skills and maternal well-being, which benefit child development. We utilize data from the German National Education Panel Study (NEPS-SC1; NEPS Network, 2023; 2012-2021; doi:10.5157/NEPS:SC1:10.1.0), covering infants born in 2012 and tracking child development from ages three to nine through objective competence tests (math, vocabulary) and parent-reported social-emotional behavior. This allows us to examine between-family differences in how maternal age at birth shapes child development in contemporary cohorts, where later motherhood is more common, ensuring adequate representation of older mothers.

By leveraging high-quality panel data for the case of Germany, we contribute to the literature in three important facts: First, we enhance the global understanding of the role of advanced maternal age in cognitive and non-cognitive child development by providing novel insights for Europe, where trends in maternal age exceed those in the US. Second, we systematically investigate theory-derived mechanisms linking maternal age to child development, expanding prior evidence and deepening the understanding of its implications. Lastly, to facilitate integration into the US-dominated literature, we replicate the findings of Duncan et al. (2018), thus, providing a direct comparison of the relevance of maternal age across Europe and the US.

Studying the link between maternal age at birth and child development is crucial, as most literature examines the *overall* relationship identifying potential key drivers (e.g., Grätz & Wiborg, 2024). So far, few US studies explore the mediational pathways through family resources, learning environments, child characteristics, or parental aspirations (e.g., Duncan et al., 2018; Yu & Yan, 2022), but none fully explain the age effect. This underscores the need for extended analyses incorporating mechanisms like parenting quality and maternal well-being, particularly in the European context.

2. Institutional Context: Family Formation in Germany

Germany provides an ideal case to investigate the relationship between advanced maternal age at birth and child development, as delayed childbirth has become the norm rather than the exception. In 2021, the average maternal age at first birth was 30.1 years, exceeding both the EU average (29.7 years) and the US average (27.3 years) (Eurostat, 2024; National Vital Statistics Reports, 2023). Figure V.1 illustrates the rising age at first birth in Germany since the 1990s, also highlighting a persistent educational disparity, with delayed births being more common among tertiary-educated mothers. This development is also found in other European countries (e.g., Compans, 2021). Generally, the widespread prevalence of delayed motherhood across socioeconomic groups, increases the likelihood of maternal age effects, providing a unique opportunity to investigate its relationship with child development.

The German welfare state offers robust family support that stand in stark contrast to the liberal market economy and limited policies in the US. Healthcare is mandatory and universally accessible, covering essential prenatal screenings, childbirth, and all medical care for children at no additional cost. Paid maternity leave includes six weeks before and eight weeks after birth, followed by job-protected parental leave of up to 36 months. Parents receive 14 months of parental leave benefits at 67% of their income. Families also benefit from legal entitlement to childcare, child allowances, child tax allowances, and up to 15 paid sick days per parent (30 days for single parents) to care for sick children under 12. These universal policies reduce financial stress and economic worries, enabling families to prioritize health and well-being during and after pregnancy. By promoting greater social and economic

stability for families, Germany's family-focused welfare system provides significantly more support for young mothers and children compared to the US and liberal or Southern European welfare states.

Extensive social policy support may lead to different implications of advanced maternal age in Germany compared to the US. Particularly for families from lower socioeconomic backgrounds, who often start families at younger ages, such support might be crucial to provide children with beneficial learning environments. Other institutional settings, like largely free education in Germany, contrast with the US, where private resources determine children's educational prospects (Pfeffer & Hällsten, 2012). Thus, the age-child-relationship may be less pronounced in Germany due to strong state support, raising questions about whether findings from other contexts apply.

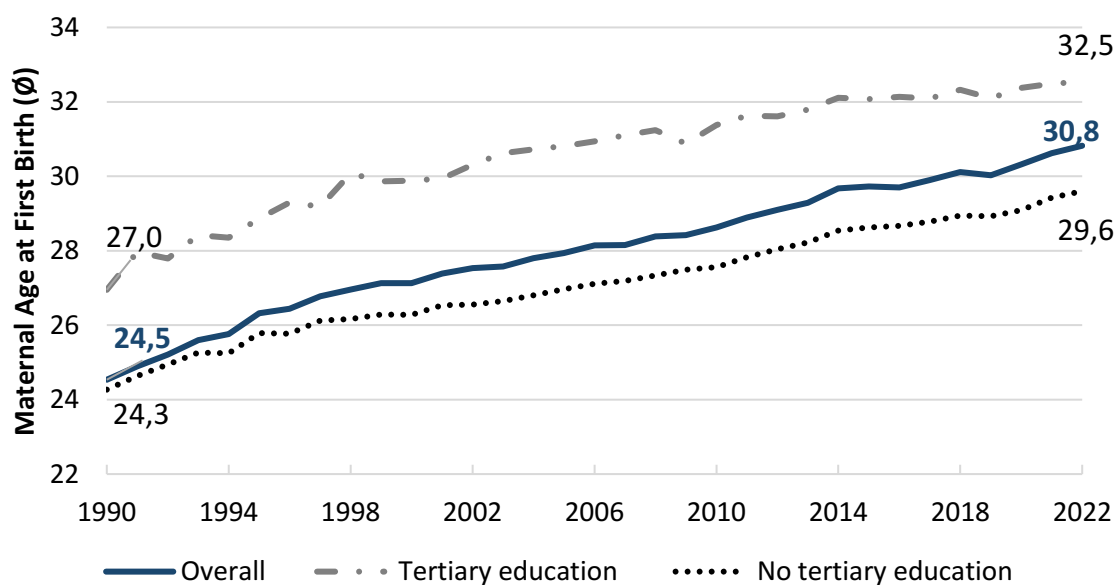


Figure V.1: Mean Maternal Age at First Birth in Germany (1990 - 2022)

Source: German Microcensus 2008, 2016, 2022. Own illustration based on a special evaluation by the Federal Statistical Office.

3. Theoretical Considerations and Hypotheses

We draw on sociological and economic theories on skill formation to theorize the implications of advanced maternal age at birth for child development. We expect that the positive age-child-relationship is largely attributable to mechanisms at the individual and household level, rather than maternal age itself being the direct causal factor. Our *baseline hypothesis* is that *the higher the maternal age at childbirth, the better the child's (a) cognitive and (b) non-cognitive development*. Since resources and maturity increase rapidly at younger ages but tend to stabilize later, we expect a non-linear relationship, with stronger maternal age effects early on that gradually weaken at higher ages. Additionally, due to the biological decline in fertility, which may affect child health outcomes, we anticipate a potential link to child competencies that eventually diminishes the positive link (e.g.,

Fishman & Min, 2018; Lemoine & Ravitsky, 2015). In the following, we discuss the relevance of personal development, using psychological concepts of maturity and the family's home learning environment, as well as family resources such as mothers' education and employment.

3.1 Maternal Age and Resources

Family resource endowment has important implications for family formation and child development: on the one hand, women with more resources self-select into older motherhood (*selection mechanism*); on the other hand, an older age at family formation enables parents to have attained more resources, which can improve learning environments and child development (*causal mechanism*). In accordance with the *selection mechanism*, fertility decisions are socially stratified and determine mothers' age at childbirth (Doepke et al., 2022; Guzzo & Hayford, 2020). Mothers expecting high education and career returns may delay childbirth to avoid missed opportunities and wage losses. For women who do not anticipate high returns, starting a family might appear less costly because their investments begin to pay off sooner, leading them to earlier family formation (Doepke et al., 2022). As a result, large differences in resource endowment emerge between younger and older mothers that are likely to impact family life, home environments, and, thus, child development. The literature recognizes such *between-family* differences, demonstrating higher levels of education, greater income, and more stable relationships of older mothers in the US and Germany (e.g., Duncan et al., 2018; Zerle et al., 2012). For the UK, Goisis et al. (2017) identify a reinforcing cohort effect, suggesting that older mothers exhibit increasingly advantageous characteristics in more contemporary birth cohorts. If this holds for Germany, the sample composition by maternal birth cohort and socioeconomic background is even more crucial.

In line with the *causal mechanism* of resource endowment, Cunha's and Heckman's (2010) dynamic skill production process theory states that early investments in children yield the highest developmental returns. Parents with greater human capital at childbirth are better positioned to invest in their children from an early age. Since older parents are more likely to have accumulated more capital, their offspring benefit from birth onward. Following the principle that "skills beget skills" (Cunha & Heckman, 2010, p. 7), these children have better opportunities to accumulate larger resources during their first years, leading to better development. Hence, here we expect *within-family* differences in child development if family resources vary (Fishman & Min, 2018). Empirical evidence supports these theoretical arguments, suggesting that older mothers' greater resources enhance child abilities (e.g., Fulco et al., 2020). Whereas higher financial resources have been shown to enhance the home learning environment (e.g., Cooper & Stewart, 2021; Votruba-Drzal, 2003), higher education primarily affects parenting skills (e.g., Kalil et al., 2012; Şengül-İnal et al., 2025), providing a more stimulating and nurturing setting. Thus, we presume that *higher family resources partly explain the relationship between maternal age and (a) augmented cognitive and (b) non-cognitive child development (resource hypothesis)*.

3.2 Maternal Age and Maturity

Similar to resources, psychological theories on personality development (Allport, 1961; Ryff & Keyes, 1995) suggest that *maturity* increases with age, particularly during young adulthood. Depending on the concept, maturity is also understood as a healthy personality (Allport, 1961) or psychological well-being (Ryff & Keyes, 1995). Theories associate maturity with higher levels of self-acceptance, autonomy, personal growth, or the ability to relate to oneself warmly with others, which facilitates the successful mastering of everyday work or family life (Josefsson et al., 2013). Thus, maturity explains why increased maternal age may benefit child development, as it is associated with beneficial personal characteristics that enhance children's home learning environments.

We therefore argue that maturity positively stimulates key aspects of the home learning environment dimensions, i.e., process quality, structural quality, and educational beliefs. Accordingly, maturity can be positively associated with *process quality*, i.e., the manner of interactions within the family (Kluczniok et al., 2013). More mature mothers are likely to be more responsive to their children's needs and to react more warmly, which may enhance parenting quality and support child development (Allport, 1961; Baumrind, 1989). Evidence demonstrates that both older maternal age (Farley et al., 2021; Trillingsgaard & Sommer, 2018) and increased maturity (Camberis et al., 2016) positively correlate with parenting quality.

Moreover, maturity is linked to better *personal, structural quality*, i.e., stable characteristics of the mother and the family (Kluczniok et al., 2013), via higher levels of maternal well-being and self-acceptance with older age (e.g., Bauger et al., 2021; Galambos & Krahn, 2008). Similarly, self-esteem tends to increase with age (Orth et al., 2018), and is a strong predictor of a mother's perceived parenting ability (Ahmad et al., 2024; Leerkes & Crockenberg, 2002). Especially older mothers with higher parity births might benefit from their parenting experience with the first child. Furthermore, greater maturity is reflected in personal growth: older women often feel more prepared and emotionally ready for motherhood (e.g., Ahmad et al., 2024), which may contribute to a higher rate of wanted pregnancies – a factor linked to better maternal mental health (Rackin & Brasher, 2016). More broadly, older and more mature mothers also tend to engage in healthier lifestyles and show better health behaviors during pregnancy (Robert Koch Institute, 2020), benefiting both prenatal and postnatal child development.

The last dimension *educational beliefs* develops over the lifespan but is seen as rather time-constant (Kluczniok et al., 2013), thus, it only plays a minor role in the implications of maturity for maternal age at birth. To summarize, we expect that enhanced home learning environments – through (I) *higher parenting quality* and (II) *better maternal well-being* – partly explain the relationship between maternal age at birth and (a) *augmented cognitive* and (b) *non-cognitive child development (environmental hypothesis)*.

3.3 Maternal Age and Heterogeneity

Given that formal education is a key resource for mothers, we expect differences in the age-child-relationship depending on mother's education. Status attainment models (Breen & Goldthorpe, 1997) emphasize that parents strive for at least the same or better education and occupational status for their children, resulting in targeted child promotion, particularly among high-status parents. Possibly, younger mothers with higher educational resources anticipate potential disadvantages and compensate for them by fostering their children even more through stimulating learning environments. This might lead to a diminished relevance of older maternal age for higher-educated mothers because the overall level of resources is higher. Additionally, high-educated mothers may be better equipped to apply their increased maturity, while external constraints may make it more challenging for low-educated mothers to translate personal growth into improved parenting and well-being. For example, higher job strain, less schedule control and more work-to-family stress may prevent lower-educated mothers from fully realizing their potential to create optimal home learning environments. Thus, we presume that *the positive relationship between older age at birth and (a) augmented cognitive and (b) non-cognitive child development is more pronounced for mothers without tertiary education than for tertiary-educated (heterogeneity hypothesis).*

4. Methods

4.1 Data and Sample

We analyzed the relationship between maternal age at birth and child development across different developmental stages using Pooled Ordinary Least Squares (POLS) regressions with longitudinal data from the newborn cohort of the German National Education Panel Study (NEPS-SC1) (Blossfeld & Roßbach, 2019; NEPS Network, 2023; 2012-2021; NEPS:SC1:10.1.0). Since August 2012, the NEPS-SC1 surveys parents and their children born between February and July 2012, who were sampled via a register-based, two-stage disproportional stratified sampling technique. Starting at age 6-8 months, interviews were conducted at least once a year, providing information about family life, maternal well-being, career trajectories, and parental resources. Additionally, the data include detailed, age-appropriate cognitive competence tests of the focal child (Schlesiger et al., 2011; Weinert et al., 2016), while non-cognitive development is measured through parental reports. As the only long-running panel study available, the NEPS is particularly well-suited for examining the of interest during the first ten years of life.

For our gross sample, we identified biological mothers who participated in the first wave ($n=3,418$) and their children who completed at least one competence tests in any wave (2015 wave 4 – 2021 wave 10; $N=12,972$; 2,387 mother-child dyads). We excluded dyads with missing information on all child abilities ($n=1,094$). Based on complete information on maternal age and depending on the particular indicator of child abilities, the analysis is left with a sample of $n_{\text{Math}}=2,290$, $n_{\text{Vocabulary}}=2,150$ and

$n_{SEB}=2,280$ mother-child dyads with a maximum of seven observation years between ages three to nine (for more details, see online appendix Table A-V.1). Missing data on controls and mediators were accounted for in all models using missing indicator approach (further details in section Analytical Strategy).

Our sample included mothers born between 1962 and 1994, with the majority ranging from 1969 to 1989, and their children observed between ages three to nine. Most mothers gave *first* birth between 25 and 35 years (77%), with fewer individuals giving birth below age 25 (11%) and some at a more advanced age above 35 years (12%). Since our sample consisted of only 50% mother-child dyads that were firstborns and we assume that mechanisms for first and following births are similar, except for parenting experience which is controlled in all models, we combined first and higher parity births in the analysis. Robustness analysis restricted to firstborns only supported this decision, demonstrating similar results with larger confidence intervals for the more conservative sample (see Figure A-V.1 in the online appendix). Figure V.2 pictures the overall age distribution, separated by maternal tertiary education, highlighting the selection into higher age at childbirth.

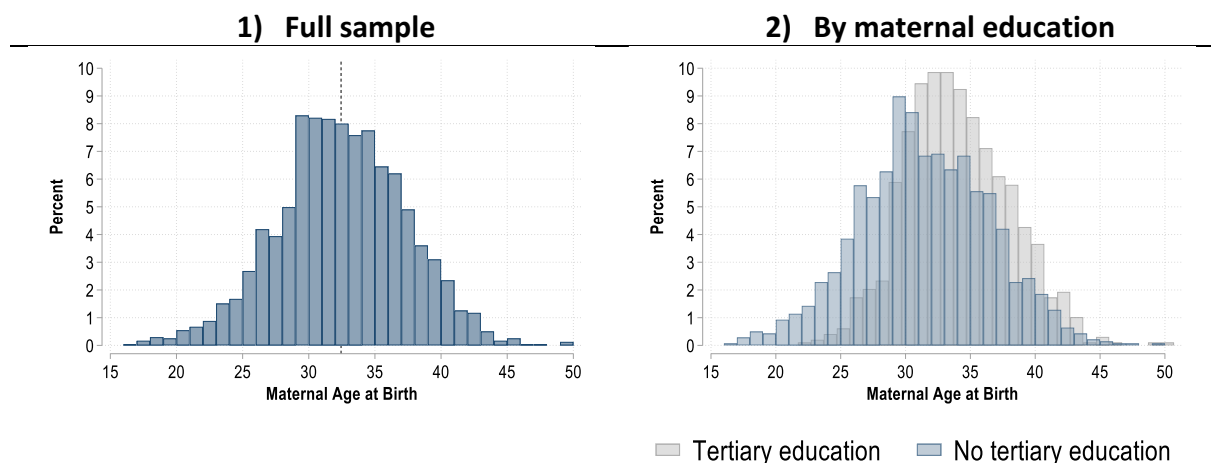


Figure V.2: Sample Distribution of Maternal Age at Birth of Focal Child

Note: Mean age=32.4 indicated by black dotted line, $n_{Full}=2,387$, $n_{Tertiary}=978$, $n_{Non-Tertiary}=1,403$.

Source: NEPS-SC1 10.1, 2012-2021.

4.2 Variables

We examined the effect of maternal age on child development using a set of cognitive and non-cognitive child outcomes measured across between age three and nine, including indicators on math, vocabulary, and social-emotional behavior (see details on variables in Table A-V.2). *Mathematical literacy* (OECD, 2003) measured the children's competence to use their math abilities to meet daily-life challenges (measured at ages 4, 6, and 8). Test scores represent Weighted Likelihood Estimators (WLE) provided by the NEPS, with positive values indicating above-average ability and vice versa. The WLE weights scores according to their complexity to address the varying difficulty levels between test

items and waves. In addition, we examined *receptive vocabulary* based on an internationally applicable indicator of language abilities, the Peabody Picture Vocabulary Test (PPVT-IV; measured at age 3, 5, 7, and 9). These established measures have been elaborately developed and extensively tested to capture children's age-specific abilities in the best possible way (NEPS, 2022; 2023).

Lastly, we examined non-cognitive child development through maternal reports on the child's positive *social-emotional behavior* (reported at ages 5, 6-7, and 8-9). For simplicity, we built a compound index of four indices, each containing five items: behavioral problems (e.g., tells lies), peer problems (e.g., gets teased), hyperactivity (e.g., easily distracted), and prosocial behavior (e.g., helps others voluntarily). Depending on the wave, Cronbach's alpha ranged from $\alpha=0.74$ to $\alpha=0.77$, indicating good reliability for the social-emotional behavior index. However, we ran robustness checks using individual scores that supported our approach (available upon request). The social-emotional behavior index and vocabulary score were mean-standardized for each time of measurement. Higher values indicate better social-emotional behavior and better vocabulary knowledge.

Our central independent variable was *maternal age at birth of the focal child*, calculated using the exact birth dates of both mother and child, resulting in a continuous age variable.

To investigate the age-child-relationship more thoroughly, we explored potential mechanisms reflected in variables measuring parenting skills, maternal well-being, and family resources. *Parenting quality* was operationalized through a parent-child interaction quality score, assessed by NEPS via videotaped sessions of mothers playing with their child. Trained personnel evaluated these videos based on maternal sensitivity and level of language stimulation (age 2). Additionally, the home learning environment was measured through a score capturing the frequency of educational activities such as reading or singing together (age 2). *Maternal well-being* was represented by a maternal happiness score (age 7), a self-assessed health dummy (age 7), and two dummies for smoking and drinking behaviors during pregnancy. Lastly, *family resources* were measured through mother's years of education at birth, logarithmic household income in Euro (age 2), years of maternal work experience before first childbirth retrieved from employment histories, work tasks complexity around childbirth (un-/semiskilled, skilled complex, or highly complex task), and whether the mother lived with a partner in each wave.

We additionally controlled for the family context regarding child's number of siblings at the latest observation (none, one to two, three or more), years of birth spacing between the firstborn and the focal child, and a dummy indicating whether at least one parent immigrated to Germany, as well as demographic information on paternal age at birth and the child's age. Sample descriptives for all variables are presented in Table A-V.3.

4.3 Analytical Strategy

We examined the role of maternal age at birth for child development using a two-step approach: First, we tested our core assumption that older maternal age has is positively associated with child development by estimated pooled OLS (POLS) regression analysis, which treats repeated panel data as cross-sectional. This way we obtained between-family coefficients for different outcomes of child i at child's age t (equation 1).

$$\begin{aligned} ChildDevelopment_{it} = & \alpha_0 + \beta_1 MaternalAge_i + \beta_2 MaternalAge_i^2 \\ & + \beta_3' Covariates_{it} + \beta_4' Covariates_i + \varepsilon_{it} \end{aligned} \quad (1)$$

The main predictor, maternal age at childbirth and its square is denoted by β_1 and β_2 . Results using a linear age predictor were similar (available upon request), but the curvilinear predictor provided a better fit, aligned more closely with the data and is more theoretically justified due to expected diminishing marginal returns. This finding is consistent with Fishman and Min (2018), who examined the functional form of the age-child-relationship.

We also included separate vectors of time-varying controls (β_3) and time-constant controls (β_4). We do not control for maternal birth cohort or wave to avoid overcontrol bias due to multicollinearity and age-period-cohort problems, as all sampled children were born in 2012. Furthermore, we followed the recommendations by the NEPS survey experts to implement the model-based approach, i.e., to include relevant covariates that drive sample selectivity rather than including sample weights (Würbach et al., 2016).

To avoid larger listwise deletion and potential sample bias, we applied a straightforward missing indicator approach: we included missing categories for categorical variables and replaced missing values in continuous variables with sample means, adding indicator dummies to flag imputed values. Robustness checks performing listwise deletion yield similar conclusions (not shown).

Secondly, we leveraged the depth and quality of our data to conduct a more nuanced analysis of the underlying mechanisms by estimating our POLS models with additional mechanisms (equation 2).

$$\begin{aligned} ChildDevelopment_{it} = & \alpha_0 + \beta_1 MaternalAge_i + \beta_2 MaternalAge_i^2 \\ & + \beta_3' ParentingQuality_i + \beta_3' WellBeing_i + \beta_3' Resources_{it} \\ & + \beta_3' Covariates_{it} + \beta_4' Covariates_i + \varepsilon_{it} \end{aligned} \quad (2)$$

We included rich information on parenting quality, maternal well-being, and family resources to thoroughly explore the underlying mechanisms that may drive the observed relationship. Some of the mechanisms could also serve as controls but potentially limit our ability to assess their relevance for the age-child-relationship, e.g., maternal education influences children's home learning environment. Ideally, we would account for maternal education at the time of competence testing while controlling

for maternal pre-birth skills, but our data lacks this information. Given the low variance in maternal education during early childhood and its high correlation over time, controlling for time-variant education is not expedient. Thus, we treat education as a mechanism. Nonetheless, further analyses that account for maternal education lead to similar conclusions about the age-child-relationship and demonstrate robustness of this procedure. Lastly, we examined the role of maternal education for the observed associations, distinguishing between mothers with and without tertiary education, followed by several robustness checks.

5. Results

Figure V.3 illustrates descriptive evidence that pointed to positive, curvilinear associations between maternal age groups and both average cognitive and non-cognitive child outcomes. A strong relationship emerged between younger maternal age and lower cognitive outcomes (panels a, b), with children of mothers aged 20 years or younger achieving below-average scores of -1.1 SD in math and -0.8 SD in vocabulary. The cognitive scores converged to the mean as the mother's age at birth increased and ultimately demonstrated a slight above-average attainment of about 0.1 SD from age group 31 onward. Beyond age 30, however, the marginal gain of postponing childbirth declined and occasionally turned negative, as ability scores plateaued across older age groups. Findings for non-cognitive child development (Figure V.3, panel c) showed a weaker relationship that hinted in the same direction, although above-average scores were attained of mothers with age 34 onward. These patterns underscore the value of modeling maternal age as non-linear variable, while using its high level of detail due to continuous measurement, to fully capture its relationship with child outcomes.

5.1 Explaining the Age-Child-Relationship

Figure V.4 presents results from POLS models, estimating the relationship between maternal age and cognitive and non-cognitive child outcomes across child's age (full models in Table A-V.4). Panel 1 of Figure V.4 displays profile plots indicating predicted probabilities of child abilities across maternal age based on results from equations (1) and (2). We distinguish raw, baseline models (blue) from full models accounting for covariates and potential mechanisms (grey).

Consistent with the descriptive findings, baseline results revealed an inverse U-shaped association between maternal age and child outcomes. The largest cognitive gains occurred among children of younger mothers before and during their 20s, showing similar patterns for math and vocabulary (Figure V.4, panels 1a, 1b). For example, children of 18-year-old mothers scored below-average math abilities about $y_{\text{Math_Raw18}} = -1$ SD ($y_{\text{Vocab_Raw18}} = -1$ SD), whereas those of 36-year-old mothers attained above-average scores around $y_{\text{Math_Raw36}} = 0.1$ SD ($y_{\text{Vocab_Raw36}} = 0.1$ SD). However, maternal age higher than 30 mainly indicated above-average abilities that were marginal in size. In contrast, the non-cognitive social-emotional behavior had a flatter inverse U-shape, indicating a weaker, possibly linear

relationship with maternal (panel 1c; $y_{SEB_Raw18}=-0.3$ SD; $y_{SEB_Raw36}=0.04$ SD). For mothers age 38 or older, results suggested negative marginal returns. However, sparse data beyond age 43 and the chosen functional form limit interpretation.

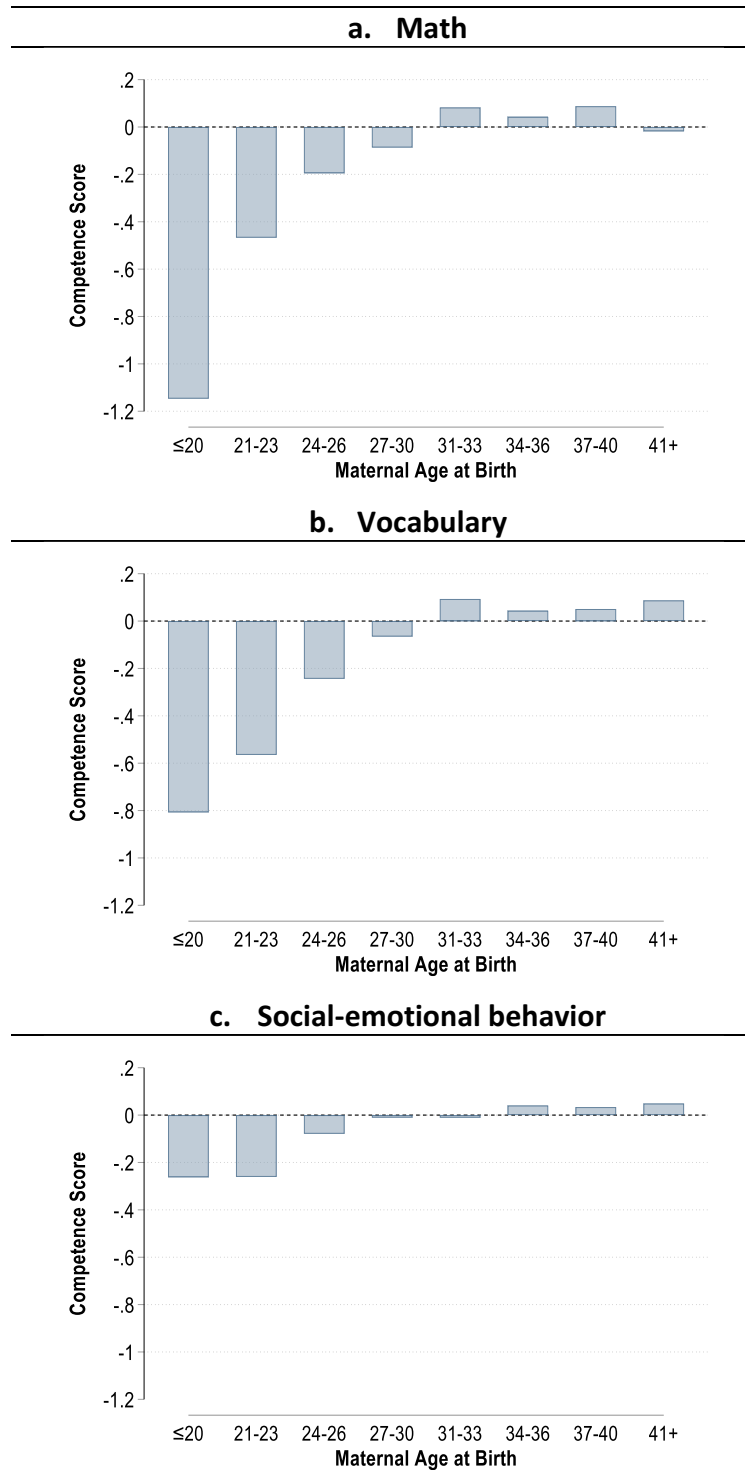


Figure V.3: Descriptive Evidence – Maternal Age and Child Development

Source: NEPS-SC1 10.1; 2012-2021; N=12,972, unweighted.

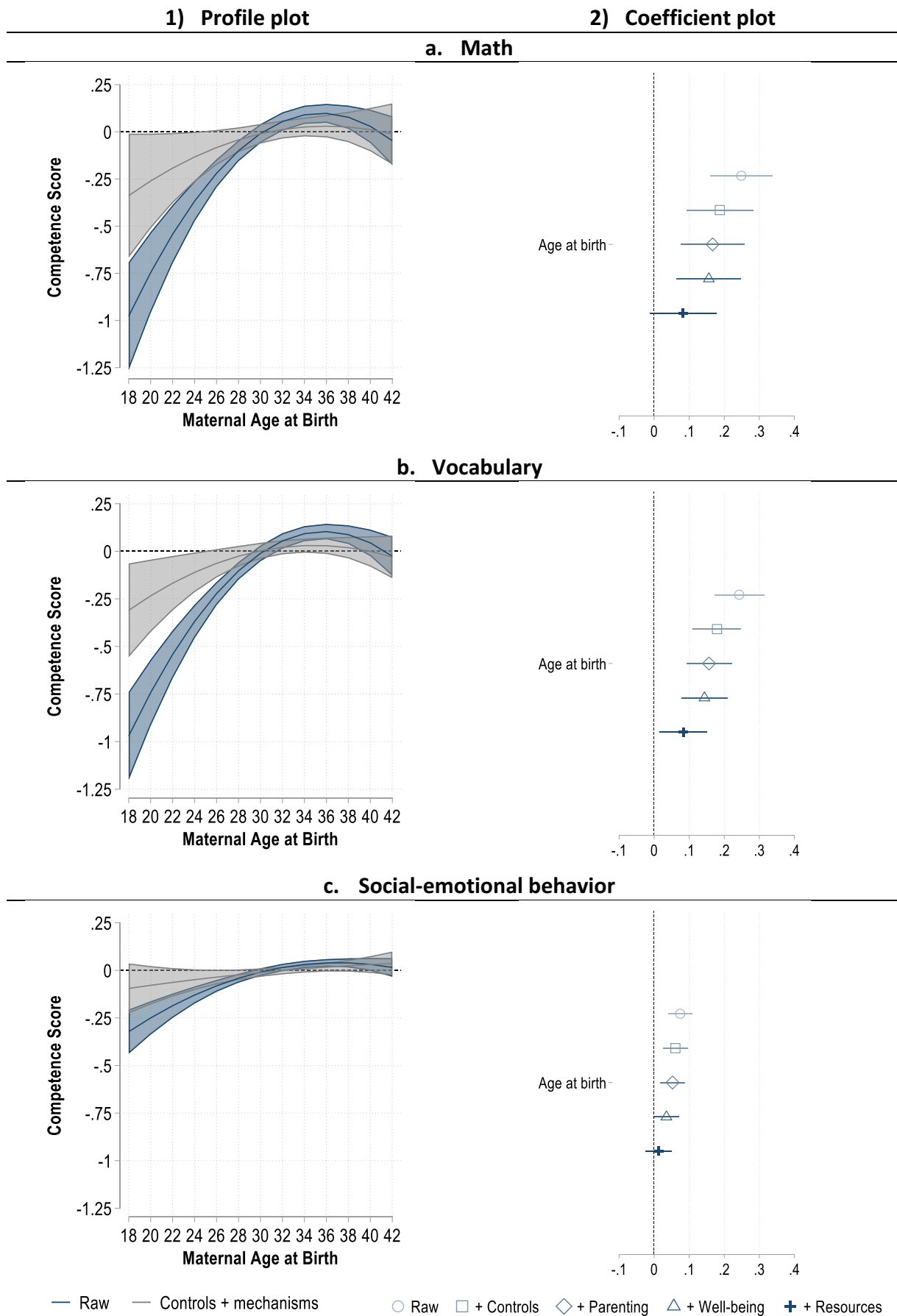


Figure V.4: Main Results – Maternal Age at Birth and Child Development

Note: Panel 1: Predicted probabilities / profile plots; Panel 2: Coefficient plots;

Raw and fully controlled models of POLS regressions. Panel 2 shows the main coefficient of maternal age at birth, its square is suppressed due to small size of coefficient.

Controls: number of siblings, birth spacing, immigrant origin, paternal age at birth, age of child;

Mechanisms: Parenting quality (parent-child-interaction-quality; home activities), maternal well-being (maternal happiness, maternal self-assessed health, smoking and drinking behavior during pregnancy), family resource (logarithmic household income, mother's years of education, maternal work experience, level of work requirements, cohabitation with partner).

Source: NEPS-SC1 10.1; N=12,972; 95%-CI; individual-clustered standard errors

Adding controls to our raw models only slightly altered the main coefficients across all outcomes (not shown), supporting the presence of a curvilinear relationship for cognitive abilities up to mothers' 30s, with minimal benefits beyond this age. Hence, our findings partially support the *baseline hypothesis*, presuming that *higher the maternal age at childbirth, the better the child's (a) cognitive and (b) non-cognitive development*.

We further examined whether the age-child-relationship was mediated by differences in parenting, mothers' well-being, and resources. Panel 2 of Figure V.4 presents estimated coefficients for maternal age at birth from stepwise POLS models. The top coefficient (circle) complements the blue line for parsimonious models in panel 1, whereas the bottom coefficient (cross) belongs to the grey line with the full set of covariates and mechanisms.

Stepwise models showed that controlling for the mechanisms parenting quality and maternal well-being slightly reduced the maternal age coefficients, partially explaining the age-child-relationship, as smaller fractions of all child abilities are attributable to maternal age (Figure V.4, panel 2). Adding family resources substantially reduced coefficients and flattened the curve, resulting in minor differences in child abilities across maternal ages (panel 1). For example, children of 18-year-old mothers scored below-average math abilities of $y_{\text{Math_Control18}} = -0.3$ SD, while those of 36-year-old mothers peaked with lower certainty at $y_{\text{Math_Control36}} = 0.03$ SD. Similar patterns held for vocabulary ($y_{\text{Vocab_Control18}} = -0.3$ SD; $y_{\text{Vocab_Control36}} = 0.03$ SD). Despite controls, modest cognitive disadvantages remained for the youngest mothers, accounting for roughly one-third of the raw association, suggesting an unexplained direct residual association. In contrast, the weaker relationship with social-emotional behavior became almost fully explained after adjusting for all mechanisms.

The results therefore provided support for the *environmental hypothesis*, assuming that (I) *higher parenting quality* and (II) *better maternal well-being partly explain the relationship between maternal age at birth and (a) augmented cognitive and (b) non-cognitive child development*. Given that family resources had the largest power to explain the age-child-relationship, results also provide support for the *resource hypothesis*, presuming that *higher family resources partly explain the relationship between maternal age and (a) augmented cognitive and (b) non-cognitive child development*. However, our findings indicated stronger support for non-cognitive child abilities compared to more persistent associations for cognitive abilities.

5.2 Analyzing Effect Heterogeneity by Maternal Education

Lastly, we examined educational disparities in the age-child-relationship, finding higher cognitive ability levels for children of tertiary-educated mothers. Figure V.5 displays results for mothers with tertiary education (panel 1) and without tertiary education (panel 2). Again, we distinguish raw relationships under control of education and models with full sets of controls and mechanisms. Raw relationships depict a steeper inversely U-shaped link between age and cognitive development, with age being more relevant for non-tertiary-educated mothers (panels 2a, 2b). Children of mothers who gave birth at age 18 attain below-average math abilities of about $y_{\text{Math_Raw_Low18}} = -1$ SD and vocabulary scores of about $y_{\text{Voc_Raw_Low18}} = -0.9$ SD. Similar to the main results, these predicted probabilities enhanced with older maternal age, peaking around age 34 (math) and 36 (vocabulary). Hence, the main results were driven by mothers without tertiary education.

After including controls and mechanisms, predicted probabilities demonstrate robust evidence for educational disparities. For children of mothers with tertiary education (Figure V.5, panels 1a, 1b), the relationship between maternal age and cognitive abilities remains fairly parallel to the x-axis, indicating a possible linear relationship. However, results should be interpreted with caution due to a low number of observations of mothers under age 25 with tertiary education. For non-tertiary-educated mothers (Figure V.5, panels 2a, 2b), disparities in below-average cognitive abilities attributable to maternal age at birth decreased ($y_{\text{Math_Control18}} = -0.6$ SD; $y_{\text{Vocab_Control18}} = -0.6$ SD). Nevertheless, differences in cognitive abilities remained statistically significant until around ages 40 to 42, with the largest marginal gains until around age 38. Hence, our results confirmed the *heterogeneity hypothesis* assuming that (a) *the positive relationship between older age at birth and cognitive child development is more pronounced for mothers without tertiary education*.

For non-cognitive child development, differences between educational groups were small. In panel 1c of Figure V.5, the raw models demonstrated minor positive associations for social-emotional behavior for children of older tertiary-educated mothers from age 32 onward ($y_{\text{SEB_Raw36}} = 0.1$ SD). In contrast, children from non-tertiary-educated mothers showed relevant gains *prior* to age 30 (panel 2c). After including controls and mechanisms, findings for non-cognitive abilities changed between educational groups. We observed below-average social-emotional behavior for children of young, tertiary-educated mothers ($y_{\text{SEB_Control18}} = -0.4$ SD), which increases with age and peaks around age 40. Conversely, for non-tertiary-educated mothers, the age-child-relationship weakens and reverses, with smaller social-emotional behavior differences emerging between ages 24 and 36 ($y_{\text{SEB_Control36}} = -0.04$ SD). Again, mothers without tertiary education drive the results. Hence, our findings for non-cognitive development contradicted the *heterogeneity hypothesis* postulating that (b) *the positive relationship between older age at birth and non-cognitive development is more pronounced for mothers without tertiary*, as results demonstrate a more pronounced association for mothers obtaining tertiary education.

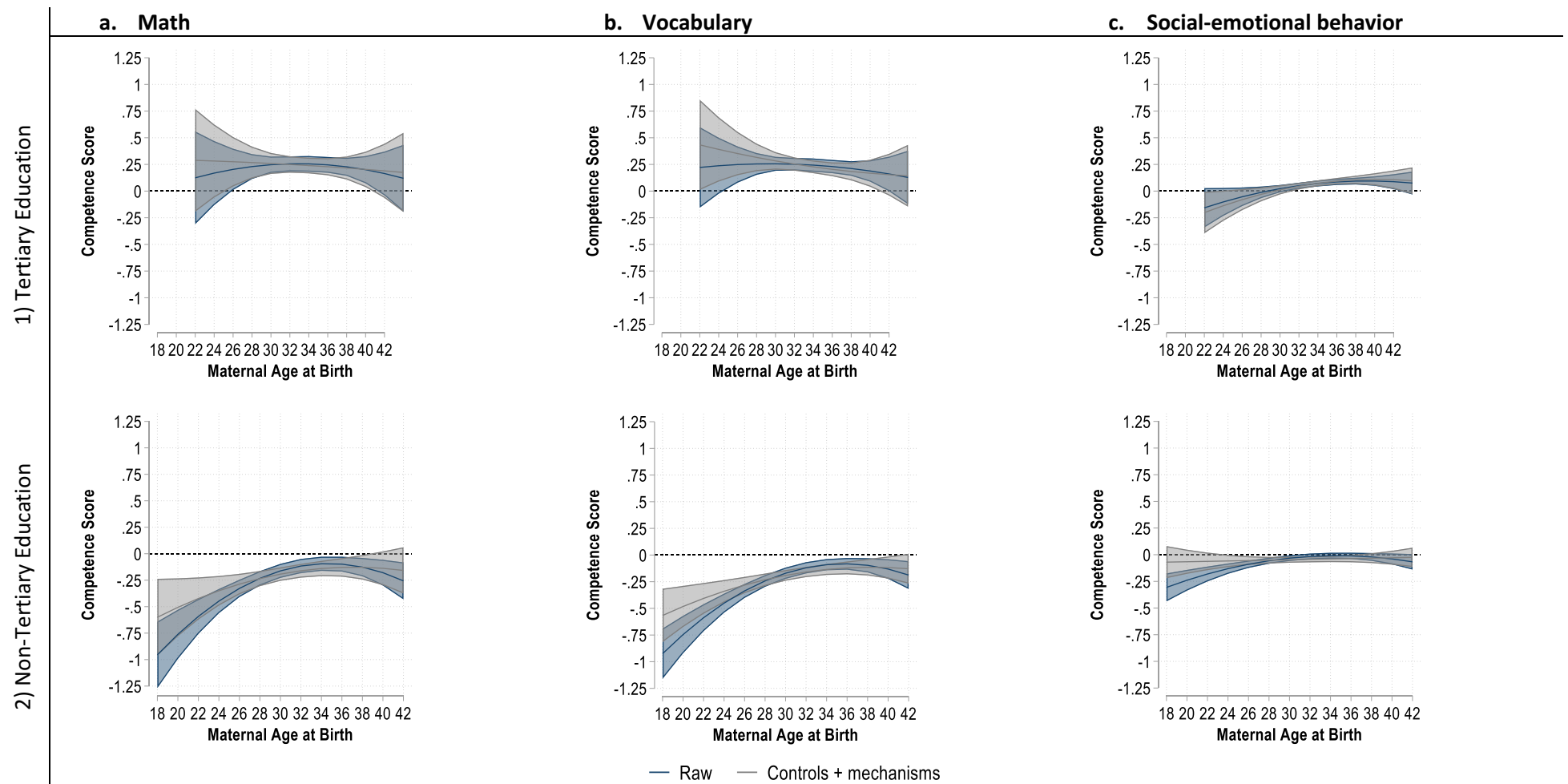


Figure V.5: Effect Heterogeneity by Tertiary Education: Maternal Age and Child Development

Note: Panel 1 profile plot for tertiary-educated mothers ($N_{\text{tertiary}}=5,677$) and Panel 2 for non-tertiary-educated mothers ($N_{\text{non-tertiary}}=7,265$). Predicted probabilities for raw and fully controlled models of POLS regressions. Panel 1 displays only ages where observations in sample exist, i.e., from age 22 onward.

Controls: number of siblings, birth spacing, immigrant origin, paternal age at birth, age of child;

Mechanisms: Parenting quality (parent-child-interaction-quality; home activities), maternal well-being (happiness, self-assessed health, smoking and drinking behavior during pregnancy), family resource (log household income, mother's years of education, maternal work experience, level of work requirements, cohabitation with partner).

Source: NEPS-SC1 10.1; $N=12,942$; 95%-CI; individual-clustered standard errors.

5.3 Robustness Checks

To ensure the robustness of results, we ran several sensitivity checks, including (1) linear age analysis, (2) the use of single behavioral scores (peer problems, behavioral problems, hyperactivity, prosocial behavior) instead of the compound social-emotional behavior index, and (3) extended analysis of mechanisms comprising child health (birth weight, birth week, health restrictions) and indicators for maternal risk aversion, preparedness for motherhood, and egalitarian care distribution with a partner. All additional analyses revealed similar results that confirmed the main findings of the preferred specification (available upon request).

Additionally, we analyzed age-specific models to examine differences across children's developmental stages. Revised models largely supported the main findings, with minor age-related variations (Figure A-V.2, A-V.3). Notably, a stronger age-child-relationship emerged for vocabulary at age three, while differences at older ages were of lower certainty. Furthermore, we used a lower educational cutoff for effect heterogeneity analysis, i.e., the German university-entrance certificate *Abitur*, to better account for young but highly educated mothers. This way, we created a more homogeneous lower-education group compared to non-tertiary-educated mothers. Confidence intervals narrowed at the edges, but results remained consistent with slightly reduced level differences in child abilities (Figure A-V.4). Overall, sensitivity checks confirmed the robustness of our results.

Lastly, we replicated parts of the empirical strategy of the well-known study by Duncan, Lee, Rosales-Rueda, and Kalil (2018) with POLS regression to directly compare the US literature to the European context. They used the US National Longitudinal Study of Youth data to explore the effects of advanced maternal age at birth on child development. However, their sample primarily included mothers who gave birth at 25 or younger from older maternal birth cohorts (1957-1965), reflecting historically high rates of very young motherhood (Kirmeyer & Hamilton, 2011). Such limited observations in older age groups posed inherent challenges for capturing the full spectrum of impacts of advanced maternal age, which inspired us to revisit their study with our data to build upon their valuable contribution. Further information and results are available in Tables A-V.5, A-V.6, and A-V.7. Our comparison of OLS results lead to similar conclusions in simply controlled models: each additional year of maternal age at birth improved cognitive abilities by about $\beta_{US_Math}=0.04$ SD and $\beta_{GE_Math}=0.03$ SD ($\beta_{US_Lang}=0.03$ SD and $\beta_{GE_Lang}=0.03$ SD). Conversely, our findings for non-cognitive, externalizing behavior ($\beta_{GE_Ext}=-0.01$ SD) were much weaker compared to the US ($\beta_{US_Ext}=-0.03$ SD). Including all their paper's mechanisms fully explained the age-child-relationship for Germany regarding math and externalizing behavior but not for our language indicator vocabulary ($\beta_{GE_Lang}=0.01$ SD). Conversely, stronger relationships remained for all outcomes in the US-OLS models. Therefore, our fully controlled OLS models were less in line with Duncan's and colleagues' OLS models. It revealed more similar results to their cousin FE models, which did not identify a remaining relationship after the inclusion of mechanisms.

6. Discussion

This study is the first to examine the relationship between advanced maternal age at birth and cognitive as well as non-cognitive child development in Germany, providing a detailed analysis of underlying mechanisms. Theoretical considerations challenge a direct causal link between higher maternal age and child abilities, instead emphasizing selection processes into later childbirth. Accordingly, higher child development is likely driven by older mothers' greater capital stocks and maturity rather than age itself. We therefore expect the age-child-relationship to be fully explained by mechanisms related to parenting, well-being, and family resources.

Using rich longitudinal data from Germany, we apply POLS regressions to estimate baseline models for the total and direct age-child-relationship, followed by an analysis of indirect associations to explore key mechanisms. Our findings reveal a curvilinear relationship, with older maternal age at birth positively linked to both higher cognitive and non-cognitive child abilities. The largest marginal gains for math and vocabulary occur when mothers give birth before and during their 20s, an age when children tend to exhibit below-average abilities. Conversely, for mothers aged 30 or older at birth, only minor marginal returns emerge. Controlling for key mechanisms, i.e., parenting quality, maternal well-being, and resources, reduces the positive association between maternal age and cognitive abilities. However, a small unexplained relationship remains despite detailed information on family background and children's learning environments. Parenting quality and family resources play the most important role in explaining this relationship, while maternal well-being has limited explanatory power. For social-emotional behavior, global associations with maternal age are rather weak and fully explained by mechanisms. Furthermore, analyses of educational effect heterogeneity reveal that maternal age is positively associated with the cognitive abilities of children of non-tertiary-educated mothers. In contrast, we find a weak relationship between maternal age and non-cognitive abilities for children of tertiary-educated mothers until their late 30s, even after controlling for various mechanisms.

Our findings align with previous European and US studies by confirming the positive association between higher maternal age at birth and child development, while demonstrating some disparities. Our results for Germany support European literature showing positive relationships between maternal age and children's cognitive and non-cognitive abilities, as well as educational attainment (Goisis et al., 2017; Grätz & Wiborg, 2024; Kalmijn & Kraaykamp, 2005; Trillingsgaard & Sommer, 2018). However, our findings that revealing an association between maternal age and child abilities up to age nine contrast with Grätz (2018). They found no effect on cognitive abilities at age 16, suggesting a possible fade-out over time. Our findings also align with numerous US studies (Addo et al., 2016; Augustine et al., 2015; Duncan et al., 2017; Fishman & Min, 2018), which indicate that the age-child-relationship is primarily driven by young mothers, with few differences at older maternal ages – consistent with our results.

Differences in coefficient sizes across studies may stem from variations in data sources and methodological approaches. Many European studies use large administrative data (e.g., Barclay & Myrskylä, 2016; Fredriksson et al., 2022), which can improve reliability, whereas most US studies – and ours – rely on panel survey data (Duncan et al., 2018; Fishman & Min, 2018). Additionally, differences also arise from variations in functional form, as there is no consensus on the ideal model specification. Some studies adopt curvilinear forms (e.g., Barclay & Myrskylä, 2016; Duncan et al., 2018; Fishman & Min, 2018), while others use linear models (e.g., Grätz, 2018; Kalmijn & Kraaykamp, 2005). Accordingly, our robustness analysis using the linear specification from Duncan et al. (2018) yield results more consistent with theirs, which present somewhat stronger relationships. This demonstrates the sensitivity of evidence to the choice of functional form. Finally, it is important to note that within-family designs produce inherently different estimates from between-family models like ours, and ongoing concerns about linear dependence in sibling fixed effects studies (Kravdal, 2019) highlight the need for further methodological scrutiny.

Moreover, our analyses expand previous research by providing a detailed analysis of theory-derived mechanisms linking maternal age to child development. Prior studies were unable to fully explain the age-child-relationship (e.g., Duncan et al., 2018). Addressing these gaps with theoretical guidance, we fully account for the age-child-relationship in non-cognitive abilities, underscoring the value of our analyses in uncovering the key drivers of maternal age impacts. These results also align with more causal findings from family FE studies (Barclay & Myrskylä, 2016; Duncan et al., 2018; Fredriksson et al., 2022), which control for all time-constant family characteristics – similar to our mechanisms – and do not find age effects. These results provide indirect support and highlight the theoretical importance of early childhood characteristics for child development. However, a small association remains for cognitive abilities, which is unexplained by our extensive data on early family and learning environments, indicating a need for further research.

Our findings on educational disparities contribute to the limited European research, demonstrating weaker positive associations between maternal age and child development for children from higher socioeconomic backgrounds (Grätz, 2018; Grätz & Wiborg, 2024). These findings contrast with tendential null-findings from the US (Augustine et al., 2015; Duncan et al., 2018). Unexpectedly, we find a weak association between maternal age and non-cognitive abilities among children of tertiary-educated mothers, contradicting our initial assumption that maternal age would matter more in lower-educated families. This weak relationship may partly reflect social-desirability bias in self-reported data, as higher-educated and older individuals are more likely to provide socially desirable responses according to previous research (e.g., Auspurg et al., 2015; Soubelet & Salthouse, 2011). Consequently, these children may receive inflated social-emotional behavior scores, potentially driving disparities in our results.

In contrast, our findings on educational disparities in cognitive abilities align with theory but differ from the mixed literature. Resource-based theories and the status attainment model (Breen & Goldthorpe,

1997) suggest that younger, higher-educated mothers might anticipate potential disadvantage and proactively compensate for them, reducing the relevance of tertiary-educated mothers' age for cognitive outcomes. While our null-finding supports this theoretical perspective, it contradicts previous evidence in Germany, as we neither confirm the small positive relationship reported by Grätz and Wiborg (2024) nor the small negative effects found by Grätz (2018). However, in line with theory and empirical evidence, we find the strongest positive age-child-relationships for children of low-educated mothers. Our results emphasize cognitive benefits particularly for children of *younger* mothers, whereas Grätz and Wiborg (2024) report a relevant relationship with children's educational attainment for of somewhat *older* mothers giving birth in their mid-20s and beyond.

Our results expand the previously limited understanding of the drivers of the cognitive age-child-relationship, by providing novel indication that mechanisms vary by education. While Grätz and Wiborg (2024) conclude that the benefits of maternal age for child abilities most likely stem from increased resources of older, lower-educated mothers, our study highlights that such resources are highly relevant but cannot sufficiently explain educational disparities despite a large set of resource mechanisms. The remaining correlation may be attributed to other family characteristics influencing the age-child-relationship, particularly for lower-educated mothers, which we are unable to capture with our data. For instance, factors such as parental relationship quality, maternal health behavior after childbirth, genetic factors, and parental cognitive competencies may vary by education and differently affect the relationship between maternal age and child development. This may also apply to the availability of social networks and the knowledge and ability to seek support or assert legal claims. It is left to future research to investigate which of these potential mechanisms drives the age-child-relationship for lower-educated families.

Taking a broader view, our findings indicate that maternal age remains influential in Germany, despite its more supportive policy framework compared to the US. While cross-country variations in the age-child-relationship may be shaped by differences in the institutional settings, including family policies, employment regulations, and social benefits, our results challenge the expectation that maternal age would be less relevant in Germany. Instead, its impact largely operates through underlying mechanisms rather than direct age influences. Moreover, the age-child-relationship is primarily driven by younger mothers – though not teenage births – similar to patterns observed in the US. This suggests that policy support may be less effective than anticipated, particularly for young mothers. Despite extensive leave and childcare reforms, state-subsidized childcare shortages persist (BMFSFJ, 2023), limiting young mothers' access to education (e.g., Duncan et al., 2018), job-related training (Zoch, 2023), and early career progression (Aisenbrey & Fasang, 2017), with lasting impacts on their future resource accumulation (European Institute for Gender Equality, 2024).

7. Limitations

Naturally, this study comes with some limitations. Most importantly, our analyses are limited by methodological constraints, as they reveal correlations rather than causal relationships. Despite rich data, omitted variable bias remains a concern, as key factors like maternal ability, delinquency, social networks, or paternal characteristics beyond age (e.g., parenting quality, well-being) are unaccounted for. This might limit our ability to fully explain the underlying mechanisms of the age-child-relationship, particularly for non-tertiary-educated mothers. Additionally, we cannot apply state-of-the-art methods such as sibling FE to address between-family heterogeneity. Nevertheless, our data remains the most comprehensive source available for examining these mechanisms in the German context. Moreover, we cannot fully address age-period-cohort (APC) problems. While our models account for maternal and child age while indirectly controlling for cohorts – since all children were born in 2012 – unconsidered period effects may remain. This is particularly relevant for the last two waves, conducted in 2020 and 2021, where the COVID-19 pandemic might have affected competence testing. However, robustness checks on age-specific models reveal no systematic differences before and during the pandemic, mitigating concerns about potential bias.

Furthermore, our data is subject to several data-related limitations. The data may slightly overrepresent mothers with more favorable conditions and higher socioeconomic backgrounds. Given smaller associations of maternal age at birth for more advantaged families, our findings are likely to provide rather lower bounds of possible age benefits for families with lower socioeconomic background. Lastly, our sample includes relatively few mothers who gave birth before age 22, limiting the applicability of our findings to younger groups. However, as teenage births have always been less common in Europe and Germany, our data – characterized by large proportions of older mothers – provides a more accurate reflection of current trends compared to samples dominated by very young mothers. Hence, this strengthens the relevance of our study, which further contributes to the understanding of the various implications of advanced maternal age in older societies.

8. Conclusion

Despite these limitations, our findings address a critical gap in the literature on contemporary cohorts and non-US contexts, providing novel insights for Germany and contributing to a deeper understanding of the ongoing trend of aging societies. Our results underscore that advanced motherhood has a limited impact on cognitive and non-cognitive child development for mothers with tertiary education. In contrast, children of mothers from lower socioeconomic backgrounds exhibit higher cognitive abilities as maternal age increases, a relationship that persists independently of key family characteristics. Nevertheless, our study does not suggest that women should postpone motherhood to enhance child development but rather highlights socioeconomic inequalities as the primary driver of the disparities observed with maternal age.

From a broader perspective, our findings therefore suggest that resource-oriented support for younger and lower-income mothers could help mitigate the intergenerational transmission of inequalities by fostering child development. For example, expanding access to reliable, high-quality publicly funded childcare could ensure that all children benefit from supportive learning environments, regardless of family background. Policymakers might consider maternal and paternal ages as a criterion for prioritizing childcare enrollment to ease access for young mothers, enabling them to complete their education or vocational training. Possibly, such measures might slow the trend of delayed motherhood in aging societies by providing greater support for family formation at younger life stages.

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Chapter VI – Integrative Discussion and Conclusion

This dissertation investigates three major ongoing societal developments and their implications to answer the overarching research question of *how maternal characteristics and early learning environments contribute to early heterogeneities in children’s developmental outcomes*. Specifically, societal shifts in maternal employment, external childcare usage, and delayed family formation have altered maternal characteristics, such as resource endowment, and influence children’s home and institutional learning environments in various ways. Overall, this dissertation views mothers as “gatekeepers” in childrearing decisions, as they remain to be the primary caregivers (e.g., Samtleben & Müller, 2022; Zoch & Heyne, 2023), and highlights the crucial role of learning environments and their respective learning opportunities. From a theoretical perspective, SES affects maternal rational decisions, resulting in socially selective educational choices throughout childhood, including childcare uptake in infancy and early childhood, schooling during middle childhood and adolescence, as well as home educational activities across children’s full life courses. Mothers’ investment behaviors, shaped by their education, occupation, income, and age, create disparities in parenting practices. As a result, children’s life courses are heavily influenced by mothers’ SES, ultimately impacting child development.

The following subchapters will briefly summarize the main findings of the individual articles, followed by an integrative discussion of results in light of ongoing trends and their overarching contribution. After discussing the overall limitations of this thesis, I will provide concluding remarks and an outlook for future research and social policy implications.

1. Short Summary of Main Findings

Study 1 establishes the foundation of this dissertation by jointly examining the two major trends of increased maternal employment and childcare usage, which are clearly illustrated in the results (Chapter II). Addressing part (a) of the research question on how maternal employment shapes early learning environments (see Figure I.2), it descriptively assesses the interrelation between maternal employment trajectories and childcare arrangements, identifying distinct childcare-work patterns that shape early learning environments. Multichannel sequence and cluster analysis reveal six clusters, categorized into two overarching patterns that outline distinct strategies for balancing maternal employment and childcare: (1) family-focused patterns, characterized by low-intensity workforce participation, longer employment interruptions, or steady non-employment, along with greater reliance on family childcare at younger ages; and (2) work-centered patterns for most mothers, characterized by full- or part-time employment and early use of institutional childcare, sometimes combined with extended family care.

Selection into these patterns is influenced by sociodemographic differences, although to a limited extent. There is a slight gradient of disadvantage, rather than strong divides by SES, with family-focused patterns being more common among mothers with lower education levels and lower household

incomes. Particularly younger mothers with more children tend to follow consistent homemaker trajectories. Conversely, work-centered patterns are more likely among higher-educated, higher-income mothers, especially when they highly value employment and external childcare. Their ideal enrollment ages are also younger. Results display the unique context differences between East and West Germany, with East-born mothers more likely to follow work-centered patterns due to differing normative and egalitarian orientations. While regional characteristics are important to consider macro contexts, neither unemployment nor childcare rates show statistically significant associations with cluster affiliation. Overall, study 1 enhances the understanding of the dynamic interplay of maternal employment and childcare usage, providing exclusive insights into diverse childcare-work trajectories that shape early learning environments in Germany, where distinct labor market regulations and childcare regimes exist.

Additionally, study 2 contributes to part (b) of the research question by examining how early institutional learning environments shape child development (Chapter III). It leverages a 1996 reform that expanded access to universal childcare from age three, providing professional and stimulating learning environments independent of family background. The first-stage results show that children statistically significantly prolonged their duration in childcare due to the reform. However, second-stage estimates reveal a non-significant, near-zero effect of duration in ECEC on the first attained school-leaving certificate. Heterogeneity analyses by education and immigrant origin do not alter these conclusions. In summary, this study contributes to the understanding of the context-specific role of universal institutional childcare for long-term educational attainment in Germany, demonstrating the limited effectiveness of *Kindergarten* for educational attainment and equity.

Studies 3 and 4 address the remaining research questions (c) asking about the relevance of maternal characteristics, i.e., occupational skills and age at birth, for child development, and additionally investigate question (d) on the mediating role of learning environments. The findings of study 3 on part (c) reveal that maternal occupational skills are associated with cognitive child development, although the relationships were small and only significant for mothers' highly specialized, analytical non-routine skills and children's vocabulary (Chapter IV). For the other cognitive outcomes, i.e., math and science, as well as non-cognitive competences, no statistically significant associations with the remaining maternal occupational skills were detected. Thus, the findings suggest that maternal occupational skills play a limited, yet theoretically important role in the intergenerational transmission of children's early developmental outcomes. Addressing part (d) of the research question, the mediating role of learning environments did not alter conclusions.

Lastly, the results of study 4 investigating the relevance of mothers' life-course timing in giving birth contribute to answering research question (c) by demonstrating an inversely u-shaped positive relationship between maternal age and cognitive and non-cognitive child competencies until about age 30 (Chapter V). This association was particularly pronounced among lower-educated mothers, whose children experience progressively better developmental outcomes when childbirth occurred at

an older age compared to the early 20s. In contrast to cognitive outcomes, children's social-emotional behavior showed a flatter and weaker inversely u-shape relationship with maternal age at birth, indicating less relevance. With regard to research question (d), the inclusion of mechanisms contributing to the home learning environment, i.e., maternal well-being, parenting quality, and family resources, explained much of the associations, particularly through the latter two. The explanatory power of these mechanisms was larger for lower-educated mothers. Overall, this study contributes novel insights into the relationship between maternal age and child development in the German context, highlighting the significance of better home learning environments in explaining this association.

2. Integrative Discussion

The findings of this dissertation contribute to the body of research by investigating *how maternal characteristics and learning environments contribute to early heterogeneities in child development*. Thereby, it addresses several gaps in the literature regarding the implications of ongoing societal trends on maternal employment, childcare, and older motherhood, which are discussed in the following.

2.1 The Relevance of Maternal Employment for Child Development

The first societal development considered in this dissertation is the trend of increased maternal employment and its implications for child development through distinct channels affecting learning environments. The trajectory-based perspective contributes a comprehensive and dynamic assessment of the prevalence of maternal employment after childbirth, clearly displaying the ongoing trend of increased maternal labor market participation. The majority of mothers follows work-centered trajectories with higher-intensity workforce, primarily from about 12 months after childbirth onwards. This reflects the life-course principle of multilevel processes, as the macro regulations on parental leave strongly shape its actual duration on the individual level (Mayer, 2004). Even in more family-focused patterns with weaker work preferences and lower work intensity, mothers increase their employment when the child becomes older. Given that these findings can only indicate that maternal employment trajectories potentially shape child development through differences in the timing, duration, and intensity of work, the relationship between mother's professional development and the promotional potential for child development is additionally examined in this dissertation.

To this end, the role of mothers' occupation-specific skills is elaborated as a key dimension of their human capital endowment. The evidence contributes to the body of research by extending the previously examined child outcomes, i.e., science and non-cognitive skills. Science competencies require other underlying cognitive skills compared to previously assessed math or vocabulary competencies (Tolmie et al., 2016). Likewise, proficient socio-emotional skills, such as empathy or the

ability to maintain friendships, are vital for children's social integration, personal well-being, and long-term development, as they are significant predictors of academic and professional achievement (Heckman et al., 2006; Linberg et al., 2020). However, the results on maternal occupational skills suggest limited importance beyond education for cognitive and non-cognitive child development. Only one statistically significant but weak domain-global relation between vocabulary and maternal analytical non-routine skills exists, without indication of domain-specific relations. This partly supports the previous literature that identified both domain-specific and global associations (Barg & Klein, 2024; García-Sierra, 2025; Yetis-Bayraktar et al., 2013), while being contradictory in light of evidence that highlights domain-specific associations between mothers' occupation-related interests, skills, and contents. These have been shown create distinct home learning environments that translate into children's development (Bowden et al., 2018; Guo et al., 2019; Mues et al., 2021; Plasman et al., 2021; Zucker et al., 2021), but the present thesis did not identify such associations with mechanisms on the home learning environment and family resources.

Contrary to theoretical expectations of the parent socialization model and home learning environment (Eccles, 1993; Klucznik et al., 2013), the presented findings on the limited relevance of maternal employment for child outcomes indicate that not all maternal skills, interests, and resources are easily transmitted within family spheres. These results contradict previous evidence demonstrating that higher maternal skills and interests improve home learning environments, and, finally, benefit child development (Cheung et al., 2025; Cosso et al., 2023; Del Río et al., 2017; Lin et al., 2015; Mues et al., 2022; Zippert & Rittle-Johnson, 2020). Possibly, some maternal occupations require skills that may not yet be developed in the age group in focus here or that are not reflected in the measured domains, such as, for example, policing that fosters critical thinking and physical fitness. However, the body of research did not examine such comprehensive sets of occupational skills like the newly adopted task-based approach in this thesis (Autor et al., 2003). Most previous literature focuses on STEM occupations (Bowden et al., 2018; Guo et al., 2019; Mues et al., 2021; Plasman et al., 2021; Zucker et al., 2021) and measures maternal occupational skills in terms of math and science – competencies central to childcare and school curricula. Thus, their transmission in child outcomes might be easier to identify. Another explanation lies in the selectivity of the STEM field, which differs from other occupations in terms of skill requirements, interests, gender composition, and the common attraction of more highly educated individuals (e.g., Kuhn & Wolter, 2022), highlighting the merit of this thesis' comprehensive approach.

The findings of this thesis additionally contribute to a deeper understanding of how early inequalities emerge by moving beyond global relations and systematically examining educational heterogeneity in maternal employment, where large disparities emerge. Mothers with high education tend to follow work-centered patterns, characterized by short parental leave and subsequent part-time or full-time employment (see Figure A-VI.1 and A-VI.2 in the appendix). Conversely, the workforce participation of lower-educated mothers is generally lower and gradually increases as children age. After longer

parental leave, there are consistently smaller shares in full-time than part-time employment, with marginal employment and stable home trajectories more common among the lower-educated. Despite the strong differences in employment trajectories, the educational divide in occupational skills is limited. Higher-educated mothers with high-profile cognitive skills showed a positive relation with child development, whereas lower-educated in manual-dominated jobs show negative relations, although most were not significant and modest in size.

Such an educational divide in maternal employment suggests strong implications for child development. The absence of employment, or a low intensity, can reduce work-family conflict and job strain, while larger time resources often benefit mother-child activities (e.g., Bass et al., 2009; Cho et al., 2024; Greenhaus & Beutell, 1985; Hook et al., 2022; McCredie et al., 2025). However, financial constraints can occur, which restrict mother's ability to invest in her child (Bourdieu, 1983; Conger et al., 2010), and increased economic stress may deteriorate parenting behavior (e.g., Conger & Donnellan, 2007; Nærde et al., 2026; Neppl et al., 2016; Um & Mincy, 2025). Non-employment is also associated with lower human capital, as no income is generated and occupation-specific skills may depreciate or not develop during employment interruptions (Becker, 1975; Jonsson et al., 2009; Mincer & Polachek, 1974). Despite inconsistent implications, processes of cumulative disadvantage likely occur (Cunha & Heckman, 2010; DiPrete & Eirich, 2006): when primarily lower-educated individuals do not work and care for their children, who often provide lower quality home learning environments, these children are almost exclusively restricted to their systematically lower maternal investments, potentially leading to poorer child development. However, this thesis finds limited global associations between occupational skills and child development, and combined with education's key role in shaping career trajectories, the transmission of occupational skills has a small potential for further educational disparities. Instead, education appears as key differentiator in overall employment trajectories, contributing to early heterogeneities in child development.

In summary, these insights address the research question of how maternal characteristics in terms of employment affect children's learning environment and overall development. The findings support theoretical assumptions about the higher resource endowment of working mothers (Becker, 1975; Bourdieu, 1983; Conger & Donnellan, 2007; Jonsson et al., 2009), which benefits child development through improved learning environments. The presented results contribute by investigating the micro-processes behind the intergenerational transmission of inequality more thoroughly by integrating comprehensive measures of maternal occupational skills and child development to enhance the understanding of the relevance of maternal employment. Although employment endows mothers with occupation-specific skills that are only limitedly transmittable to home learning environments and their children, these skills remain an important part of mothers' human capital, despite their minor impact beyond education.

2.2 The Relevance of Childcare for Child Development

The second societal shift guiding this dissertation is the increase in childcare usage, which alters learning environments and potentially affects child development. The detected dynamics of childcare arrangements contribute, with their trajectory-based perspective, to a deeper understanding of the diverse pathways mothers choose for childcare before school, which has been previously limited. The identified childcare-work trajectories mirror the unique German context, characterized by widespread use of relatively affordable childcare and limited supply, with nearly all children eventually entering institutional childcare. Typically, they visit the *Kindergarten* by age three, which aligns with the legal entitlement to ECEC independent of maternal employment status. This highlights, in accordance with the life-course framework, that life courses are multilevel processes, where macro-level institutional settings shape individual micro-level trajectories (Elder et al., 2003; Mayer, 2004). This rather late institutional uptake was more common within family-focused patterns, where mothers were less active in the labor market. Conversely, mothers with high-intensity workforce participation enrolled their children in ECEC as early as age one – also at a time when legal institutional regulations apply. In spite of these structures that shape maternal decisions on childcare, trajectories of part-time working mothers exist, who primarily rely on family care between the first and second birthdays of their children and gradually shift into a combined arrangement of family and institutional childcare. This indicates that mothers continue to have *human agency* (Elder et al., 2003), despite the structural guidance of institutions.

The identified disparities in childcare arrangements can have important implications for child development, as institutional learning environments are often of higher quality than informal care (Barschkett et al., 2022; Del Boca et al., 2017; P. Leach et al., 2008; Otero & Melhuish, 2015). However, this thesis shows limited long-term benefits of childcare attendance on children's educational attainment, possibly, due to insufficient quality in German childcare (Tietze, 1998). While structural quality criteria are legally mandatory and, therefore, should be more consistent, process quality is harder to monitor and maintain at a consistently high level, despite its greater relevance for child development (Fackler et al., 2024; Kluczniok & Roßbach, 2014; Slot et al., 2018). Consequently, process quality is often neglected in research (e.g., Cornelissen et al., 2018; Fackler et al., 2024; Kühnle & Oberfichtner, 2020; Pessanha et al., 2007; Slot et al., 2018). Without including these criteria in analyses, it remains uncertain whether higher-quality institutional childcare leads to long-term benefits, or if the contribution of ECEC to educational attainment is limited by fade-out processes. Research on fade-out provides an alternative explanation for the limited effectiveness, as a growing body of literature suggests that skills fostered by ECEC are constrained, indicating children will learn them eventually, which diminishes their impact on long-term educational achievement (Abenavoli, 2019; Ansari et al., 2020; Dietrichson et al., 2026; McCormick et al., 2021).

While insights from the Kindergarten reform are relevant, the reform is from an earlier period, when trends in increased usage of external childcare and maternal employment were just emerging. This

suggests that a similar reform, like the 2013 introduction of a legal entitlement for one-year-olds, could be more effective due to its broader scope and stronger emphasis on quality since the 2019 Childcare Quality Act. Given the recency of these reforms, current literature can only evaluate short- and medium-term child development (e.g., Felfe & Lalive, 2018) or impacts on mothers (e.g., Duletzki & Lim, 2026), and leaving the long-term promotion of educational attainment an open question for future research.

Moreover, this dissertation contributes an elaborated measure of factual educational success by first-ever investigating the long-term educational attainment in the context of increased ECEC provision in Germany. Thereby, it complements previous research on low-stakes assessment scores and provides valuable new insights amid the mixed and limited long-term evidence. Many observational studies identify beneficial relationships with short-term child development (e.g., Konrad-Ristau & Burghardt, 2021; Kratzmann & Schneider, 2009; Skopek, 2017), which are also found by robustness analyses of the current thesis. Nevertheless, these short-term gains failed to translate into long-term benefits for attaining the highest school-leaving certificate, ultimately challenging theoretical expectations on cumulative advantage (Cunha & Heckman, 2010; DiPrete & Eirich, 2006). Previous longitudinal and quasi-experimental research is less consistent regarding the promotional potential of childcare, with some supporting (e.g., Dustmann et al., 2013; Felfe & Lalive, 2010, 2018; Ghirardi et al., 2023; Klein & Becker, 2017) and others providing contradictory results (e.g., Cornelissen et al., 2018; Kühnle & Oberfichtner, 2020; Schlotter, 2011; Steinmann et al., 2016). The findings of this thesis now provide robust evidence that a longer duration in German Kindergarten neither improves general educational attainment nor produces equalizing effects for disadvantaged children.

Furthermore, this dissertation provides insights into selective childcare usage based on maternal education, although without lasting consequences for child development. The majority of higher educated mothers relies on institutional childcare from age one onwards, with some using childminders before age three. In contrast, lower-educated mothers more frequently choose family care for their one-year-olds, and their institutional childcare usage converges with those of higher-educated mothers by age three (see Figure A-VI.1 and A-VI.2). Despite the theoretical relevance of regional constraints and opportunity structures during infancy and early childhood, empirical results reveal that mothers' preferences are the more predictive factor in arranging childcare and employment. This finding aligns with results from the Kindergarten reform of this thesis, as lower-educated mothers, compared to their higher educated counterparts, do not enroll their children earlier in ECEC when access is facilitated. This is to some extent consistent with the theoretical considerations of RC and SEU theory (e.g., Fishburn, 1981; Opp, 1999), which highlight subjectively perceived utility as a key determinant in decision-making processes. The limits in regional childcare supply or labor market opportunities are theoretically relevant costs, as they necessitate more elaborate searching strategies that are started ahead of time while being less likely to succeed. However, the identified lower importance of regional constraints may also stem from individuals' tendency to align

preferences with their circumstances to reduce cognitive dissonance (e.g., Acharya et al., 2018), limiting the ability to disentangle both factors.

Although the findings reveal no educational divide in children's long-term educational attainment based on institutional childcare attendance, usage patterns remain socially selective. Lower-educated mothers potentially provide lower-quality learning environments through external caregivers and at home, supporting theoretical considerations of cumulative disadvantage (Cunha & Heckman, 2010; DiPrete & Eirich, 2006). The contrafactual mode of care is decisive, as the quality of maternal childcare or by relatives strongly depends on mothers' education and SES. Children of lower-educated mothers less often experience high-quality home learning environments (e.g., Berkowitz et al., 2021; Bornstein et al., 2020; Cuartas, 2022; McKee et al., 2021; Mues et al., 2022), and the care quality provided by grandparents or childminders is often inconsistent compared to professional facilities (Del Boca et al., 2017; Forry et al., 2013; P. Leach et al., 2008; Otero & Melhuish, 2015). Given that findings on children's educational attainment do not consider the diversity in childcare histories demonstrated by this thesis, due to data limitations, it might explain the limited beneficial implications. For example, when lower-SES mothers combine care in ECEC with lower-quality grandparental care, it may hinder stimulating effects due to inconsistent quality. Similarly, more complex arrangements can also cause stress, as they are harder to organize for mothers, leading to more instability for children instead of constructive routines (Morrissey, 2008; Selman & Dilworth-Bart, 2024), which limits the potential benefits of ECEC. Despite the transitional analyses not encompassing the full range of childcare types and their quality, these point-in-time analyses provide a valuable addition to the trajectory based-perspective on childcare-work trajectories.

To summarize, the findings contribute to answering the research question (b) on how external learning environments affect child development (Figure I.2). While large disparities exist between mothers in how they arrange childcare throughout infancy and early childhood, the use of institutional childcare from age three onwards is widespread. However, it cannot compensate in the long run for the inequalities that potentially emerged prior to enrollment. This indicates that the developmental influence of childcare depends on how it is embedded in broader family strategies, e.g., regarding their parenting, not just on exposure length, thereby highlighting the relevance of *home* learning environments for child development compared to institutional ones.

2.3 The Relevance of Maternal Age at Birth for Child Development

The third societal trend important to this dissertation is the increasing maternal age at first birth, which is particularly pronounced in the German context. The findings of this dissertation contribute by thoroughly investigating the implications of advanced maternal age on cognitive and non-cognitive child development, extending research dominated by analyses of educational attainment. The results suggest that children of younger mothers before and during their 20s benefit more in terms of

cognitive and non-cognitive developmental outcomes, with a minor relevance after this age. These findings support previous evidence that also identifies a smaller relevance of age at birth beyond a certain threshold (Addo et al., 2016; Augustine et al., 2015; Duncan et al., 2017; Fishman & Min, 2018). Since fertility decisions are socially stratified and disadvantaged women often become mothers at younger ages (Doepke et al., 2022; Goisis et al., 2017; Guzzo & Hayford, 2020), this can have lasting consequences for child development. The results revealed that younger mothers are significantly more likely to follow consistent homemaker trajectories with low or no employment activity, resulting in lower resource endowment. This is also reflected in the mechanism-analysis that reveals a high explanatory power of maternal well-being, parenting quality, and family resources, with the latter two being most relevant in explaining the association between maternal age and child development. This highlights that the quality of home learning environments improves with older maternal age, supporting previous research that shows better parenting behavior regarding sensitivity, communication styles, and lower use of sanctions among older mothers (e.g., Ahmad et al., 2024; Barnes et al., 2014; Camberis et al., 2016; Farley et al., 2021; Holden, 2020; Sosu, 2014; Trillingsgaard & Sommer, 2018), thereby promoting child development.

Additionally, although the trend of advanced maternal age is more pronounced among higher-educated mothers, educational heterogeneity analyses display that maternal age is more crucial for child development of lower-educated mothers. Children of non-tertiary-educated mothers benefit from higher maternal age in cognitive development, suggesting improvements in parenting quality, maternal well-being, and family resources over the life course. In contrast, higher-educated mothers appear better equipped to promote their children's development regardless of age at birth, as child outcomes remain consistently high across maternal ages, even in raw models controlling for education only. These findings align with the family investment and family stress model (Conger et al., 2010; Conger & Donnellan, 2007), suggesting that higher maternal resources, including education and finances, lead to better learning environments, supporting previous evidence that older mothers engage in better parenting and investment behavior that benefits child development (Ahmad et al., 2024; Camberis et al., 2016; Farley et al., 2021; Trillingsgaard & Sommer, 2018).

For higher-educated mothers, the mechanism-based analyses fully explain the relationship between age and child development. However, for lower-educated mothers, the remaining significant relations indicate that additional unobserved factors, such as social network availability, are influential. Previous studies reveal higher relationship satisfaction with older age and lower stability among lower-educated couples, suggesting that *partnership stability* might drive results (e.g., Karney, 2021; Luong et al., 2011). Additional social networks that assist with childcare may also support younger, lower-educated mothers. For example, grandparental childcare is more common and beneficial when grandparents are younger, healthier, and nearby (Barschkett et al., 2022; Seilbeck & Langmeyer, 2018). This dynamic is more prevalent in low-SES families (e.g., Doepke et al., 2022; Guzzo & Hayford, 2020), who start families younger and exhibit less geographical mobility (e.g., Brandén, 2013). These remarks

underscore the need for future research to investigate additional mechanisms more deeply. Nevertheless, this thesis contributes to the field of research by elucidating driving mechanisms and providing new insights into educational heterogeneities in relevant mechanisms.

In summary, these findings contribute to answering the research question (c) of how maternal characteristics, i.e., age at birth, affect child development (d) through disparities in learning environments (Figure 1.2). The findings demonstrate that the trend of advanced maternal age at childbirth is associated with children's higher skill levels, and particularly that children of lower-educated mothers benefit. As theoretically expected, these early inequalities in child development primarily stem from higher-quality learning environments and larger resources, which are more commonly provided by older mothers. The disparities among younger and lower-educated mothers point to the importance of integrating such intersectional perspectives of age and SES in future research and identifying how they shape family processes over the life course.

3. Limitations

Despite the manifold contributions of this dissertation to the field of child development, it comes with several limitations. The database for this thesis relies on the NEPS, which likely suffers from selection and attrition bias common in panel survey data. Although the individual articles include different starting cohorts of the NEPS, i.e., one, three, and four, sometimes with administrative data additions, providing some degree of data triangulation, the survey participants exhibit more favorable sociodemographic characteristics compared to the general population. Mothers with lower education or immigrant origin, as well as children with lower competencies have a higher risk for dropout (Zinn et al., 2018). While the analyses attempt to address this selectivity by incorporating relevant controls into the models or employing advanced methods, this approach still relies on observables, leaving a risk of bias that can never be ruled out fully. Therefore, the findings' generalizability may be restricted to mothers with more advantageous characteristics. Results on lower-SES mothers might represent the lower bound of beneficial relationships, as the most disadvantaged often have the highest potential to benefit from interventions or increased resources, which cannot be depicted here.

Moreover, limitations regarding child outcomes occur. The utilized survey-reported items on social-emotional behavior do not rely on objective measurements and, thus, more likely suffer from social desirability bias and subjective maternal perceptions. Throughout the studies, non-cognitive associations showed weaker associations compared to cognitive test scores, indicating a possible bias. Although this subjective measurement is common in much literature (e.g., Duncan et al., 2018; Felfe & Lalive, 2013; Ghirardi et al., 2023), future research should use more objective measurements, including educators or scientific staff coding child behavior through videotapes, similar to the observational approaches in NEPS, to evaluate whether findings hold. Moreover, this thesis is limited to the investigation of cognitive and non-cognitive competencies, as well as factual academic

achievement. Another relevant determinant of child development might be health, which has been shown to be an important driver of long-term child's prospects (Jackson, 2009; Li et al., 2009; Manning et al., 2014). However, due to a lack of repeated measurements in the data, their investigation was not comprehensively possible throughout early childhood, warranting further research.

Furthermore, this dissertation investigated SES-driven differences in child development, focusing throughout all studies on educational disparities, alongside occupational divides. Obviously, other relevant determinants of stratification exist that received less attention, such as a migrant background, income, and, more specifically, poverty dynamics. These aspects are likely to also shape child development through differences in resource endowments and family environments (Conger et al., 2010; Conger & Donnellan, 2007). However, the focus on education was reasonable for two reasons: Firstly, education is a rather time-constant indicator of SES, that overcomes the inconsistent measures of income or occupational status while being predictive of both these aspects. These are rather inconsistent for mothers, particularly during times of family formation, and are more likely prone to measurement error (Passaretta et al., 2022; Skopek & Passaretta, 2021). Secondly, the used data are limited in their potential to investigate these dynamics, as disadvantaged sociodemographic groups are often more reluctant in survey participation, possibly due to heavier time restrictions regarding their employment or anticipated stigma. In the NEPS, there was no oversampling of mothers with immigrant origin, which would be necessary to derive meaningful conclusions that are not restricted by sample size, given this group's heterogeneity regarding countries of origin. Mothers' origin has diverse implications for their socialization, culture, and reasons for migration, all of which can influence preferences and behaviors related to work, childcare, and fertility (Biegel et al., 2021; Maes et al., 2023; Milewski & Adserà, 2023). Similarly, poverty is likely to exert an specific impact that differs from "just low income", as it is normally a systematic, long-term condition in which several disadvantages regarding stress, economic hardship, and time constraints are accumulated (Headey, 2008), leading to strong detrimental impacts on child health and academic performance, unfolding long-term effects on children's prospect careers (e.g., Skinner & Kennedy, 2025). The growing gap between rich and poor (Brülle & Spannagel, 2023) further highlights the need for future research to implement strategies to reach these key populations and to gain higher quality insights into childhood dynamics for disadvantaged groups (Social Research Association, 2024).

4. Outlook

Overall, this dissertation contributes to an elevated understanding of the heterogeneities in child development, highlighting large disparities in developmental outcomes that arise within families well before schooling begins, challenging the meritocratic ideal of equal educational opportunity. Recent decades have seen substantial changes in family life due to shifts in maternal employment, childcare usage, and timing of family formation, accompanied by social policies that added to these ongoing changes. These developments primarily impacted mothers' resource endowment in its widest sense.

Since mothers are the primary caregivers during infancy and early childhood (BMFSFJ, 2020; Samtleben & Müller, 2022; Zoch & Heyne, 2023), these developments also affect their children and early learning environments. With this dissertation, I move beyond isolated factors to investigate their joint role in shaping early heterogeneities comprehensively.

In summary, this thesis provides new insights into how maternal characteristics and early learning environments contribute to disparities in child development amid societal trends. The findings underscore the crucial role of maternal resources for child outcomes, showing that higher labor market participation benefits mothers' resource endowment, although its contribution to the transmission of maternal occupational skills appears limited. Additional findings on maternal age at childbirth highlight its educationally stratified timing, which has lasting developmental consequences rooted in maternal resources. Finally, the results reveal the diversity of childcare arrangements during infancy and early childhood, with institutional childcare being especially relevant, although the duration in ECEC facilities does not enhance child development.

The findings of this dissertation have important implications for future research. This thesis implicates considering early learning environments and parenting behavior is essential for a comprehensive study of child development. In earliest years, child development largely depends on the learning opportunities mothers create, as children often lack exposure to other potentially influential environments that contribute to child development. While parenting behavior is closely related to mothers' SES, it also exerts a direct, independent impact on children that is overseen in existing literature on inequalities. Therefore, the sociology of family and of equal educational opportunity must converge to include both parenting as well as home characteristics jointly in their investigations.

The findings further highlight the value of a trajectory-based framework in early childhood research, advocating for a shift from static, point-in-time evaluations to more dynamic, longitudinal approaches. Despite the usefulness of single-event studies, they can only partially capture social realities, neglecting the complex dynamics of family life revealed in this thesis. For example, trajectory-based approaches can better illustrate the evolution of maternal preferences regarding childcare and employment over time; uncover mechanisms behind ongoing decision-making processes; and evaluate the alignment of preferences in light of real-life constraints. This contributes to an elevated understanding of children's developmental histories and their dependence on the interplay between family dynamics and institutional settings that gives rise to developmental inequalities. Broadly implementing such approaches will provide a solid foundation for international comparisons to identify global disparities and their drivers. Finally, integrating these trajectories with causal methods will clarify their definitive impact on child development.

Moreover, findings emphasize the importance of examining maternal employment in greater detail, shifting from a focus on individual workplace characteristics to an approach centered on latent

constructs of work-related innate skills and motivations of mothers. Although the findings on occupational skills were limited, they demonstrated relevant associations that suggest new directions for future research in this emerging field. So far, these more latent aspects have received little attention in the body of literature. The unique impact of maternal motivation in employment on children's skills and attitudes, including how much mothers identify with their work and whether their employment aligns with their occupational self-concept, are important avenues for future research, as they may contribute to early disparities in children's perspectives on life dynamics. As a first step, a clearer differentiation between tasks performed at work and the underlying skills seems fruitful to disentangle the small associations in greater detail.

Simultaneously, several avenues for future research remain. The focus of this thesis is limited to the three major societal trends of increased maternal employment, childcare usage, and older age at family formation. Many other relevant developments have occurred in recent decades that potentially contribute to child development. Alongside the demographic shift, normative orientations have become more egalitarian, which is reflected in a less traditional division of paid and unpaid work between couples. While this thesis elaborates in great detail about paid maternal work and childcare, the other domain of unpaid work, i.e., housework, remains uninvestigated. Literature shows that despite stark increases in dual-earner families, women still perform more housework than men, who only moderately increase their contributions (Kan et al., 2022; Sullivan et al., 2018). Nevertheless, these small shifts might add to a more egalitarian partition of unpaid work, which has been shown to improve relationship satisfaction (e.g., Carlson et al., 2016). This potentially affects home learning environments according to the family stress model in its widest sense, which emphasizes parental partnership quality as an important factor for parenting quality (Conger et al., 2010). Moreover, with the value shift, normative standards have diluted, which is mirrored in the decline of marriage and cohabitation in life trajectories, as well as a rise in single motherhood (BMFSFJ, 2025; Statistisches Bundesamt, 2025, 2026). These developments will shape children's early learning environments, as the presence of a partner potentially affects family resource endowment among other family dynamics. Furthermore, besides postponed motherhood, overall fertility has declined, changing family composition, as fewer siblings are present, potentially affecting children's home learning environments and development (e.g., McHale et al., 2012).

Consistent with previous remarks (see Chapter I/1.3), fathers play a unique and important role in child development that could not be considered in this thesis due to data limitations. Although the NEPS provides rich data, it reflects the research priorities of its founding in 2008, when the role of fathers was less emphasized. Nearly 20 years later, research into *active fatherhood* has gained momentum (Joshi, 2021; Zerle-Elsäßer & Li, 2017). However, granular details on paternal roles is lacking regarding fathers' relationship trajectories with mothers, their involvement in childrearing, as well as their preferences, parenting styles, or parenting knowledge (e.g., McKee et al., 2021). In cases of separated parents, focusing on fathers can be especially challenging, as children most often stay with mothers

and single fathers are rare in Germany. This also raises the question of how the absence of fathers might shape child development. Overall, this is a highly promising direction for future research better understand fathers' drivers and their parenting roles for child development.

Similarly, this thesis adopts a heteronormative perspective on different-sex parents, while the role of the same-sex secondary parent is equally relevant and warrants future research. Although previous studies have revealed limited differences in child development between children of same-sex and different-sex parents (e.g., Manning et al., 2014), children with same-sex parents may have different experiences during childhood. On the one side, they may face stigma, which can pose challenges on their mental health or social networks (e.g., Farr & Vázquez, 2020; Goldberg, 2014). On the other side, they might experience more equitable distribution of paid and unpaid work among their parents (e.g., Bauer, 2016; Fischer, 2024), which can lead to different dynamics in child development. It is left to future research to explore these interrelations more closely.

Taking a broader view, these findings have several policy implications. A key conclusion of this thesis is the importance of home learning environments for child development. Given the meritocratic aim of equal educational opportunity, a possible political strategy is to reduce barriers to formal learning environments by adopting a targeted communication approach and service supply. Firstly, constraints in provision need to be further reduced. Despite significant efforts to ensure adequate supply, even following the recent expansion in 2013, competition remains fierce, and care needs concerning availability and scope of care are still not fully addressed (BMFSFJ, 2023; Fackler et al., 2024). Childcare services must be tailored to mothers' needs that are often shaped by employment characteristics. Given that lower-SES mothers are more likely to work non-standard hours (Gracia et al., 2021), their reliance on informal or family care becomes plausible. Offering them flexible childcare outside standard hours presents a critical opportunity to reduce disparities in early learning environments. In addition, sufficient childcare that meets maternal needs has also been shown to reduce maternal stress and work-family conflict (e.g., Arpino & Luppi, 2020; French et al., 2018), which in turn enhances parenting and the home learning environment (Holmes et al., 2018; L. S. Leach et al., 2021; McCredie et al., 2025).

Secondly, merely increasing supply is insufficient to reach disadvantaged target groups, as this thesis indicates the limited effectiveness of such approaches in achieving earlier enrollment. Therefore, integrating the interdependent domains of institutions and families into a cohesive political framework is a promising strategy to address early childhood inequalities. This could involve offering incentives for participation in free interventions targeted at lower-SES mothers to educate them on identifying high-quality childcare settings and demonstrating the benefits of childcare for their children's development. This approach could reduce skepticism and increase acceptance of ECEC facilities (e.g., Diabaté & Beringer, 2018). Another strategic option could involve local authorities sending information materials when a childbirth is officially registered, equipping mothers with relevant knowledge on childcare systems and application strategies in advance (e.g., Hermes et al., 2025). In this context, the

provision of targeted materials, such as in foreign or simplified languages for families with immigrant origins or lower SES, might enhance their understanding, which has been shown to be a barrier among these groups (e.g., Jessen et al., 2020; Seibel, 2021).

Thirdly, in order for the first two points to be effective, an emphasis on quality is key for lasting advantages in child development and educational success, as demonstrated by the limited beneficial effects of childcare. The ongoing Childcare Quality Act currently monitors the policy objectives regarding quality improvements but lacks a focus on process quality. While structural quality is essential for high-quality learning environments (Hausladen et al., 2026; Kluczniok & Roßbach, 2014), process quality is underrated despite its stronger relevance and needs political attention (Fackler et al., 2024; Slot et al., 2018). Beyond beneficial impacts, evidence suggests that mothers are more willing to use childcare when quality is high (Stahl & Schober, 2020), providing a further incentive for this political strategy.

Another approach beyond childcare strategies is an efficient resource policy. This thesis clearly demonstrates the crucial impact of multiple maternal resources, particularly education and income, which often prove more decisive for child development than other maternal characteristics, such as occupational skills or age. The already discussed provision of sufficient childcare is here also an important factor, as it enables mothers to generate their own resources. Particularly younger mothers may benefit from this, as it can help them to finish education and find employment (e.g., van Vugt et al., 2025). But also more direct measures are possible, such as financial incentives for mothers in vocational or academic education. Currently, child allowances (*Kindergeld*) are paid regardless of income, favoring high-income mothers who do not need financial support. While the German welfare state allows low-income families to apply for child supplement payments (*Kinderzuschlag*), the limited popularity of this subsidy combined with application barriers often deter usage. Therefore, combining current approaches to reduce these barriers by implementing non-application-based and income-dependent allowances seems to be a promising approach for resource-oriented support of mothers to reduce early heterogeneities in child development.

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Appendix Chapter II

Study 1 – The Early Interplay of Childcare Histories and Maternal Work Trajectories: A Multichannel Sequence Analysis

Tables

Table A-II.1: Sample Reduction	193
Table A-II.2: Operationalization of Variables	193
Table A-II.3: Sample Descriptives and Imputation Method	196
Table A-II.4: Average Status Durations for Six Cluster Solution	197
Table A-II.5: Multinomial Logistic Regression Results of Cluster Affiliation (Average Marginal Effects)	198
Table A-II.6: Sensitivity Analysis: Multinomial Logistic Regression Results of Cluster Affiliation (Average Marginal Effects)	199

Figures

Figure A-II.1: Cluster Cutoff Criteria for Childcare-Work Clusters Derived from MCSA.....	200
Figure A-II.2: Silhouette Values for Each Sequence by Cluster in the Six-Clusters PAM+Ward Solution	200
Figure A-II.3: Average Status Durations for Six-Cluster-Solution in Percent.....	201
Figure A-II.4: Dissimilarities to the Medoid Within Each Frequency Group by Six-Cluster Solution ..	202

Table A-II.1: Sample Reduction

	Individuals dropped	Total individuals remaining (n)	Total person-years remaining (N)
Gross Sample		3,481	
Biological & Adoptive Mothers' Non-Participation Wave 1	- 8	3,473	208,824
No Consent to Data Linkage or Linkage not successful	- 1,459	2,014	121,352
No subject to social security	- 175	1,839	110,852
Data Linkage of Men	*	*	*
Missing Value on Child Birthdate	*	*	*
30% Missing Values or More in Trajectories	- 285	1,521	91,260
Analysis Sample		1,521	91,260

Note: * Numbers below 20 cannot be presented due to data protection regulations by the Institute of Employment Research, therefore, one other category has to be omitted, too. Dropped individuals may remain in the sample if not all observations are missing, e.g., independent variables vary over time and are only fully excluded if none valid value is available.

Source: NEPS-SC1-ADIAB 2012-2017.

Table A-II.2: Operationalization of Variables

Name	NEPS Wave	Description	Measurement
Key Variables			
Childcare ¹ Status	NEPS Waves 1-6 (pa0100a - pa0100j)	Attendance childcare institutions: a) Day childcare institution, nursery, kindergarten b) Childminder c) Nanny d) Au-Pair e) Grandparents f) Other relatives, acquaintances, neighbors j) another type of childcare	1= only Parents 2= Kinship (e, f) 3= Institution (a) 4= Childminder (b, c, d, j) 5= Institution & Childminder 6= Kinship & Institution 7= Kinship & Childminder [& Institution] 8= Missing
Employment Status ¹	NEPS-ADIAB-SC1 Waves 1 - 6 IEB: kldb10_3 NEPS: pa0403y, pa0403m, pa0404y, pa0404m NEPS: p731903, p731953 IEB: teilzeit, erwstat NEPS: p731902; p731901, p731951;	Maternal employment activity or inactivity. 3-digit Occupational Classification Parental leave start and end dates (month and year) Work Status: Inactivity / Parental Leave Full- or part-time employment Marginal employment status (erwstat=109, 209) Weekly working hours Employment status	1 Parental Leave Focal Child 2 Parental Leave 3 Not Working: Childbirth 4 Housewife 5 Full-Time Work 6 Part-Time Work 7 Marginal Work 8 Unemployment 9 Missing <i>All administrative information was based on daily units and converted to a monthly format based on the predominant status for each month.</i>
Controls			

Appendix Chapter II

Maternal Education	NEPS Wave 1 (p731802_g2, p731852_g2)	What is your highest general school-leaving qualification? [1a] No qualification [1b] School leaving qualification from a Hauptschule without vocational qualification [1c] School-leaving qualification from a Hauptschule with vocational qualification [2b] Mittlere Reife (intermediate school-leaving qualification) without vocational qualification [2a] Mittlere Reife (intermediate school-leaving qualification) with vocational qualification [2c_gen] higher education entrance qualification without vocational qualification [2c_voc] higher education entrance qualification with vocational qualification [3a] degree from a university of applied sciences [3b] university degree → We use earliest information available	1a, 1b, 1c, 2b = 1 Low Education (No access to university) 2a, 2c_gen, 2c_voc = 2 Intermediate Education (university entrance qualification) 3a, 3b = 3 High Education
Log. Household Income	NEPS Wave 3 (p510005, p510006, p510007, p510008, p510009)	What is the monthly household income of all household members today? Please indicate the net amount, i.e. after deduction of taxes and social security contributions. Please include regular payments such as pensions, housing allowance, parental and child benefits, BAföG, alimony payments, unemployment benefits, etc.! «If not known exactly: have the monthly amount estimated. Inform about anonymity. If unclear what the net income is: 'Please indicate the amount you received after deduction of taxes and social security contributions'.»	For categorical answers, for each measurement the categorical income span was replaced with the mean values of open-ended answers. For example, for individuals categorized in the lowest income-group of less than 1,000 €, the mean was computed with answers from p510000 (open-ended), i.e., in this case 900 €, and inserted for all individuals in this income-group. This was done for each wave and each income-group. → Metrical variable, logarithmized to model a decreasing marginal benefit.
Birthplace Mother	NEPS All Waves (p400000, p400015, p403000_g1, p403015)	Combination of information on country of birth, and if born in Germany, born in East or West Germany.	1 Born: West-Germany 2 Born: East-Germany 3 Born: Abroad
Maternal Age at Birth	NEPS Wave 1 (p73170y, p73170m)	Subtracting year and month of mothers' birthdate from the birthdate of the given child. 1 unit = 10 years	<i>Numerical</i>
Number of Older Siblings	NEPS All Waves (pb10000, p73221y, p73221m; p73222y_w1 - p73222y_w11)	Number of observed siblings (includes all biological and social siblings, also step/half/adoptive siblings, target child is not included). Birth Date of Sibling from Spell Data and Survey Questions to check whether birthdate was before or after focal child.	<i>Numerical</i>
Importance Work Mother	NEPS Wave 1 (p30111a)	Mothers of young children have different wishes regarding their careers. How important is it for you to be employed? Is it very (1) unimportant, (2) somewhat unimportant, (3) neither important nor unimportant, (4) somewhat important, or (5) very important?	1 2 3 = 0 Low Importance Work 4 5 = 1 High Importance Work

Appendix Chapter II

Utility Childcare for Employment	NEPS Wave 1 (p30211a)	For the following questions, please imagine that <name of target child> would attend a nursery. What would that mean for <name of target child> and for you? How good would your prospects be of being able to work if <name of target child> attended a nursery? (1) Very poor, (2) rather poor, (3) neither good nor poor, (4) rather good or (5) very good?	1 2 3 = 0 Low/Medium Utility 4 5 = 1 High Utility
Idealistic Age Childcare	NEPS Wave 1 (p31011m, p31011y)	Parents have different views on the age at which children should first attend a nursery or kindergarten. If it were solely for the well-being of your child, at what age would you like <name of target child> to start attending a nursery or kindergarten?	<i>Numerical</i>
Unemployment Rate 2011	INKAR 2025	Proportion of unemployed people in the civilian labour force 2011 (regional level: districts)	<i>Numerical</i>
Childcare Rate for Under Threes 2011	INKAR 2025	Proportion of children under 3 years of age in childcare facilities out of the total number of children in that age group in 2011 (regional level: districts).	<i>Numerical</i>
Share Cohabitation with Partner	NEPS All Waves (p731111)	Do you currently live with a permanent partner? (yes/no) Years where cohabitation is observed divided by number of participated waves.	<i>Numerical, 0-10</i>
Parental Leave Dad	NEPS Waves 2, 4 (pa05020; pa04020)	Has your partner / Have you taken parental leave for <Target child's name> until to date?	0= yes, parental leave 1= no parental leave
Coparenting	NEPS Waves 2, 3 (pa03010; pa03020)	Parental tasks can be divided up in different ways within a partnership. How is it in your case: In your partnership, who takes care of <Target child's name>, e.g. feeding, changing diapers, bathing or changing? And which of you spends time with <Target child's name>, e.g. plays with him/her, looks at picture books or teaches him/her things?	1= (Mainly) Mum 2= Egalitarian 3= (Mainly) Partner

Note: ¹ We replaced short missing episodes of up to four months when individuals were observed in the same childcare or work arrangement immediately before and after the missing spell, following established practice (Halpin, 2016). This strategy minimizes distortion of trajectories while avoiding unnecessary loss of information

Table A-II.3: Sample Descriptives and Imputation Method

	$\bar{x}$	sd	Missing Values (%)	MI
Education Mother (%)				
Low	10.5			
Intermediate	53.8			
High	35.7			
Birthplace Mother (%)				
West Germany	59.6			
East Germany	24.3			
Abroad	16.2			
Maternal Age at Birth	32.1	4.7		
Number of Older Siblings	0.7	1.0	0.66	<i>pmm</i>
Household Income (log.)	3410.5	1803.9	0.39	<i>reg</i>
Importance Work (%)			0.13	<i>logit</i>
Low/Medium	30.7			
High	69.3			
Childcare Utility (%)			0.72	<i>logit</i>
Low/Medium	17.8			
High	82.2			
Idealistic Age Childcare (years)	2.0	0.9		
Unemployment Rate	8.2	2.7	9.47	<i>reg</i>
Childcare Rate for Under Threes	26.2	11.8	9.47	<i>reg</i>
<i>N</i>	1,521			

Note: MI=Imputation Method: pmm=predictive mean matching; reg=linear regression; logit=logistic regression; The MI-model also takes into account the following information: whether the father took parental leave for the target child (yes/no); the proportion of the observation period during which the mother lived with a partner; and who was primarily responsible for the target child (mostly the mother/father or equally); see also Table A-II.2.

Source: NEPS-SC1-ADIAB7521, 2012-2017, INKAR 2025; own calculations.

Table A-II.4: Average Status Durations for Six Cluster Solution

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Total
Childcare sequences							
Months in ...							
Only parents care	18.7	23.4	20.8	9.6	10.4	11.3	14.5
Kinship (K)	6.1	2.8	2.8	11.3	2.1	1.5	3.4
Institution (I)	25.6	26.1	27.2	5.5	36.3	38.4	29.9
Childminder (C)	1.0	1.0	1.5	0.8	2.4	2.9	1.9
I+C	0.0	0.2	0.6	0.2	1.0	0.9	0.7
K+I	4.4	2.6	2.8	28.8	4.5	1.9	6.0
K+C[+I]	0.6	0.1	0.2	1.9	0.8	0.3	0.6
Missing	3.7	3.7	4.0	1.8	2.6	2.8	3.0
Number of ...							
different statuses	3.5	3.1	3.2	3.9	3.4	3.3	3.4
episodes	4.1	3.7	3.7	4.5	4.0	3.8	3.9
status changes	3.1	2.7	2.7	3.5	3.0	2.8	2.9
Integration institutional childcare	0.7	0.6	0.7	0.8	0.8	0.8	0.8
Employment sequences							
Months in ...							
Parental leave	11.1	3.2	28.2	14.2	11.3	11.9	13.6
Parental leave: Sibling	1.9	0.4	8.9	3.6	4.6	4.0	4.3
Not working: birth	0.8	12.0	0.8	0.7	0.5	0.8	2.1
Inactivity	2.2	30.1	1.7	1.2	0.5	0.7	4.7
Full-Time work	1.0	0.8	2.8	5.4	37.3	1.9	9.9
Part-Time work	3.2	2.8	10.5	27.6	3.1	36.1	17.5
Marginal work	36.5	2.4	2.5	3.8	1.0	1.4	4.1
Unemployment	1.3	3.9	2.5	2.1	1.1	1.6	2.0
Missing	2.2	4.3	2.1	1.4	0.7	1.5	1.8
Number of ...							
different statuses	3.3	3.5	3.5	3.3	3.1	3.2	3.3
episodes	4.2	4.7	4.2	4.1	3.9	4.0	4.1
status changes	3.2	3.7	3.2	3.1	2.9	3.0	3.1
Integration labour market	0.1	0.1	0.3	0.6	0.8	0.7	0.5

Note: Cluster 1, Marginal Working Homemakers; 2, Consistent Homemakers; 3, Temporary Homemakers; 4, Kin-Supported Part-Time Workers; 5, Early Care Full-Time; 6, Early Care Part-Time; see also corresponding Figure A-II.4.

Source: NEPS-SC1-ADIAB7521, 2012-2017, own calculations.

Table A-II.5: Multinomial Logistic Regression Results of Cluster Affiliation (Average Marginal Effects)

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
<i>Education Mother (Ref.: low)</i>						
Intermediate	-0.054 (0.030)	-0.084** (0.029)	-0.094* (0.043)	0.000 (0.032)	0.092* (0.041)	0.140*** (0.042)
High	-0.093** (0.031)	-0.084* (0.034)	-0.123** (0.047)	0.006 (0.036)	0.101* (0.044)	0.193*** (0.046)
<i>Birthplace Mother (Ref.: West G.)</i>						
East Germany	-0.028 (0.016)	0.016 (0.026)	-0.082** (0.026)	-0.058** (0.021)	0.128*** (0.030)	0.024 (0.034)
Abroad	0.031 (0.018)	0.021 (0.020)	-0.027 (0.026)	-0.020 (0.024)	0.051 (0.031)	-0.056 (0.034)
Maternal Age at Birth	-0.002 (0.013)	-0.047** (0.017)	0.016 (0.021)	0.010 (0.019)	0.045 (0.026)	-0.023 (0.029)
Number of Older Siblings	0.003 (0.007)	0.052*** (0.006)	-0.038** (0.012)	-0.006 (0.010)	-0.044** (0.014)	0.032* (0.014)
Household Income (log.)	0.001 (0.015)	-0.048** (0.018)	0.021 (0.023)	-0.026 (0.021)	0.034 (0.026)	0.017 (0.030)
<i>Importance Work (Ref.: low/medium)</i>						
High	-0.009 (0.014)	-0.092*** (0.019)	-0.081*** (0.023)	0.019 (0.019)	0.096*** (0.024)	0.068* (0.028)
<i>Childcare Utility (Ref.: low/medium)</i>						
High	-0.033 (0.019)	-0.129*** (0.023)	-0.027 (0.026)	0.017 (0.022)	0.098*** (0.027)	0.073* (0.032)
Idealistic Age Childcare	0.001 (0.008)	0.031*** (0.009)	0.059*** (0.011)	0.016 (0.010)	-0.056*** (0.014)	-0.051*** (0.015)
Unemployment Rate (10%)	-0.020 (0.026)	0.030 (0.037)	0.013 (0.041)	-0.067 (0.035)	0.032 (0.044)	0.013 (0.051)
Childcare Rate for Under Threes (10%)	-0.018* (0.008)	0.002 (0.011)	0.012 (0.011)	-0.002 (0.010)	-0.013 (0.011)	0.018 (0.013)
<i>N</i>	1,521					

Note: Cluster 1, Marginal Working Homemakers; 2, Consistent Homemakers; 3, Temporary Homemakers; 4, Kin-Supported Part-Time Workers; 5, Early Care Full-Time; 6, Early Care Part-Time.

Significance * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. SEs in parentheses.

Source: NEPS-SC1-ADIAB7521, 2012-2017, INKAR 2025; imputed data (M=50), own calculations.

Table A-II.6: Sensitivity Analysis: Multinomial Logistic Regression Results of Cluster Affiliation (Average Marginal Effects)

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
<i>Education Mother (Ref.: low)</i>						
Intermediate	-0.050 (0.030)	-0.100** (0.031)	-0.086* (0.042)	0.005 (0.032)	0.092* (0.042)	0.140** (0.043)
High	-0.086** (0.031)	-0.092** (0.036)	-0.105* (0.046)	0.007 (0.036)	0.095* (0.045)	0.181*** (0.048)
<i>Birthplace Mother (Ref.: West G.)</i>						
East Germany	-0.028 (0.016)	0.019 (0.026)	-0.070** (0.027)	-0.056** (0.022)	0.110*** (0.030)	0.025 (0.034)
Abroad	0.027 (0.018)	0.012 (0.020)	-0.028 (0.025)	-0.016 (0.024)	0.056 (0.032)	-0.051 (0.034)
Maternal Age at Birth	0.001 (0.013)	-0.050** (0.017)	0.020 (0.021)	0.010 (0.020)	0.042 (0.026)	-0.024 (0.029)
Number of Older Siblings	0.002 (0.007)	0.055*** (0.007)	-0.044*** (0.012)	-0.006 (0.010)	-0.040** (0.014)	0.034* (0.014)
Household Income (log.)	-0.002 (0.016)	-0.073*** (0.019)	0.010 (0.024)	-0.016 (0.023)	0.055* (0.028)	0.025 (0.032)
<i>Importance Work (Ref.: low/medium)</i>						
High	-0.006 (0.014)	-0.084*** (0.018)	-0.069** (0.022)	0.016 (0.019)	0.083*** (0.024)	0.061* (0.028)
<i>Childcare Utility (Ref.: low/medium)</i>						
High	-0.030 (0.018)	-0.129*** (0.023)	-0.016 (0.025)	0.017 (0.023)	0.092*** (0.027)	0.067* (0.033)
Idealistic Age Childcare	0.001 (0.008)	0.028** (0.009)	0.054*** (0.011)	0.016 (0.010)	-0.049*** (0.014)	-0.049** (0.016)
Unemployment Rate (10%)	-0.022 (0.026)	0.042 (0.037)	0.018 (0.040)	-0.069* (0.035)	0.023 (0.044)	0.007 (0.051)
Childcare Rate for Under Threes (10%)	-0.017* (0.008)	0.002 (0.010)	0.011 (0.011)	-0.002 (0.010)	-0.011 (0.011)	0.017 (0.013)
Share Cohabitation with Partner	0.024 (0.030)	0.130*** (0.035)	0.033 (0.046)	-0.052 (0.038)	-0.083 (0.055)	-0.052 (0.062)
<i>Coparenting (Ref.: (Mainly) Mother)</i>						
Egalitarian	0.002 (0.015)	-0.039* (0.017)	-0.090*** (0.020)	0.009 (0.019)	0.097*** (0.023)	0.022 (0.026)
(Mainly) Partner	-0.064*** (0.007)	-0.140*** (0.009)	-0.064 (0.108)	0.084 (0.122)	0.027 (0.107)	0.156 (0.140)
Parental Leave Partner	0.026 (0.015)	-0.004 (0.017)	0.021 (0.020)	-0.004 (0.018)	0.002 (0.021)	-0.040 (0.025)
<i>N</i>	1,521					

Note: Cluster 1, Marginal Working Homemakers; 2, Consistent Homemakers; 3, Temporary Homemakers; 4, Kin-Supported Part-Time Workers; 5, Early Care Full-Time; 6, Early Care Part-Time.

Significance * p<0.05, ** p<0.01, *** p<0.001. SEs in parentheses.

Source: NEPS-SC1-ADIAB7521, 2012-2017, INKAR 2025; imputed data (M=50), own calculations.

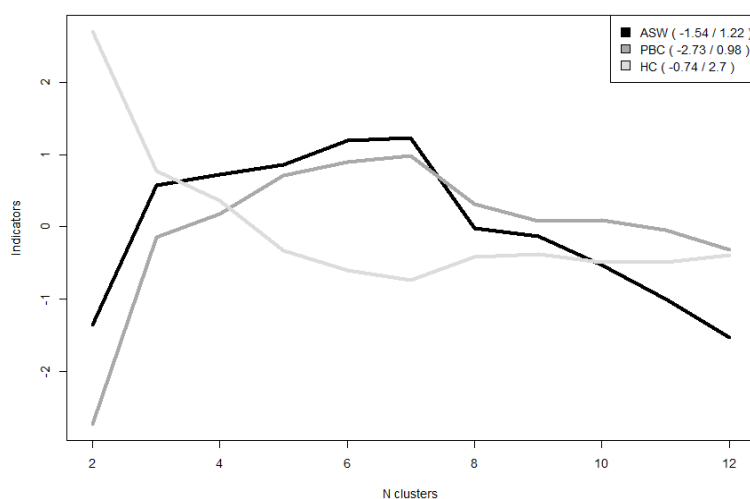


Figure A-II.1: Cluster Cutoff Criteria for Childcare-Work Clusters Derived from MCSA

Note: Standardized scores (Z-scores); ASW=Average Silhouette Width; PBC=Point Biserial Correlation; HC=Hubert's C.

Source: NEPS-SC1-ADIAB7521, 2012-2017, own illustration.

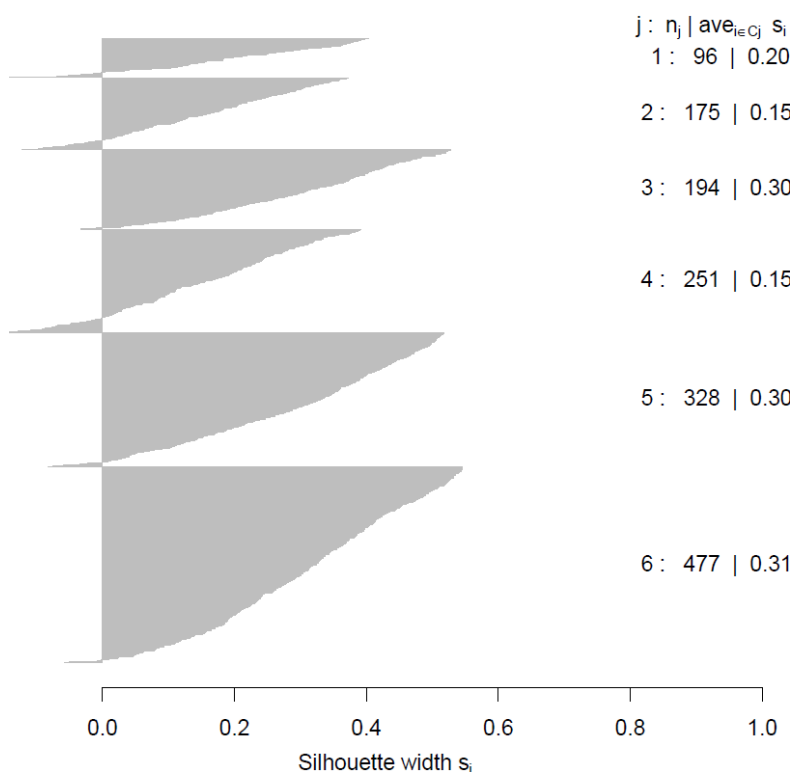


Figure A-II.2: Silhouette Values for Each Sequence by Cluster in the Six-Clusters PAM+Ward Solution

Note: Silhouette values (–1 to 1) indicate the fit of each sequence to its assigned cluster. Each bar represents one sequence. Positive values reflect a strong fit (i.e., closer to the own cluster medoid than to others), values around zero indicate weak assignment, and negative values suggest that a sequence is more similar to another cluster. Negative values highlight observations that are not well classified, although their assignment may still contribute to the optimal overall clustering solution. Cluster size and Average silhouette width (ASW) is reported for each cluster. Lower ASW values indicate weaker separation and greater within-cluster heterogeneity.

Source: NEPS-SC1-ADIAB7521, 2012-2017, own illustration.

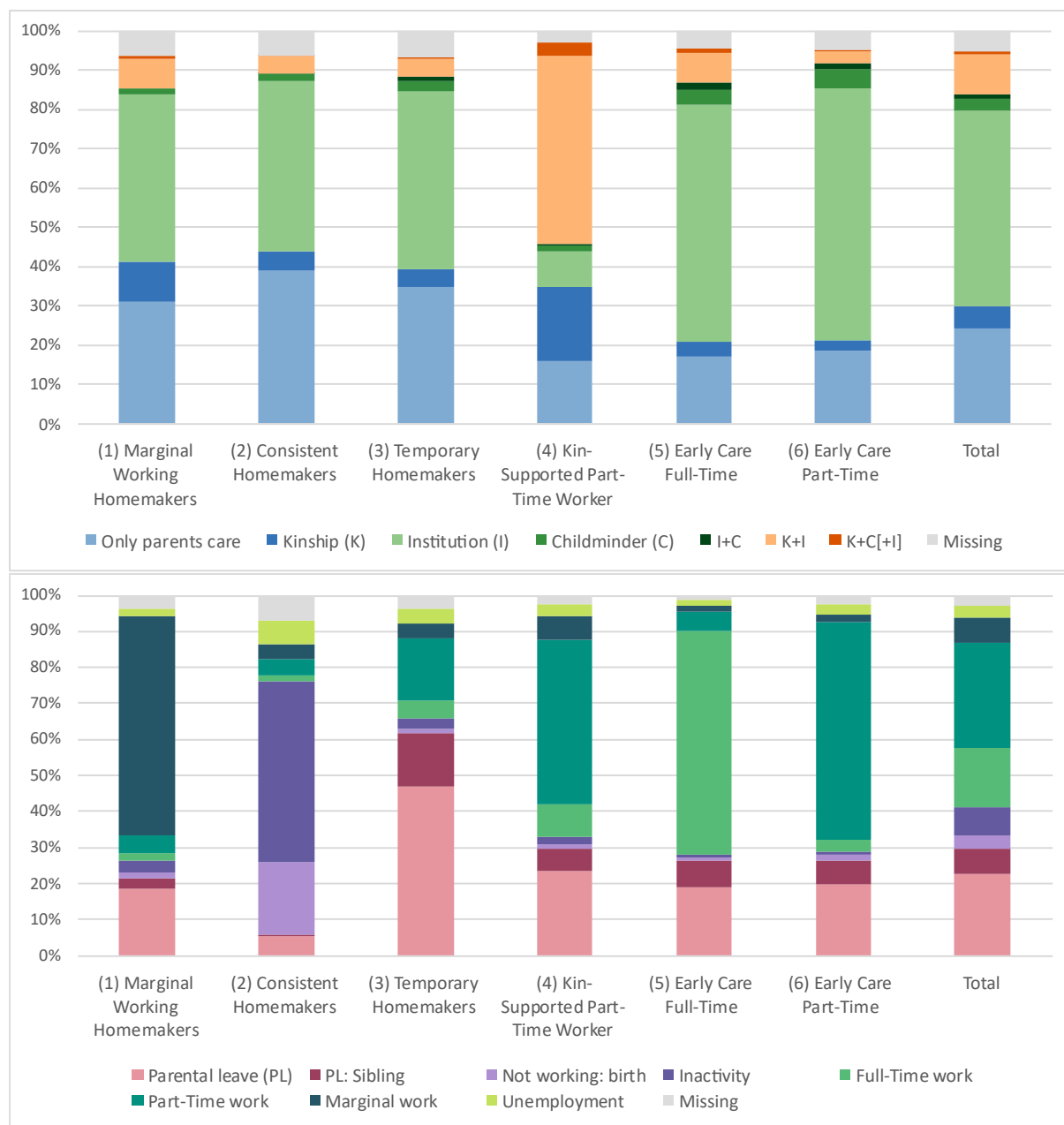


Figure A-II.3: Average Status Durations for Six-Cluster-Solution in Percent

Note: Average duration of each status in the respective care or employment category by cluster, as a percentage; see also corresponding Table A4.

Source: NEPS-SC1-ADIB7521, 2012-2017, own illustration.

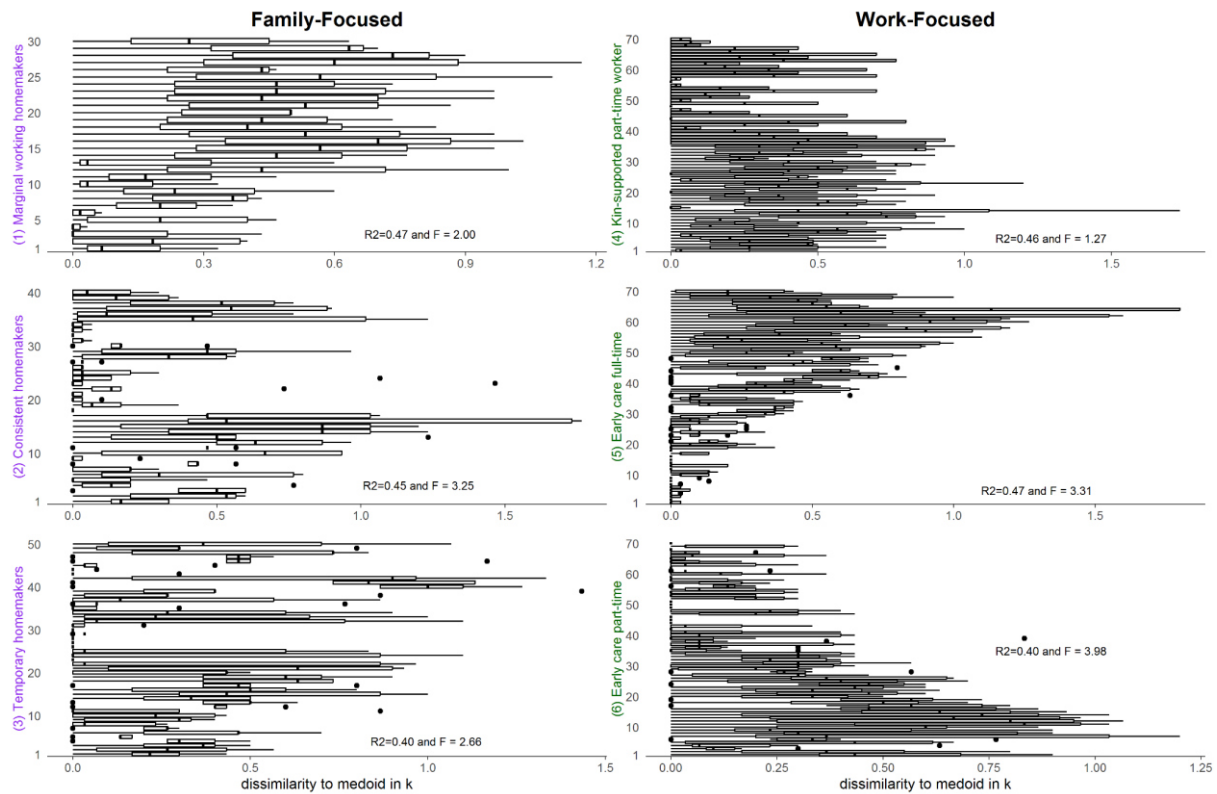


Figure A-II.4: Dissimilarities to the Medoid Within Each Frequency Group by Six-Cluster Solution

Note: The y-axis displays box-and-whisker plots summarizing the dispersion of distances to the medoid, while the x-axis represents the distance from the medoid, defined as the most representative sequence within each group. Lower dissimilarity values indicate a higher within-cluster homogeneity. For each cluster, goodness-of-fit measures (R^2 and F-statistics) are reported to assess cluster quality. In addition, the distribution of silhouette statistics within clusters provides insight into the degree of separation between clusters, with higher values indicating better-defined cluster structures.

Source: NEPS-SC1-ADIAB7521, 2012-2017, own illustration.

Appendix Chapter III

Study 2 – The Long-Term Effects of an ECEC Reform on Educational Attainment

The online appendix of the version of record of this study is published in *Child Development*: Susanne Schmid, The long-term effects of an ECEC reform on educational attainment, *Child Development*, Volume 97, Issue 3, May/June 2026, Pages 662–676, <https://doi.org/10.1093/chidev/aacaf034>; and is available online at: <https://academic.oup.com/chidev/article-abstract/97/3/662/8540220?redirectedFrom=fulltext>

Appendix Chapter IV

Study 3 – Maternal Occupation-Specific Skills and Cognitive and Non-Cognitive Child Development

Tables

Table A-IV.1: Sample Characteristics.....	205
Table A-IV.2: Sample Reduction	206
Table A-IV.3: Operationalization of Variables	207
Table A-IV.4: Full Models of Task Composition and Child Math and Science	211
Table A-IV.5: Full Models of Task Composition and Child Vocabulary and Socio-Emotional Competence	213

Figures

Figure A-IV.1: Overview Task Distribution in Sample.....	215
Figure A-IV.2: Effect Heterogeneity Education: Raw and Controlled Models.....	215
Figure A-IV.3: Effect Heterogeneity Gender: Raw and Controlled Models.....	216
Figure A-IV.4: Effect Heterogeneity Age: Task Composition and Age-Specific Child Development ...	216
Figure A-IV.5: Robustness Check: Task Composition and Mechanism Maternal Working Hours.....	217
Figure A-IV.6: Robustness Check: Task Composition and Mechanism Tenure in Occupation	217
Figure A-IV.7: Robustness Check: Task Composition and Mechanism Duration in Childcare	218
Figure A-IV.8: Robustness Check: Task Composition and Mechanism Child Health	218
Figure A-IV.9: Robustness Check: Single Task Composition and Child Development	219
Figure A-IV.10: Robustness Check: Fixed-Effects Models of Changes in Task Composition and Child Development	219

Table A-IV.1: Sample Characteristics

Variables	Full Sample		Tertiary Education			
			No Tertiary Education		Tertiary Education	
	Mean (SD) / %	Min - Max	Mean (SD) / %	Min - Max	Mean (SD) / %	Min - Max
Child Outcomes						
Mathematical Literacy	0.0 (1.1)	-3.7 - 4.1	-0.2 (1.1)	-3.7 - 4.1	0.2 (1.1)	-3.7 - 4.1
Scientific Literacy	0.1 (1.0)	-3.5 - 4.9	-0.2 (0.9)	-3.5 - 4.9	0.3 (0.9)	-2.6 - 4.0
Receptive Vocabulary	0.1 (1.0)	-6.0 - 4.3	-0.1 (1.0)	-6.0 - 2.6	2.5 (0.9)	-5.0 - 4.3
Socio-Emotional	0.0 (0.4)	-2.1 - 0.8	-0.0 (0.4)	-2.1 - 0.8	0.6 (0.4)	-2.1 - 0.8
Independent Variables: Task Measures						
Analytic Non-Routine	0.4 (0.2)	0.0 - 0.9	0.3 (0.2)	0.0 - 0.8	0.5 (0.2)	0.0 - 0.9
Interactive Non-Routine	0.2 (0.2)	0 - 0.6	0.2 (0.2)	0 - 0.6	0.2 (0.2)	0 - 0.6
Cognitive Routine	0.3 (0.2)	0 - 0.8	0.3 (0.2)	0 - 0.8	0.2 (0.2)	0 - 0.8
Manual Non-Routine	0.1 (0.2)	0 - 0.8	0.2 (0.2)	0 - 0.8	0.0 (0.1)	0 - 0.7
Manual Routine	0.0 (0.1)	0 - 0.8	0.0 (0.1)	0 - 0.8	0.0 (0.1)	0 - 0.6
Controls and Mechanisms						
Age Child	6.3 (1.9)	3 - 9.5	6.3 (1.9)	3 - 9.5	6.3 (1.9)	3 - 9.4
Maternal Age at First Birth	33.0 (4.5)	17.2 - 50.3	32.1 (4.7)	17.2 - 47.3	33.9 (4.0)	22.2 - 50.3
Log. Household Income	3.8 (0.5)	-4.6 - 8.2	3.7 (0.4)	-4.6 - 8.2	3.9 (0.4)	-4.6 - 6.8
Parent-Child Activities	0.0 (0.6)	-2.9 - 1.8	-0.0 (0.6)	-2.9 - 1.8	0.0 (0.4)	-2.9 - 1.6
Language of Interaction in Household (ref.: Mostly German)						
Mostly Foreign	10.0%		13.7%		6.1%	
Cohabitation Partner (ref.: Living Alone)						
Living with Partner	90.6%		88.0%		93.4%	
Child Gender (ref.: Male)						
Female	49.6%		47.8%		51.5%	
Older Siblings in Household (ref.: No)						
Yes	49.7%		52.4%		46.8%	
Maternal Education (wave-specific)*						
Compulsory	3.7%					
Intermediate	21.2%					
Maturity	26.2%					
Tertiary	48.9%					
Occupational Classification (1-digit)			*		*	
Agriculture, Forestry, Animal Care, Horticulture	*					
Mining, Manufacturing, and Production	4.7%					
Construction, Architecture, Surveying, Building Technology	*					
Natural Sciences, Geography, and IT	2.7%					
Transport, Logistics, Protection and Security	4.2%					

Commercial Services, Sales, Trade, and Tourism	7.8%
Business Organisation, Accounting, Law, and Administration	32.1%
Health, Social Services, Teaching, and Education	40.1%
Humanities, Culture, and Design	6.0%

Source: NEPS-SC1-ADIAB 2012-2021; N~9,808 person-years, n~2,109 mother-child dyads. n_{tertiary}~972 and n_{non-tertiary}~1,172 mother-child dyads. * Results cannot be displayed due to strict data security regulations and small sizes for subgroups.

Table A-IV.2: Sample Reduction

	Individuals dropped	Total individuals remaining (n)	Total person-years remaining (N)
Gross Sample		3,481	15,148
Biological Mothers' Non-Participation Wave 1	-63	3,418	14,777
No Consent to Data Linkage or Linkage not successful and no Survey Information on Employment	-374	3,044	13,768
Data Linkage of Men	<20	/	13,664
Missing on Independent Variable	-1,060	2,280	11,036
Missing on Dependent Variables in at All Measurements	-929	2,135	9,889
Missing on Controls	-32	2,109	9,808
Analysis Sample			
Math		1,942	4,097
Science		1,754	3,942
Vocabulary		1,890	5,000
Socio-Emotional Competence		1,980	4,654

Note: Numbers below 20 cannot be presented due to data protection regulations by the Institute of Employment Research. Dropped individuals may remain in the sample if not all observations are missing, e.g., independent variables vary over time and are only fully excluded if none valid value is available.

Source: NEPS-SC1-ADIAB 2012-2021.

Table A-IV.3: Operationalization of Variables

Name	NEPS Wave	Description	Measurement
Outcomes			
Mathematical Literacy	Wave 5, 7, 9 (man5_sc1, man7_sc1, man9_sc1) (Robustness Version: 7523 v1: man5_sc1u, man7_sc1u, man9_sc1u)	Test items are embedded in typical, real-life situations and aim to measure the child's ability to use their mathematical skills to meet daily-life challenges. Various aspects of mathematical skills are covered, e.g., dealing with quantities, space and shape, data and relationships, which require application of different cognitive component, such as arguing, modelling and problem solving.	Weighted Likelihood Estimators (WLE) provided by NEPS, positive value indicating above average math ability and vice versa.
Science	Wave 6, 8, 10 (scn6_sc1, scn8_sc1, scn10_sc1) (Robustness Version: 7523 v1: scn6_sc1u, scn8_sc1u, scn10_sc1u)	Scientific literacy is conceptualized as a one-dimensional construct comprising two subdimensions, i.e., knowledge <i>of</i> science and knowledge <i>about</i> science. The former is specified as the knowledge of basic scientific concepts and facts with the content-related components matter, system, development and interaction. The latter can be regarded as the understanding of scientific processes, with the components scientific enquiry and scientific reasoning. Both are implemented in three contexts: health, environment, technology (NEPS, 2019).	Weighted Likelihood Estimators (WLE) provided by NEPS, positive value indicating above average science ability and vice versa.
Receptive Vocabulary	Wave 4, 6, 8, 10 (von4_sc3, von6_sc3, von8_sc3, von10_sc3)	In the Peabody Picture Vocabulary Test (PPVT-IV), the child has to select one presented picture out of four that matches to the auditory presented word. Tasks are grouped in 12 levels with staggered difficulty. Each correct answer results in one point with a maximum of 228 points possible (NEPS, 2022).	Absolute Scores are mean-standardized; Positive values indicate above average abilities and vice versa.
Socio-Emotional Competence	Items problem behaviour & hyperactivity: Wave 6, 7, 9; (p67801l, p67801m, p67801o, p67801q, p67801s) (p67801k, p67801n, p67801p, p67801r, p67801t)	Items problem behaviour: • Quick-tempered • Obedient • Often fights with others • Tells lies • Steals Hyperactivity: • Restless • Fidgety • Unfocused • Thinks before acting • Good concentration span	1: not applicable 2: partially applicable 3 clearly applicable → Compound index is mean-standardized (mean = 0; standard deviation = 1) with higher values indicating better behaviour

	Items peer problems & prosocial behaviour: Wave 6, 8, 10 (p67801c, p67801e, p67801f, p67801h, p67801j)	Items peer problems: • Being a loner • Has friends • Being popular • Gets teased • Gets along better with adults than with children	
	(p67801a, p67801b, p67801d, p67801g, p67801i)	Prosocial Behaviour: • Considerate • Likes to share things • Ready to help • Kind to younger children • Helps others voluntarily	
Predictors			
Analytic Non-Routine	BERUFENET	Analytical non-routine tasks [e.g. management, planning, planning and supervision]	<i>Numerical</i> (0-1)
Interactive Non-Routine	BERUFENET	Interactive non-routine tasks [e.g. commerce, counselling, service]	<i>Numerical</i> (0-1)
Cognitive Routine	BERUFENET	Cognitive routine tasks [e.g. technology, metrics, administration]	<i>Numerical</i> (0-1)
Manual Non-Routine	BERUFENET	Manual non-routine tasks [e.g. dancing, refurbishing, service]	<i>Numerical</i> (0-1)
Manual Routine	BERUFENET	Manual routine tasks [e.g. cultivation, farming, construction]	<i>Numerical</i> (0-1)
Controls			
Older Siblings in Household	All Waves (p73221y, p73221m; p73222y_w1 - p73222y_w11)	Birth Date of Sibling from Spell Data and Survey Questions to check whether birthdate was before or after focal child.	0 = no 1 = yes (<i>time-constant</i>)
Language of interaction in Household	All Waves (p412000)	What language do you speak at home? 1 only German 2 mostly German, but sometimes also another language 3 mostly another language, but sometimes also German 4 only another language	1, 2=0 mostly German 3, 4=1 mostly foreign (<i>time-constant</i>)
Gender Child	All Waves (p700010)		0 male 1 female
Age Child	All Waves (p70012y, p70012m)	Child birthdate (year and month) subtracted from the interview date of survey.	<i>Numerical</i>
Cohabitation with Partner	All Waves (p731111)	Do you currently live with a permanent partner? (yes/no)	0 Living alone 1 Living with partner (<i>time-varying</i>)
Maternal Age at Birth	Wave 1 (p73170y, p73170m)	Subtracting year and month of mothers' birthdate from the birthdate of the given child.	<i>Numerical</i>
Maternal Education	All Waves (p731802_g2, p731852_g2)	What is your highest general school-leaving qualification? [1a] No qualification [1b] School leaving qualification from a Hauptschule without vocational qualification	1a, 1b, 1c = 1 Compulsory 2b, 2a = 2 Intermediate 2c gen, 2c voc = 3 Maturity 3a, 3b = 4 Tertiary

		[1c] School-leaving qualification from a Hauptschule with vocational qualification [2b] Mittlere Reife (intermediate school-leaving qualification) without vocational qualification [2a] Mittlere Reife (intermediate school-leaving qualification) with vocational qualification [2c_gen] higher education entrance qualification without vocational qualification [2c_voc] higher education entrance qualification with vocational qualification [3a] degree from a university of applied sciences [3b] university degree	<i>(time-varying)</i>
Maternal 1-digit Occupational Classification	IEB	1 Agriculture, Forestry, Animal Care, Horticulture 2 Mining, Manufacturing, and Production 3 Construction, Architecture, Surveying, Building Technology 4 Natural Sciences, Geography, and IT 5 Transport, Logistics, Protection and Security 6 Commercial Services, Sales, Trade, and Tourism 7 Business Organisation, Accounting, Law, and Administration 8 Health, Social Services, Teaching, and Education 9 Humanities, Culture, and Design 10 Other	Note: No “0 Military” exists in data as this occupation is not integrated in regular social security, which is available in our data <i>(time-varying)</i>
Mediators			
Parent-Child Activities	Wave 3-10 (p281321 p281322 p281323 p281324 p281325 p281327; p281362 p281363 p281364 p281365 p281366_v1 p281367; p281372; p281812 p281815; p281371 p281373 p281374)	Survey Questions: • Read out • Dealing with letters • Dealing with numbers • Learning poems, rhymes and songs by heart • Painting, drawing, crafting • Book store visit	Scale 1 “daily” -8 “never”: 1: Several times a day 2: Once a day 3: Several times a week 4: Once a week 5: Several times a month 6: Once a month 7: Less frequently 8: Never → z-standardized score. Missings in Wave 3 were imputed with information from wave 4 or 5. <i>(time-varying)</i>
Log. Household Income	Wave 3 (p510005, p510006, p510007, p510008, p510009)	What is the monthly household income of all household members today? Please indicate the net amount, i.e. after deduction of taxes and social security contributions. Please include regular payments such as pensions, housing allowance, parental and child benefits,	For categorical answers, for each measurement the categorical income span was replaced with the mean values of open-ended answers.

		BAföG, alimony payments, unemployment benefits, etc.!	For example, for individuals categorized in the lowest income-group of less than 1,000 €, the mean was computed with answers from p510000 (open-ended), i.e., in this case 900 €, and inserted for all individuals in this income-group. This was done for each wave and each income-group. → Metrical variable, logarithmized to model a decreasing marginal benefit.
Further Variables			
Maternal 3-digit Occupational Classification	IEB	Merging variable for occupational trajectories of maternal occupation-specific tasks. <i>See for example Paulus & Matthes (2013): The German Classification of Occupations 2010 – Structure, Coding and Conversion Table. FDZ-Methodenreport 08/2013.</i>	<i>categorical</i>
Mothers Tertiary Education	All Waves (p731802_g2, p731852_g2)	Highest observed maternal education as dummy.	1a, 1b, 1c, 2b, 2a, 2c_gen, 2c_voc = 0 No Tertiary Education 3a, 3b = 1 Tertiary Education (time-constant)
Maternal Working Hours	NEPS all Waves (p731901, p731951, p731902, p731901)	Weekly working hours. Inactive individuals were coded with 0 working hours	<i>Numerical</i>
Tenure	IEB (beruf)	Counts months in a certain occupational group.	<i>Numerical</i>
Duration in Childcare	NEPS All Waves (pa0112m, pa0112y, pa0113m, pa0113y)	Start and end of childcare attendance.	<i>Numerical</i>
Child Health	NEPS All Waves (p524420, p524400, p524431, p524432, p524433, p524434, p524436, p524437, p524438)	Diagnosed health problems, such as hearing, vision, motor or behavioural disorders, ADHD, autism, other. Variable turns 1 if any single or multiple conditions apply.	0 = No condition 1 = Health condition

Table A-IV.4: Full Models of Task Composition and Child Math and Science

	Math					Science		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Task Composition (ref.: Cognitive Routine)								
Analytic Non-Routine	0.643*** (0.13)	0.073 (0.18)	0.046 (0.18)	0.033 (0.18)	0.763*** (0.12)	0.129 (0.17)	0.119 (0.16)	0.118 (0.16)
Interactive Non-Routine	0.118 (0.14)	-0.083 (0.22)	-0.098 (0.21)	-0.106 (0.22)	0.16 (0.13)	-0.173 (0.20)	-0.179 (0.20)	-0.189 (0.20)
Manual Non-Routine	-0.185 (0.14)	-0.249 (0.20)	-0.264 (0.20)	-0.237 (0.20)	-0.186 (0.13)	-0.278 (0.20)	-0.282 (0.20)	-0.252 (0.20)
Manual Routine	-0.292 (0.33)	-0.682+ (0.38)	-0.739+ (0.38)	-0.713+ (0.38)	-0.44 (0.33)	-0.745+ (0.41)	-0.756+ (0.40)	-0.723+ (0.41)
Child Age		-0.000 (0.01)	-0.000 (0.01)	-0.006 (0.01)		0.016* (0.01)	0.016* (0.01)	0.009 (0.01)
Gender Child Female		-0.089* (0.04)	-0.103* (0.04)	-0.104* (0.04)		-0.02 (0.04)	-0.024 (0.04)	-0.025 (0.04)
Older Siblings in Household		-0.023 (0.05)	-0.01 (0.05)	-0.019 (0.05)		-0.041 (0.04)	-0.035 (0.04)	-0.047 (0.04)
Cohabitation with Partner		0.079 (0.08)	0.067 (0.08)	-0.015 (0.08)		0.005 (0.06)	-0.001 (0.06)	-0.1 (0.07)
Maternal Age at Birth		0.002 (0.01)	0.001 (0.01)	0.000 (0.01)		0.003 (0.01)	0.003 (0.01)	0.001 (0.01)
Maternal Education (ref.: Compulsory)								
Intermediate Level		0.08 (0.12)	0.076 (0.12)	0.067 (0.12)		0.018 (0.11)	0.017 (0.11)	0.003 (0.11)
Maturity Level		0.281* (0.12)	0.271* (0.12)	0.252* (0.12)		0.246* (0.11)	0.242* (0.11)	0.214+ (0.11)
Tertiary Education		0.472*** (0.12)	0.464*** (0.12)	0.430*** (0.12)		0.450*** (0.11)	0.447*** (0.11)	0.398*** (0.11)
Non-German Language of Interaction (ref.: mostly German)		-0.336*** (0.07)	-0.335*** (0.07)	-0.325*** (0.07)		-0.391*** (0.06)	-0.389*** (0.06)	-0.377*** (0.06)

1-digit Occupational Classification (ref.: 1 Agriculture, Forestry, Animal Care, Horticulture)									
2 Mining, Manufacturing, and Production	-0.27 (0.26)	-0.256 (0.26)	-0.255 (0.26)			-0.067 (0.23)	-0.064 (0.23)	-0.069 (0.23)	
3 Construction, Architecture, Surveying, Building Technology	-0.424 (0.30)	-0.424 (0.30)	-0.41 (0.30)			-0.107 (0.23)	-0.105 (0.23)	-0.097 (0.24)	
4 Natural Sciences, Geography, and IT	-0.215 (0.28)	-0.195 (0.28)	-0.211 (0.28)			0.08 (0.26)	0.084 (0.27)	0.063 (0.27)	
5 Transport, Logistics, Protection and Security	-0.304 (0.26)	-0.299 (0.26)	-0.306 (0.26)			-0.083 (0.22)	-0.081 (0.23)	-0.09 (0.23)	
6 Commercial Services, Sales, Trade, and Tourism	-0.475+ (0.27)	-0.476+ (0.27)	-0.465+ (0.26)			-0.16 (0.23)	-0.159 (0.23)	-0.144 (0.23)	
7 Business Organisation, Accounting, Law, and Administration	-0.398 (0.26)	-0.396 (0.26)	-0.397 (0.26)			-0.168 (0.23)	-0.166 (0.23)	-0.173 (0.23)	
8 Health, Social Services, Teaching, and Education	-0.331 (0.25)	-0.332 (0.25)	-0.327 (0.25)			-0.052 (0.21)	-0.052 (0.21)	-0.05 (0.22)	
9 Humanities, Culture, and Design	-0.248 (0.26)	-0.237 (0.26)	-0.229 (0.26)			0.136 (0.22)	0.141 (0.22)	0.146 (0.23)	
Parent-Child Activities		0.090** (0.03)	0.089** (0.03)				0.035 (0.03)	0.035 (0.03)	
Log. Household Income			0.125** (0.05)					0.160** (0.05)	
Constant	-0.223** (0.08)	0.051 (0.36)	0.094 (0.36)	-0.2 (0.38)	-0.249** (0.08)	-0.267 (0.34)	-0.251 (0.34)	-0.639+ (0.36)	
R2 Adj.	0.02	0.05	0.05	0.05	0.04	0.09	0.09	0.09	
Observations	4089	4089	4089	4089	3935	3935	3935	3935	
Individuals	1939	1939	1939	1939	1749	1749	1749	1749	

Note: 95%-CI; individual-clustered standard errors.

Source: NEPS-SC1-ADIAB 2012-2021

+ p < .1, * p < .05, ** p < .01, *** p < .001

Table A-IV.5: Full Models of Task Composition and Child Vocabulary and Socio-Emotional Competence

		Vocabulary				Socio-Emotional		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Task Composition (ref.: Cognitive Routine)								
Analytic Non-Routine	0.840*** (0.11)	0.443** (0.15)	0.435** (0.15)	0.434** (0.15)	0.111* (0.05)	0.061 (0.07)	0.044 (0.07)	0.044 (0.07)
Interactive Non-Routine	0.274* (0.12)	0.161 (0.17)	0.155 (0.17)	0.152 (0.17)	0.019 (0.05)	0.016 (0.08)	0.006 (0.08)	0.003 (0.08)
Manual Non-Routine	-0.075 (0.12)	0.083 (0.18)	0.078 (0.18)	0.089 (0.18)	-0.066 (0.06)	-0.039 (0.08)	-0.046 (0.08)	-0.03 (0.08)
Manual Routine	-0.199 (0.35)	-0.064 (0.43)	-0.073 (0.43)	-0.062 (0.43)	-0.333* (0.15)	-0.264+ (0.15)	-0.289* (0.15)	-0.271+ (0.15)
Child Age		0.008+ (0.01)	0.008+ (0.01)	0.006 (0.01)		-0.002 (0.00)	-0.001 (0.00)	-0.004 (0.00)
Gender Child Female		-0.131*** (0.04)	-0.135*** (0.04)	-0.136*** (0.04)		0.154*** (0.02)	0.146*** (0.02)	0.146*** (0.02)
Older Siblings in Household		-0.108** (0.04)	-0.103** (0.04)	-0.106** (0.04)		0.078*** (0.02)	0.087*** (0.02)	0.082*** (0.02)
Cohabitation with Partner		0.056 (0.06)	0.05 (0.06)	0.016 (0.06)		0.072** (0.03)	0.061* (0.03)	0.02 (0.03)
Maternal Age at Birth		0.017*** (0.00)	0.017*** (0.00)	0.016*** (0.00)		0.001 (0.00)	0.001 (0.00)	0.001 (0.00)
Maternal Education (ref.: Compulsory)								
Intermediate Level		-0.075 (0.10)	-0.076 (0.10)	-0.08 (0.10)		0.105* (0.05)	0.102* (0.05)	0.093* (0.05)
Maturity Level		0.049 (0.10)	0.046 (0.10)	0.037 (0.10)		0.196*** (0.05)	0.188*** (0.05)	0.173*** (0.05)
Tertiary Education		0.208* (0.10)	0.206* (0.10)	0.190+ (0.10)		0.192*** (0.05)	0.186*** (0.05)	0.162** (0.05)
Non-German Language of Interaction (ref.: mostly German)		-0.802*** (0.06)	-0.799*** (0.06)	-0.795*** (0.06)		-0.106*** (0.03)	-0.104*** (0.03)	-0.099*** (0.03)

1-digit Occupational Classification (ref.: 1 Agriculture, Forestry, Animal Care, Horticulture)								
2 Mining, Manufacturing, and Production	-0.334 (0.27)	-0.333 (0.27)	-0.334 (0.27)			-0.280** (0.09)	-0.279** (0.09)	-0.278** (0.09)
3 Construction, Architecture, Surveying, Building Technology	-0.197 (0.28)	-0.195 (0.29)	-0.192 (0.29)			-0.299** (0.10)	-0.297** (0.10)	-0.289** (0.10)
4 Natural Sciences, Geography, and IT	-0.281 (0.29)	-0.277 (0.29)	-0.284 (0.29)			-0.420*** (0.10)	-0.414*** (0.10)	-0.418*** (0.10)
5 Transport, Logistics, Protection and Security	-0.331 (0.27)	-0.329 (0.27)	-0.331 (0.27)			-0.219** (0.08)	-0.217* (0.09)	-0.217* (0.09)
6 Commercial Services, Sales, Trade, and Tourism	-0.327 (0.27)	-0.326 (0.27)	-0.321 (0.27)			-0.249** (0.09)	-0.249** (0.09)	-0.240** (0.09)
7 Business Organisation, Accounting, Law, and Administration	-0.246 (0.27)	-0.245 (0.27)	-0.247 (0.27)			-0.260** (0.09)	-0.259** (0.09)	-0.258** (0.09)
8 Health, Social Services, Teaching, and Education	-0.267 (0.26)	-0.267 (0.26)	-0.266 (0.26)			-0.271*** (0.08)	-0.276** (0.08)	-0.271** (0.08)
9 Humanities, Culture, and Design	-0.134 (0.27)	-0.13 (0.27)	-0.127 (0.27)			-0.283** (0.09)	-0.278** (0.09)	-0.273** (0.09)
Parent-Child Activities		0.031 (0.02)	0.031 (0.02)				0.066*** (0.01)	0.065*** (0.01)
Log. Household Income			0.054 (0.05)					0.067** (0.02)
Constant	-0.320*** (0.07)	-0.463 (0.34)	-0.448 (0.34)	-0.575 (0.36)	-0.011 (0.03)	-0.1 (0.14)	-0.066 (0.14)	-0.23 (0.15)
R2 Adj.	0.04	0.13	0.13	0.13	0.01	0.08	0.09	0.09
Observations	4992	4992	4992	4992	4642	4642	4642	4642
Individuals	1885	1885	1885	1885	1975	1975	1975	1975

Note: 95%-CI; individual-clustered standard errors.

Source: NEPS-SC1-ADIAB 2012-2021

+ p < .1, * p < .05, ** p < .01, *** p < .001

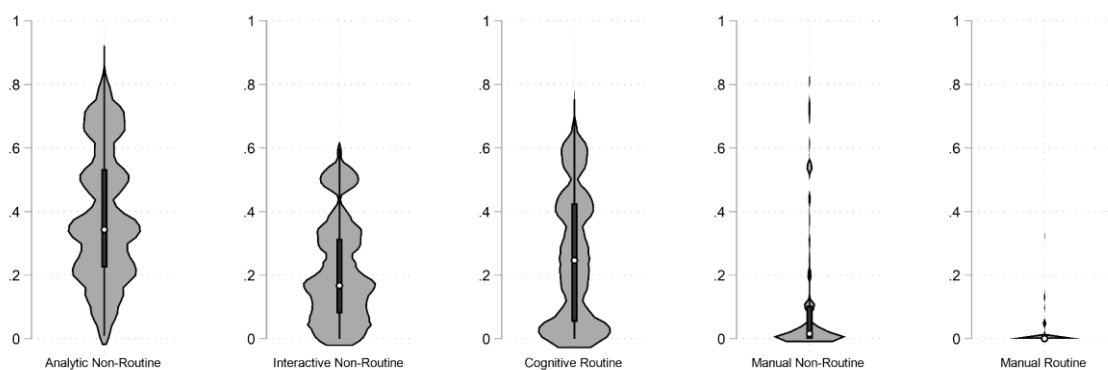


Figure A-IV.1: Overview Task Distribution in Sample

Note: Centered black rectangles represent boxplots with white circles indicate medians. Exterior black lines represent density of the skill. For further details on violinplot see Hintze & Nelson (1998). Reading Example: 50% percent of mothers in the sample work in an occupation that composites for about 37% or lower of analytical non-routine tasks, 25% of mothers with 22%.

The violinplot demonstrate that all task types are available in our sample, although we rarely observe mothers with larger shares of manual routine tasks.

Source: NEPS-SC1-ADIAB 2012-2021, $N \sim 9,808$ person-years, $n \sim 2,109$ mother-child dyads.

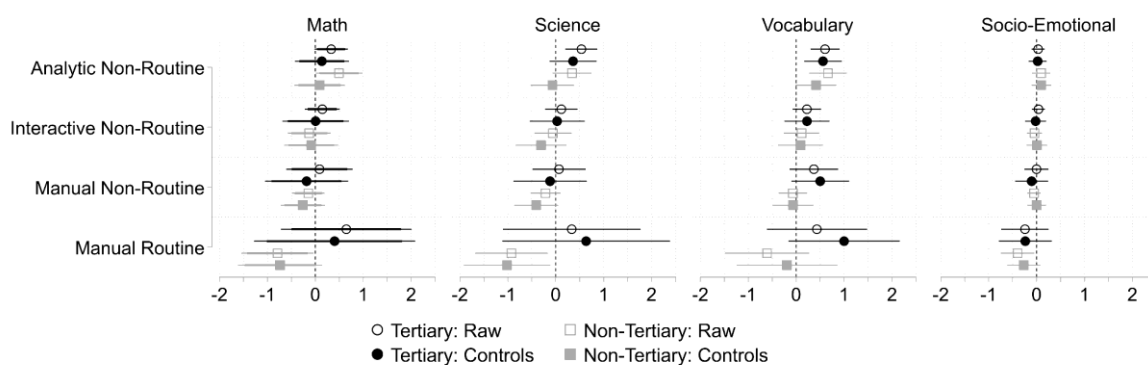


Figure A-IV.2: Effect Heterogeneity Education: Raw and Controlled Models

Note: Results from joint (pooled) OLS models of tertiary education sample split with 95% CIs (thin line) and 90% CIs (thick line). Controls: Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, $N \sim 9,808$ person-years, $n_{\text{tertiary}} \sim 972$ and $n_{\text{non-tertiary}} \sim 1,172$ mother-child dyads.

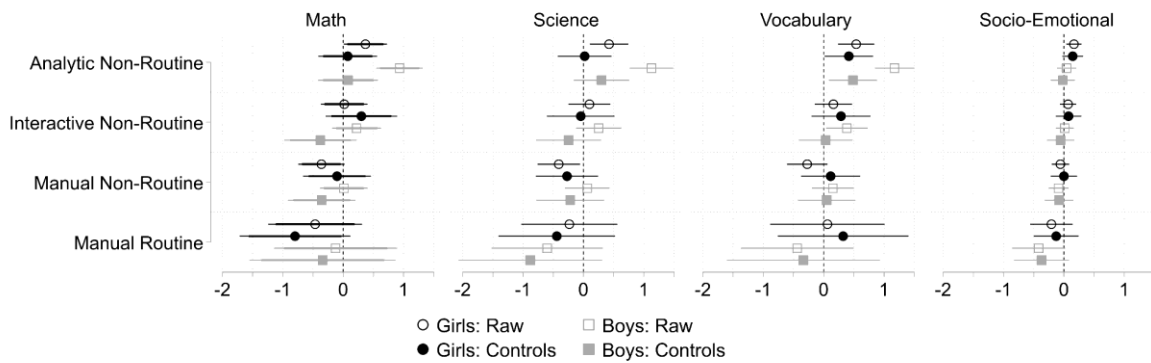


Figure A-IV.3: Effect Heterogeneity Gender: Raw and Controlled Models

Note: Results from joint (pooled) OLS models of gender sample split with 95% CIs (thin line) and 90% CIs (thick line).

Controls: Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, $N \sim 9,808$ person-years, $n_{\text{male}} \sim 1,068$ and $n_{\text{female}} \sim 1,041$ mother-child dyads.

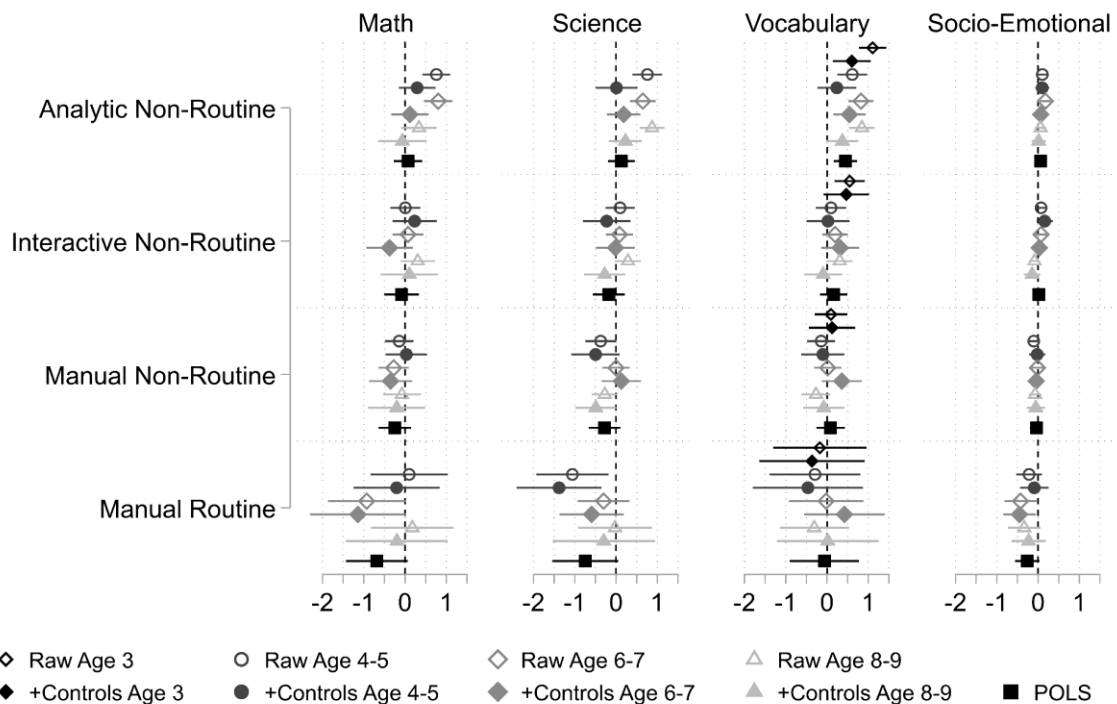


Figure A-IV.4: Effect Heterogeneity Age: Task Composition and Age-Specific Child Development

Note: Results from age-specific OLS models on maternal job task composition and child development. POLS model fully controlled.

Controls: Maternal education, maternal age at birth of focal child, non-German family language, older siblings in household, cohabitation with partner, child age, child gender, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, $N \sim 9,808$ person-years, $n \sim 2,109$ mother-child dyads, own estimates; 95%-CI; robust SEs.

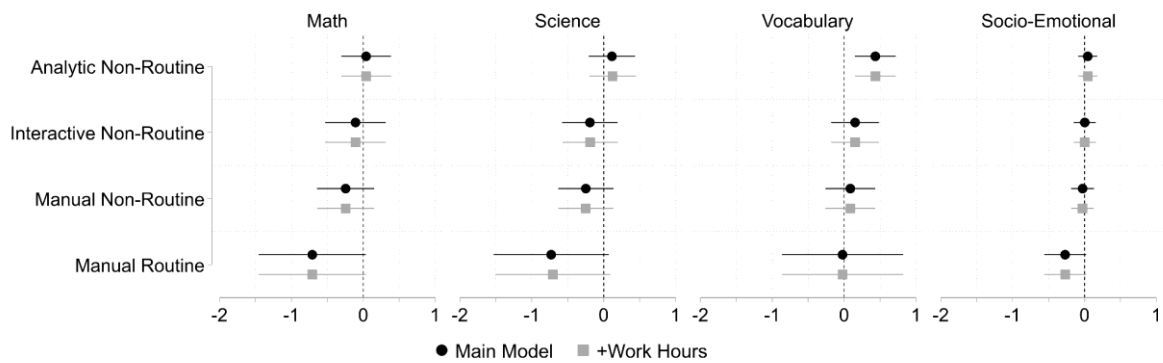


Figure A-IV.5: Robustness Check: Task Composition and Mechanism Maternal Working Hours

Note: Results from joint (pooled) OLS models with 95% CIs. Controls: Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, child gender, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, $N \sim 9,808$ person-years, $n \sim 2,109$ mother-child dyads.

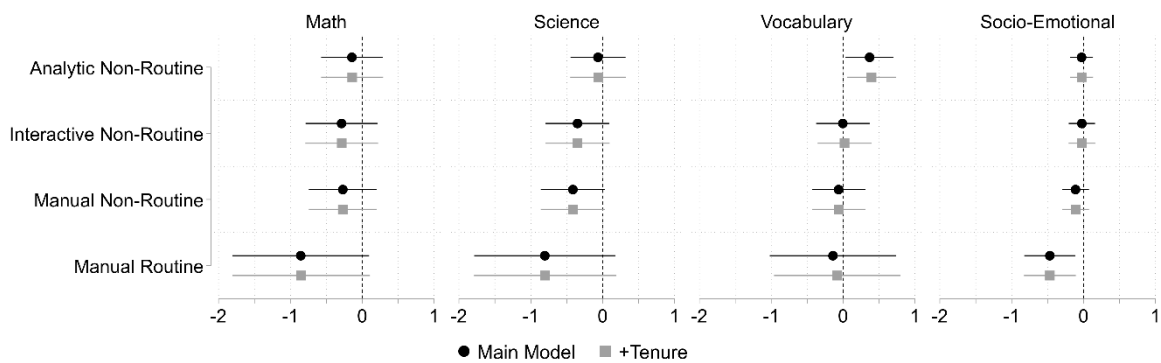


Figure A-IV.6: Robustness Check: Task Composition and Mechanism Tenure in Occupation

Note: Results from joint (pooled) OLS models with 95% CIs. Controls: Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, child gender, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, $N \sim 9,808$ person-years, $n \sim 2,109$ mother-child dyads.

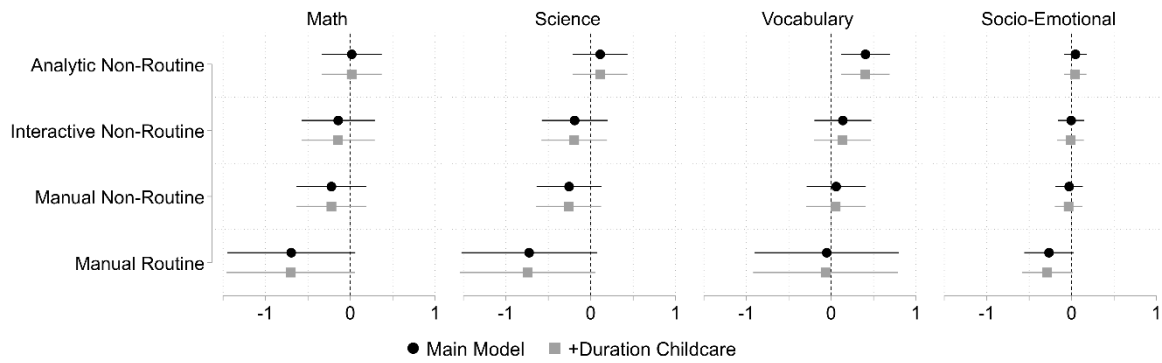


Figure A-IV.7: Robustness Check: Task Composition and Mechanism Duration in Childcare

Note: Results from joint (pooled) OLS models with 95% CIs. Controls: Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, child gender, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, N~9,808 person-years, n~2,109 mother-child dyads.

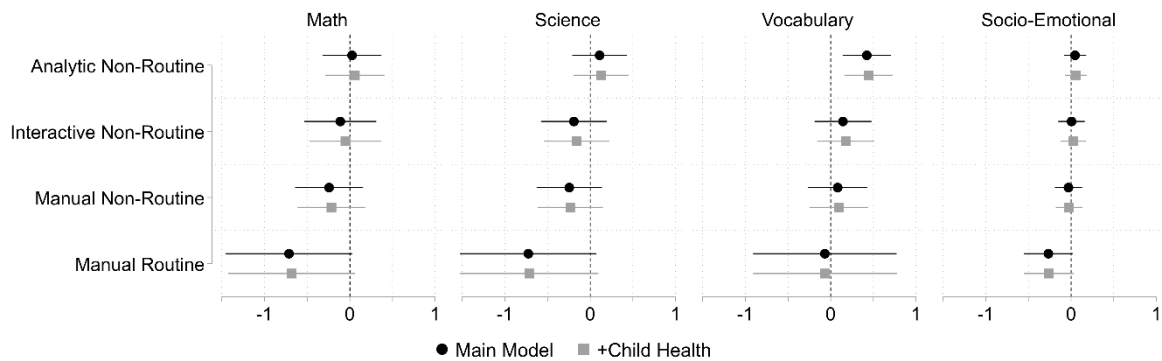


Figure A-IV.8: Robustness Check: Task Composition and Mechanism Child Health

Note: Results from joint (pooled) OLS models with 95% CIs. Controls: Maternal education, maternal age at birth of focal child, non-German family language; older siblings in household; cohabitation with partner, child age, child gender, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, N~9,808 person-years, n~2,109 mother-child dyads.

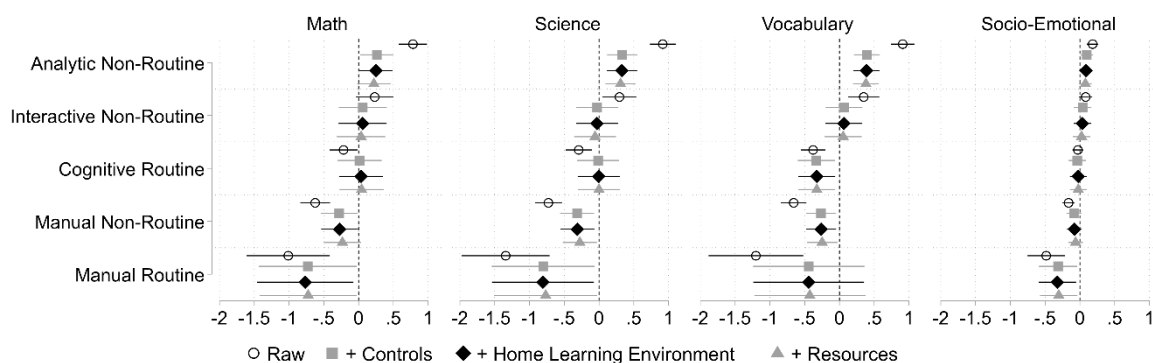


Figure A-IV.9: Robustness Check: Single Task Composition and Child Development

Note: Results from single OLS models on maternal job task composition and child development.

This Coefplot shows coefficients from single regression for each of the five tasks, contrasting models from main specification that include four out of five tasks in one joint regression. This alternative, separate specification allows for more flexibility, as an increase in the specific task, e.g., analytical non-routine, is associated with a decrease in any of the other four tasks (interactive non-routine, cognitive routine, manual non-routine and/or manual routine) without further specification. In the main specification, an increase in one task is only associated with a decrease in the omitted cognitive routine task while holding interactive non-routine, manual non-routine and manual routine constant at zero.

Raw results show somewhat larger coefficients that are more often statistically significant, demonstrating that controlling for other occupational task shares already accounts for some selection effects. After including controls and mechanisms, conclusions remain identical to our preferred, more conservative specification.

Controls: Maternal education, maternal age at birth of focal child, non-German family language, older siblings in household, cohabitation with partner, child age, child gender, KldB2010 1-digit.

Source: NEPS-SC1-ADIAB 2012-2021, N~9,808 person-years, n~2,109 mother-child dyads, own estimates; 95-% CI; individual-clustered SEs.

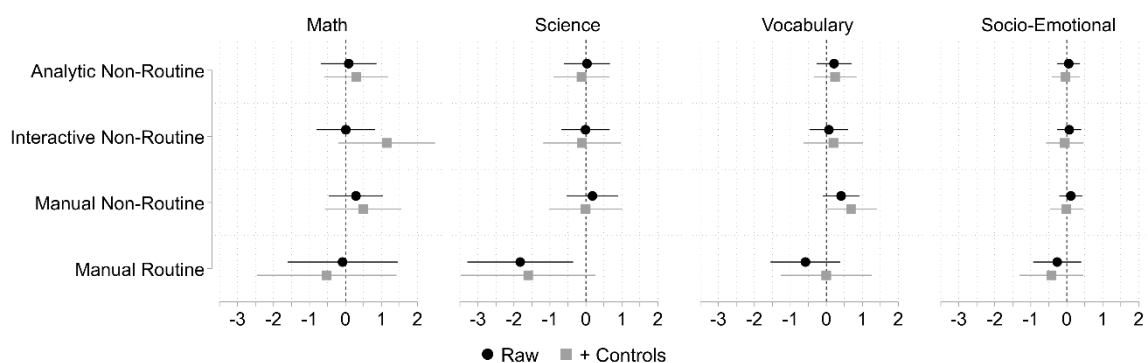


Figure A-IV.10: Robustness Check: Fixed-Effects Models of Changes in Task Composition and Child Development

Note: Results from joint (pooled) OLS models on maternal job task composition and child development. For math and science uncorrected WLEs were used to adjust for panel analysis.

Controls: cohabitation with partner, child age, KldB2010 1-digit. Note that we do not include maternal education due to low variability in educational status, therefore, treating education as a time-constant variable.

Source: NEPS-SC1-ADIAB 2012-2021 (Version: 7523 v1; doi: 10.5164/IAB.NEPS-SC1-ADIAB7523.de.en.v1), N~9,808 person-years, n~2,109 mother-child dyads, own estimates; 95-% CI; individual-clustered SEs.

Appendix Chapter V

Study 4 – Maternal Occupation-Specific Skills and Cognitive and Non-Cognitive Child Development in Germany

Tables

Table A-V.1: Sample Reduction	221
Table A-V.2: Operationalization of Variables	221
Table A-V.3: Sample Descriptives.....	223
Table A-V.4: Main Results: Full Models	224
Table A-V.5: Robustness Check: Overview of Variables of Duncan Reanalysis.....	226
Table A-V.6: Robustness Check: Sample Descriptives of Duncan Reanalysis.....	227
Table A-V.7: Robustness Check: Results of Duncan Reanalysis	228

Figures

Figure A-V.1: Robustness Check: Firstborns Only	229
Figure A-V.2: Robustness Check: Age-Specific Models – Math and Social-Emotional Behavior.....	230
Figure A-V.3: Robustness Check: Age-Specific Models – Vocabulary	231
Figure A-V.4: Robustness Check: Sample Split University-Entrance Certificate (Abitur)	233

Table A-V.1: Sample Reduction

	Individuals dropped	Total individuals remaining (n)	Total person-years remaining (N)
Gross Sample		3,481	23,939
Biological Mothers' Non- Participation Wave 1	-63	3,418	23,568
Missing on Independent Variable	0	3,418	23,568
Missing on Dependent Variables in at All Measurements			
Math	-1,191	2,290	5,454
Vocabulary	-1,331	2,150	6,543
Social-Emotional Behavior	-1,201	2,280	5,955
Analysis Sample	-1,130	2,387	12,972

Table A-V.2: Operationalization of Variables

Name	NEPS Wave	Description	Measurement
Outcomes			
Mathematical Literacy	Wave 5, 7 and 9 (man5_sc1, man7_sc1, man9_sc1)	Test items are embedded in typical, real-life situations and aim to measure the child's ability to use their mathematical skills to meet daily-life challenges. Various aspects of mathematical skills are covered, e.g., dealing with quantities, space and shape, data and relationships, which require application of different cognitive component, such as arguing, modelling and problem solving.	Weighted Likelihood Estimators (WLE) provided by NEPS, positive value indicating above average math ability and vice versa.
Receptive Vocabulary	Wave 4, 6, 8 and 10 (von4_sc3, von6_sc3, von8_sc3, von10_sc3)	In the Peabody Picture Vocabulary Test (PPVT-IV), the child has to select one presented picture out of four that matches to the auditory presented word. Tasks are grouped in 12 levels with staggered difficulty. Each correct answer results in one point with a maximum of 228 points possible (NEPS, 2022).	Absolute Scores are mean-standardized; Positive values indicate above average abilities and vice versa.
Social- Emotional Behavior	Items problem behavior & hyperactivity: Wave 6, 7 and 9; (p67801l, p67801m, p67801o, p67801q, p67801s) (p67801k, p67801n, p67801p, p67801r, p67801t)	Items problem behavior: • Quick-tempered • Obedient • Often fights with others • Tells lies • Steals Hyperactivity: • Restless • Fidgety • Unfocused	1: not applicable 2: partially applicable 3 clearly applicable → Compound index is mean-standardized (mean = 0; standard deviation = 1) with higher values indicating better behavior

	Items peer problems & prosocial behavior: Wave 6, 8 and 10 (p67801c, p67801e, p67801f, p67801h, p67801j)	• Thinks before acting • Good concentration span Items peer problems: • Being a loner • Has friends • Being popular • Gets teased • Gets along better with adults than with children	
	(p67801a, p67801b, p67801d, p67801g, p67801i)	Prosocial Behavior: • Considerate • Likes to share things • Ready to help • Kind to younger children • Helps others voluntarily	
Predictor			
Maternal Age at Birth	Wave 1 (p73170y, p73170m)	Subtracting year and month of mothers' birthdate from the birthdate of the given child.	<i>Numerical</i>
Controls			
Number of Siblings	Wave 1-3, 5-7, 9-10 (pb10000)	Maximum number of observed siblings (includes all biological and social siblings, also step/half/adoptive siblings, target child is not included)	<i>Numerical</i>
Firstborn	Wave 4, 8 (spell: p73221m, p73221y; p73222y_w1-20)	If biological sibling with earlier birthdate is reported in siblings-spell-data, the child is considered not to be firstborn, and to be the firstborn, if none of its siblings, if available at all, is born earlier. If information on kinship is missing, maternal-reported siblings are considered that plausibly can be the children of the reporting mother regarding age at birth.	0: Not firstborn, 1: firstborn
Birth Spacing (Parenting Experience)		Years between the oldest sibling's birthdate and the focal child. Firstborns without older siblings are assigned the value 0.	<i>Numerical</i>
Child Immigrant Origin	Wave 1 (p400500_g1v1)	Parents born in Germany or other country.	0: Native born in Germany 1: Born in foreign country
Paternal Age at Birth	Wave 1 (p73170y, p73175y)	Birth year focal child (2012) subtracted by birthyear of partner in household at time of birth.	<i>Numerical</i>
Age Child	Wave 1 (p70012y, p70012m)	Child birthdate (year and month) subtracted from the interview date of survey.	<i>Numerical</i>

Table A-V.3: Sample Descriptives

Variables	Mean / %	SD	Min - Max
Age at Birth	32.6	±4.6	16 - 50
Math	-0.0	±1.1	-4 - 4
Vocabulary	0.0	±1.0	-4 - 5
Social-Emotional Behavior	-0.0	±0.4	-3 - 1
Paternal Age at Birth	35.7	±5.6	20 - 62
Child Age	6.2	±1.9	3 - 10
Birth Spacing	2.5	±3.8	0 - 34
Parent-Child-Interaction Quality	0.0	±0.6	-3 - 1
Home Learning Environment	0.0	±0.5	-3 - 1
Mothers Mean Happiness	7.9	±1.4	0 - 10
Log. Net Household Income	8.2	±0.5	6 - 10
Mothers Work Experience	4.5	±4.6	0 - 24
Mothers Years of Education	15.2	±2.5	4 - 18
Maximum Number of Siblings: 0	12.6		
1-2	77.1		
3+	10.3		
Immigrant Origin: No immigrant origin	76.6		
Immigrant origin	23.4		
Mothers Self-Assessed Health: (Very) good	82.7		
Mediocre/(very) bad	17.3		
Alcohol During Pregnancy: No	92.4		
Yes	7.6		
Smoking During Pregnancy: No	93.6		
Yes	6.4		
Cohabitation Partner: Living alone	9.3		
Living with partner	90.7		
Mothers Job Niveau: Un-/semiskilled task	3.5		
Skilled task	39.8		
Complex task	15.1		
Highly complex task	38.7		
Mothers Tertiary Education: No tertiary education	56.1		
Tertiary education	43.9		

Note: Total sample: N=12,972 person-years, n=2,387 individuals

Source: NEPS-SC1 10.1

Table A-V.4: Main Results: Full Models

	Math		Vocabulary		Social-Emotional Behavior	
	(1)	(2)	(3)	(4)	(5)	(6)
	Raw	All Mediators	Raw	All Mediators	Raw	All Mediators
Age at Birth	0.187*** (0.05)	0.082* (0.05)	0.179*** (0.04)	0.084* (0.03)	0.061*** (0.02)	0.013 (0.02)
Age at Birth # Age at Birth	-0.002** (0.00)	-0.001 (0.00)	-0.002*** (0.00)	-0.001* (0.00)	-0.001** (0.00)	-0.000 (0.00)
Number of Siblings (ref: 0):	0.094	-0.001	0.029	-0.029	0.045+ (0.03)	0.006 (0.02)
1-2	(0.06)	(0.06)	(0.05)	(0.05)		
3+	-0.058 (0.09)	-0.131 (0.09)	-0.108 (0.07)	-0.154* (0.07)	0.055 (0.04)	0.027 (0.04)
Immigrant Origin (ref.: No immigrant Origin)	-0.292*** (0.05)	-0.146** (0.05)	-0.542*** (0.04)	-0.393*** (0.04)	-0.023 (0.02)	0.007 (0.02)
Child Age	0.002 (0.01)	-0.007 (0.01)	0.001 (0.00)	0.002 (0.00)	-0.001 (0.00)	-0.002 (0.00)
Birth Spacing	-0.037*** (0.01)	-0.017** (0.01)	-0.021*** (0.00)	-0.003 (0.00)	-0.003 (0.00)	0.005+ (0.00)
Birth Spacing: Dummy	-0.067 (0.17)	0.063 (0.17)	-0.112 (0.17)	0.005 (0.13)	-0.066 (0.06)	-0.009 (0.06)
Missings Imputed						
Paternal Age at Birth	0.001 (0.00)	-0.001 (0.00)	0.003 (0.00)	0.002 (0.00)	0.001 (0.00)	-0.000 (0.00)
Dad Age: Dummy Missings Imputed	-0.246* (0.10)	-0.051 (0.10)	-0.232** (0.07)	-0.075 (0.07)	-0.143*** (0.04)	-0.017 (0.04)
Parent-Child-Interaction Quality		0.218*** (0.04)		0.175*** (0.03)		0.060*** (0.01)
Parent-Child-Interaction Quality: Dummy Missings Imputed		-0.114+ (0.06)		-0.202*** (0.05)		-0.028 (0.02)
Home Learning Environment		0.208*** (0.04)		0.182*** (0.03)		0.087*** (0.02)
Mom Mean Happiness		-0.008 (0.01)		-0.020+ (0.01)		0.049*** (0.01)
Happiness: Dummy Missings Imputed		-0.330 (0.22)		-0.218 (0.26)		-0.182 (0.12)
Mothers Health (ref.: (Very) good):		-0.013 (0.06)		-0.085* (0.04)		-0.069** (0.02)
Mediocre/(very) bad		0.234 (0.23)		0.184 (0.27)		0.155 (0.13)
Missing						
Alcohol During Pregnancy (ref.: No):		0.167* (0.07)		0.046 (0.05)		-0.081** (0.03)
Yes						
Missing		0.287 (0.23)		-0.086 (0.41)		0.302*** (0.08)
Smoking During Pregnancy (ref.: No):		-0.042 (0.08)		-0.082 (0.07)		-0.120*** (0.04)
Yes		0.000 (.)		0.000 (.)		0.000 (.)
Missing						
Log. Net Household Income		0.206*** (0.05)		0.078+ (0.04)		0.032 (0.02)
Log Net Household Income: Dummy Missings Imputed		0.008 (0.14)		-0.057 (0.11)		0.026 (0.04)
Work Experience		0.000		0.003		-0.002

Appendix Chapter V

	(0.00)		(0.00)		(0.00)	
Level of Work (ref: Un-/semiskilled task):	0.023		-0.003		0.097 ⁺	
Skilled task	(0.12)		(0.09)		(0.05)	
Complex task	0.014		0.085		0.111 [*]	
	(0.13)		(0.10)		(0.05)	
Highly complex task	0.097		0.101		0.107 [*]	
	(0.13)		(0.09)		(0.05)	
No level	0.136		0.121		0.056	
	(0.14)		(0.11)		(0.07)	
Level of Work: Dummy	0.006		-0.063		0.003	
Missings Imputed	(0.07)		(0.05)		(0.03)	
Maternal Years of Education	0.049 ^{***}		0.038 ^{***}		0.012 ^{**}	
	(0.01)		(0.01)		(0.00)	
Cohabitation Partner (ref.: Living alone): Living with partner	-0.002		0.026		0.008	
	(0.07)		(0.05)		(0.03)	
Constant	-3.428 ^{***}	-3.714 ^{***}	-3.178 ^{***}	-2.489 ^{***}	-1.166 ^{***}	-1.191 ^{***}
	(0.77)	(0.81)	(0.56)	(0.60)	(0.29)	(0.33)
Adj. R2	0.050	0.102	0.086	0.132	0.021	0.109
Observations	5454	5454	6543	6543	5955	5955
Individuals	2290	2290	2150	2150	2280	2280

Source: NEPS-SC1 10.1; 95%-CI; individual-clustered standard errors.

+ p < .1, * p < .05, ** p < .01, *** p < .001

Table A-V.5: Robustness Check: Overview of Variables of Duncan Reanalysis

Our study	Duncan et al. (2018)
Controls & Predictors	
Maternal Age at Birth (– 16 years)	General Life Experience (Maternal Age – 16 years)
Birth Spacing	Years Between First and Given Child / Parenting Experience
Child Gender	Child Gender
Child Firstborn	Child Firstborn
Immigrant Origin	Mother Native Born
Total Number of Siblings	Number of Siblings Before Birth
	Mother's Cognitive AFQT Score
	Mother Ever Fight and Ever Steal
	Mother's Birth Cohort
	Childs Race (White/Black/Hispanic)
<i>Controlled by Sample Design</i>	Child's Birth Decade (1980s, 1990s, 2000s)
Age Focal Child	
Mediators	
Maternal Years of Education	Maternal Years of Education
Home Learning Environment	HOME (Early-Life Home Environment) Score at Age 2 or 3
Birthweight Child	Birthweight Child
Mother Smoking During Pregnancy	Prenatal Cigarette use per Day
Mother Drinking During Pregnancy	Prenatal Alcohol use per Month
Log. Family Income	Total Net Family Income at Age 2 or 3
Share of Mother Living with a Partner	Fraction of Years Between Birth and age 13 in Single-Parent Household
	Average Number of Siblings Between Birth and Age 13
	Fraction of 5 Years Before Birth in Single-Parent Household

Sources: Germany: NEPS-SC1 10.1; USA: NLSY79, CNLSY79, Duncan et al. 2018.

Table A-V.6: Robustness Check: Sample Descriptives of Duncan Reanalysis

Variables	Mean / %	SD	Min-Max
Math	-0.0	±1.1	-4 - 4
Vocabulary	0.0	±1.0	-4 - 5
Externalizing Behavior	0.0	±0.5	-1 - 3
General Life Experience / Maternal Age at Birth	14.1	±5.0	0 - 34
Birth Spacing	2.5	±3.8	0 - 26
Number of Siblings	0.7	±0.9	0 - 6
Child Age	6.2	±1.9	3 - 10
Years of Education	15.2	±2.5	4 - 18
Share of Years Cohabitation Partner	0.9	±0.2	0 - 1
Maximum Number of Siblings	1.4	±1.1	0 - 15
Log Net Household Income	8.2	±0.5	6 - 10
Home Learning Environment	0.0	±0.5	-3 - 1
Immigrant Origin: No immigrant origin	76.8		
Immigrant origin	23.2		
Gender Child Female: Male	50.0		
Female	50.0		
Child is Firstborn: Older sibling present	49.0		
Firstborn	51.0		
Birthweight: 3000g-<3500g	34.9		
<2000g	1.9		
2000g-<2500g	3.0		
2500g-<3000g	14.9		
3500g-<4000g	34.3		
4000g-<4500g	9.1		
4500g+	1.9		
Alcohol During Pregnancy: No	92.2		
Yes	7.8		
Smoking During Pregnancy: No	93.6		
Yes	6.4		

Note: Total sample: N=12,505 person-years, n=2,281 individuals

Source: NEPS-SC1 10.1

Table A-V.7: Robustness Check: Results of Duncan Reanalysis

	Germany (own estimates)		USA (Duncan et al. 2018)			
	POLS		OLS		Cousin FE	
Panel a) Math	M1	M2	M3	M4	M5	M6
Maternal Age at Birth	0.030*** (0.00)	0.007 (0.01)	0.039*** (0.01)	0.029*** (0.01)	0.028* (0.01)	0.021 (0.01)
Controls	✓	✓	✓	✓	✓	✓
Mechanisms		✓		✓		✓
Observations	5,245	5,245	5,380	5,380	1,762	1,762
Panel b) Vocabulary / Reading						
Maternal Age at Birth	0.026*** (0.00)	0.009* (0.00)	0.028*** (0.01)	0.020*** (0.01)	0.017 (0.01)	0.011 (0.01)
Controls	✓	✓	✓	✓	✓	✓
Mechanisms		✓		✓		✓
Observations	6,351	6,351	5,376	5,376	1,762	1,762
Panel c) Social-Emotional Behavior						
Maternal Age at Birth	-0.008*** (0.00)	0.000 (0.00)	-0.029*** (0.01)	-0.019** (0.01)	-0.021† (0.01)	-0.020 (0.01)
Controls	✓	✓	✓	✓	✓	✓
Mechanisms		✓		✓		✓
Observations	5,821	5,821	5,673	5,673	1,830	1,830

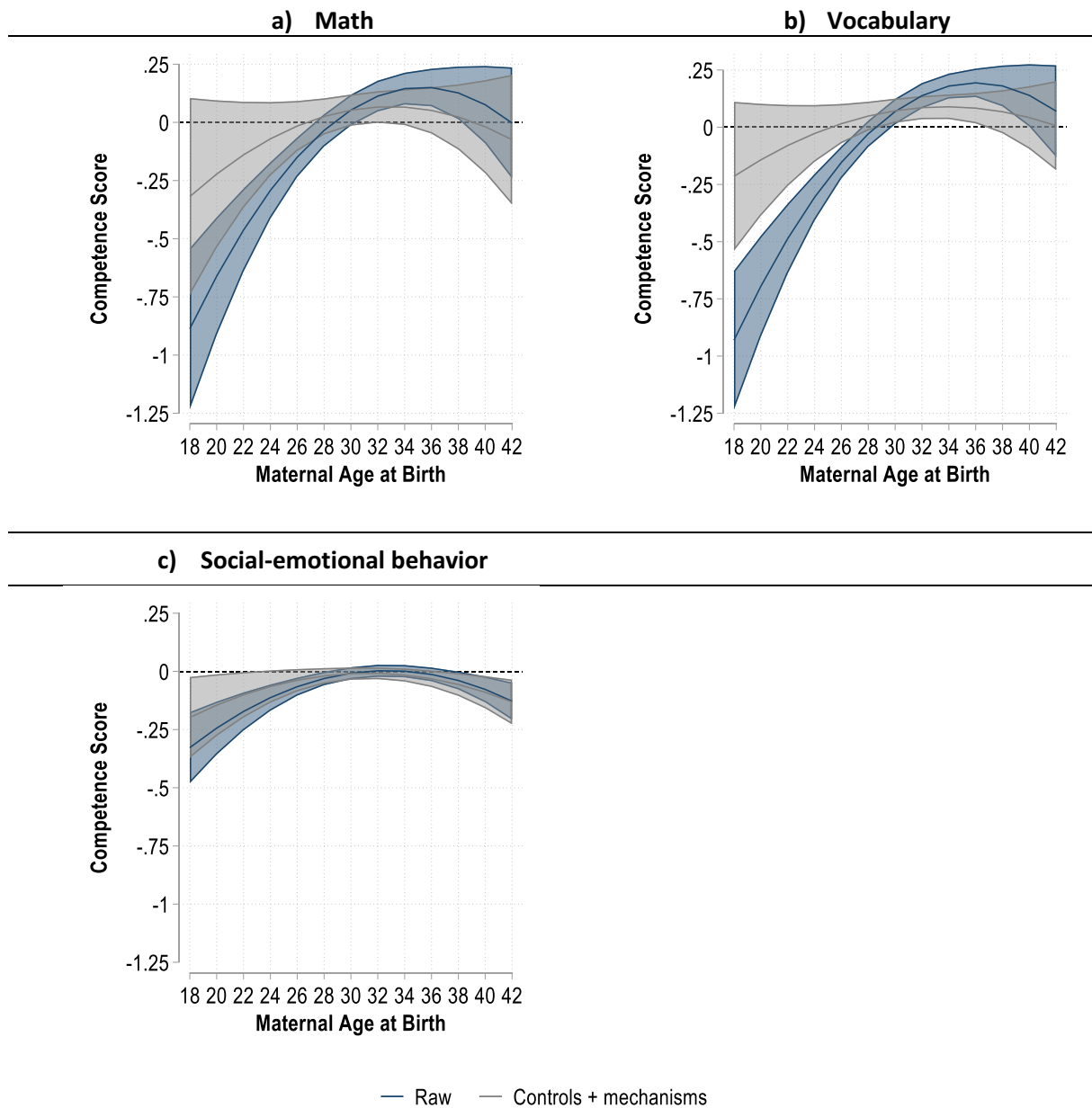
Results from POLS with ID-clustered standard errors and OLS with robust standard errors in parentheses. Maternal Age at Birth = Years from Age 16 until Birth.

Controls: All models include: Child Firstborn, Mother Native born (US) or Immigrant Origin (GE), Child Gender, Birth Spacing/Parenting Experience; US models additionally include: Child Birth Decade, Mother Birth Cohort, Mother Deviant Behavior, Mother's Cognitive Test Score; Child Race, Number of Siblings Before Birth; German models additionally includes: Age Focal Child; Total Number of Siblings.

Mediators: All models include: Maternal Years of Education, log. Family Income, Share of Mother Living with Partner, Mother Smoking and Drinking During Pregnancy, Birthweight Child, Home Learning Environment; US models additionally include: Average Number of Siblings Between Birth and Age 13, Fraction of 5 Years Before Birth in Single Parent Household.

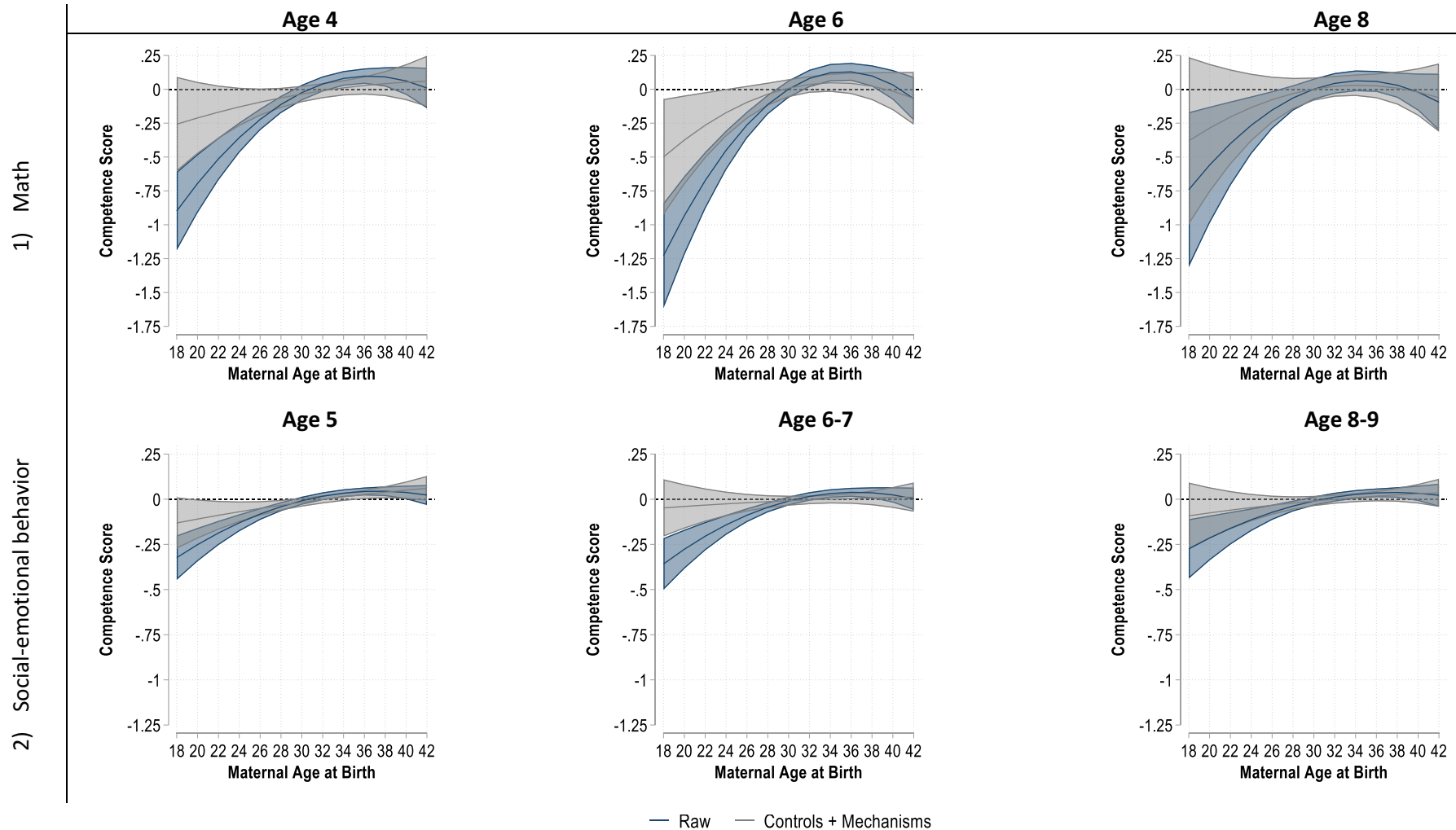
Sources: Germany: NEPS-SC1 10.1, Child age 3-9, own estimates; USA: NLSY79, CNLSY79, Child age 10-13, Duncan et al. 2018.

†p < .10, * p < .05, ** p < .01, *** p < .001



Note: Predicted probabilities / profile plot. Raw and fully controlled models of POLS regression.
Controls: number of siblings, birth spacing, immigrant origin, paternal age at birth, age of child;
Mechanisms: Parenting quality (parent-child-interaction-quality; home activities), maternal well-being (maternal happiness, maternal self-assessed health, smoking and drinking behavior during pregnancy), family resource (logarithmic household income, mother's years of education, maternal work experience, level of work requirements, cohabitation with partner).
Source: NEPS-SC1 10.1; Firstborns only (n=6,520); 95%-CI; individual-clustered standard errors.

Figure A-V.1: Robustness Check: Firstborns Only



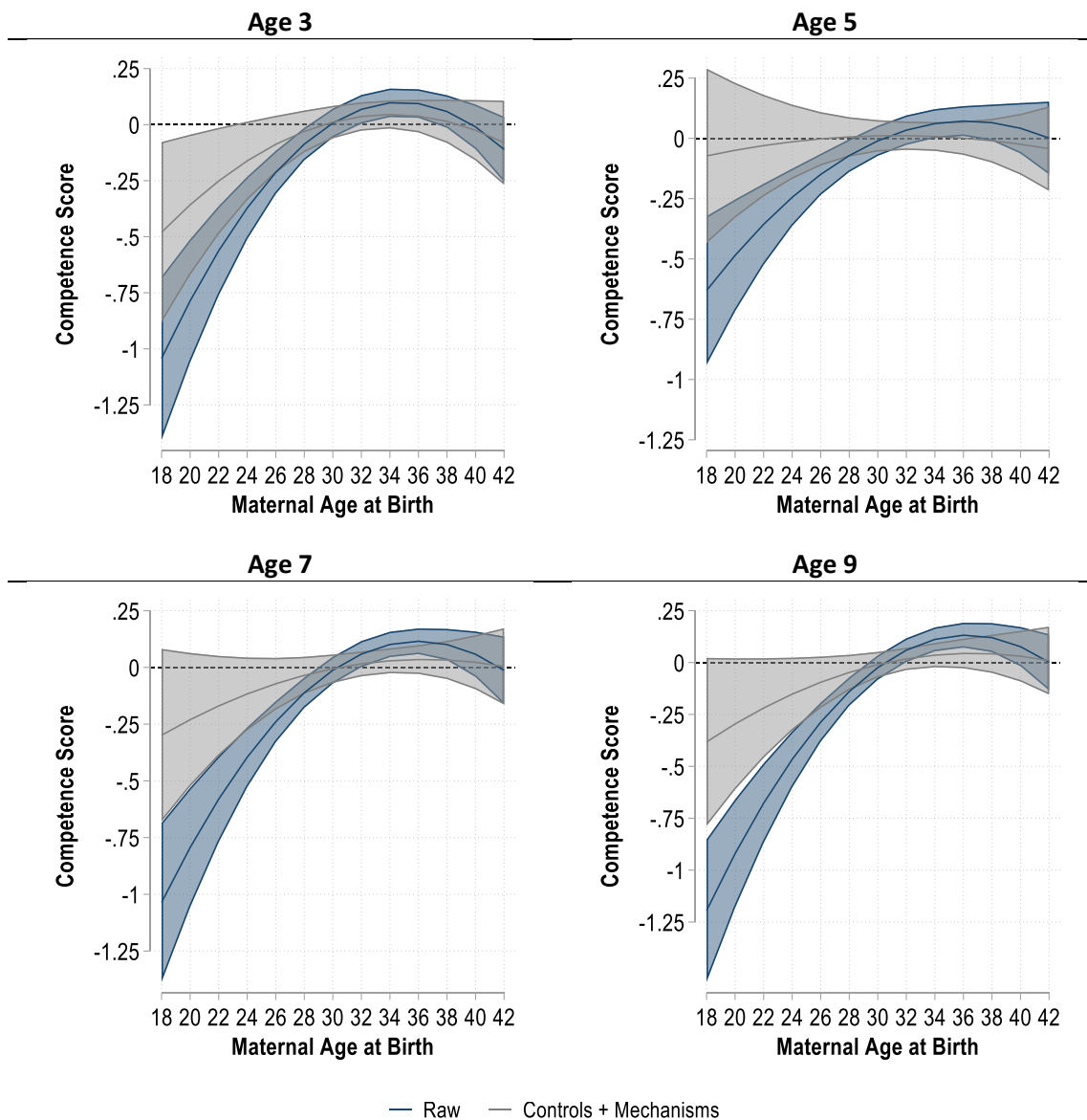
Note: Predicted probabilities / profile plot. Raw and fully controlled models of POLS regression.

Controls: number of siblings, birth spacing, immigrant origin, paternal age at birth, age of child;

Mechanisms: Parenting quality (parent-child-interaction-quality; home activities), maternal well-being (maternal happiness, maternal self-assessed health, smoking and drinking behavior during pregnancy), family resource (log household income, mother's years of education, maternal work experience, level of work requirements, cohabitation with partner).

Source: NEPS-SC1 10.1; Math: $n_4=1,985$, $n_6=1,940$, $n_8=1,529$; Social-emotional behavior: $n_5=2,067$, $n_7=2,019$, $n_9=1,869$; 95%-CI; robust standard errors.

Figure A-V.2: Robustness Check: Age-Specific Models – Math and Social-Emotional Behavior

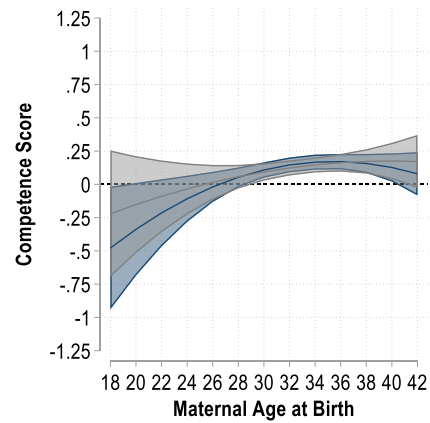
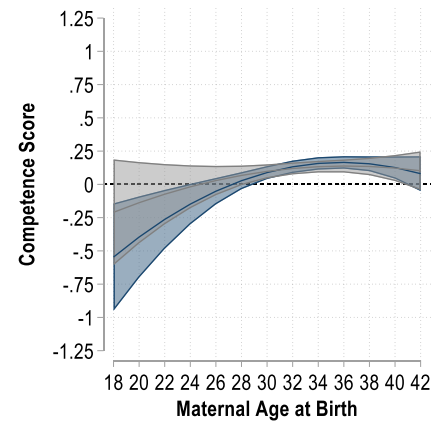
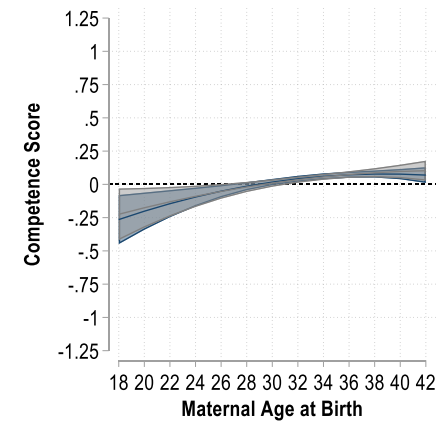


— Raw — Controls + Mechanisms

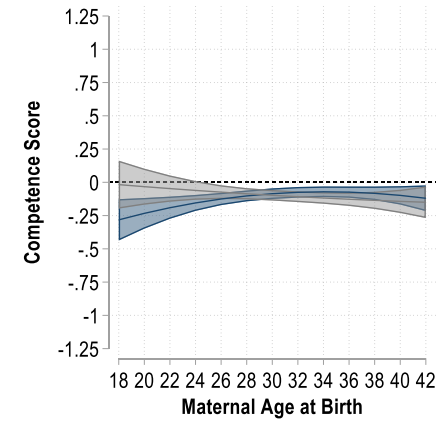
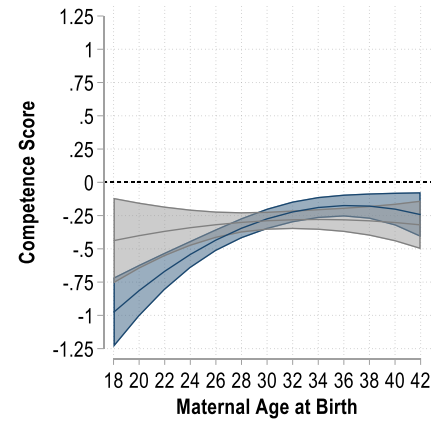
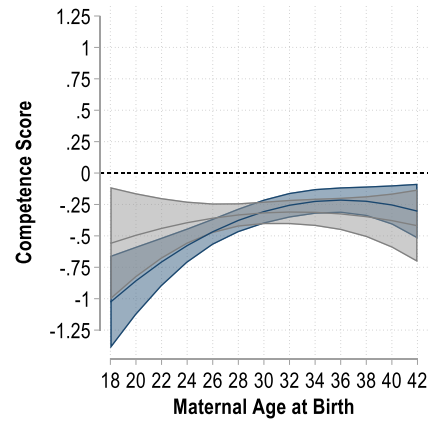
Note: Predicted probabilities / profile plot. Raw and fully controlled models of POLS regression.
Controls: number of siblings, birth spacing, immigrant origin, paternal age at birth, age of child;
Mechanisms: Parenting quality (parent-child-interaction-quality; home activities), maternal well-being (maternal happiness, maternal self-assessed health, smoking and drinking behavior during pregnancy), family resource (logarithmic household income, mother's years of education, maternal work experience, level of work requirements, cohabitation with partner).
Source: NEPS-SC1 10.1; $n_3=1,474$, $n_5=1,574$, $n_7=1,819$, $n_9=1,676$; 95%-CI; robust standard errors.

Figure A-V.3: Robustness Check: Age-Specific Models – Vocabulary

1) University-Entrance Certificate

a. Math**b. Vocabulary****c. Social-emotional behavior**

2) No University-Entrance Certificate



— Raw — Controls + mechanisms

Note: Profile Plot: mothers with university-entrance certificate ($N_{\text{Abi}}=9,399$; Panel 1); and for mothers without university-entrance certificate ($N_{\text{NoAbi}}=3,543$; Panel 2). Raw and fully controlled models of POLS regression. Panel 1 displays predicted probabilities only for ages where observations in sample exist, i.e., from age 22 onward.

Controls: number of siblings, birth spacing, immigrant origin, paternal age at birth, age of child;

Mechanisms: Parenting quality (parent-child-interaction-quality; home activities), maternal well-being (maternal happiness, self-assessed health, smoking and drinking behavior during pregnancy), family resource (log. household income, mother's years of education, maternal work experience, level of work requirements, cohabitation with partner).

Source: NEPS-SC1 10.1; $N=12,942$; 95%-CI; individual-clustered standard errors.

Figure A-V.4: Robustness Check: Sample Split University-Entrance Certificate (Abitur)

Appendix Chapter VI

Figures

Figure A-VI.2: Status Distribution Plot of Maternal Employment by Maternal Education 235

Figure A-VI.1: Status Distribution Plot of Childcare Arrangements by Maternal Education..... 235

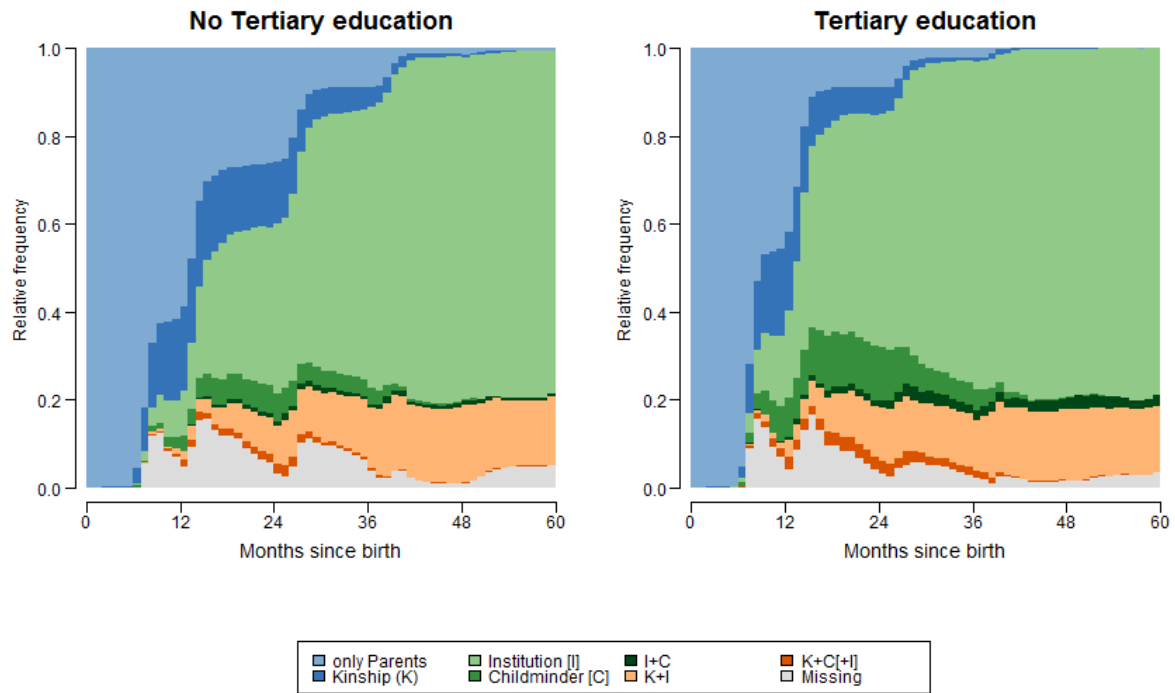


Figure A-VI.2: Status Distribution Plot of Childcare Arrangements by Maternal Education

Note: Each month displays the proportion of individuals in a given state.

Source: NEPS-SC1-ADIB7521, 2012-2017, own illustration.

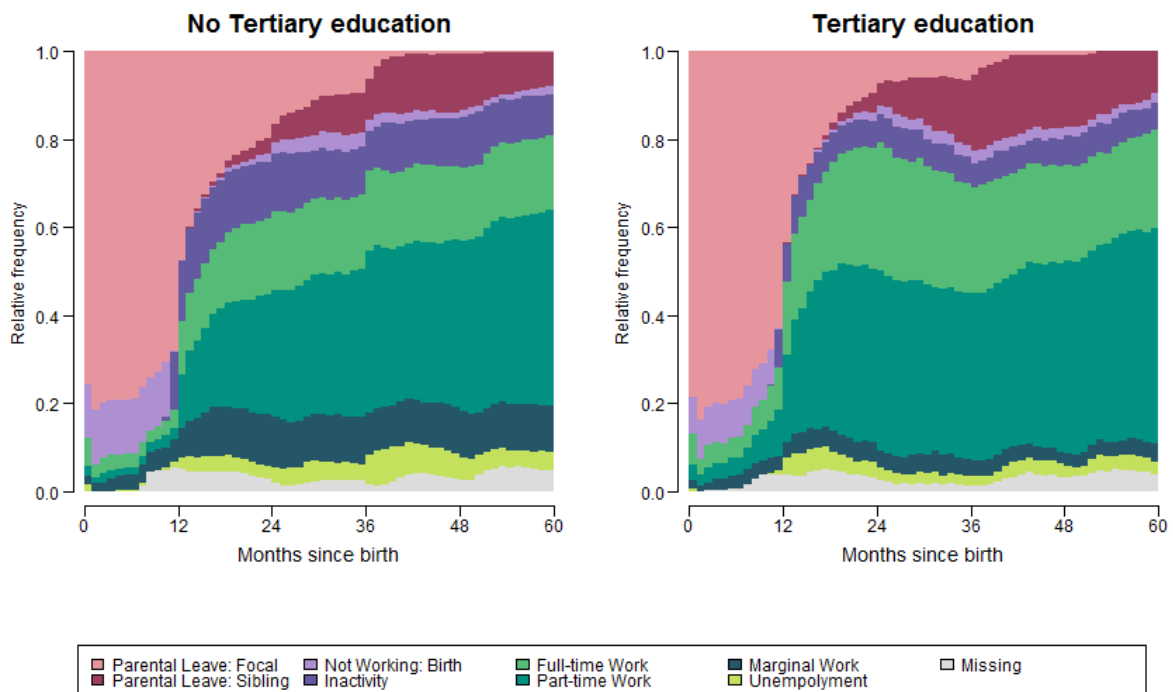


Figure A-VI.1: Status Distribution Plot of Maternal Employment by Maternal Education

Note: Each month displays the proportion of individuals in a given state.

Source: NEPS-SC1-ADIB7521, 2012-2017, own illustration.

